Grizzly Bears in the Greater Yellowstone Ecosystem

From Garbage, Controversy, and Decline to Recovery

Mark A. Haroldson, Charles C. Schwartz, and Kerry A. Gunther

NPS/AL NASH

IN THE 30 PLUS YEARS since dumps in Yellowstone were closed and loss of a large portion of the population precipitated listing under the Endangered Species Act, the grizzly bear has recovered in numbers and expanded its range in the Greater Yellowstone Ecosystem (GYE). Here we provide a brief account of the history and concerns for the future that have shaped its story.

Prior to European settlement of North America, grizzly bears could be found from northern Alaska south through Canada and the western United States and into northern Mexico (Rausch 1963). In the contiguous United States, habitat was altered or destroyed by farming, ranching, livestock grazing, logging, mining, and development of cities, towns, and homesteads. Important bear foods like salmon, elk, and bison were greatly reduced by dam building, market hunting, and competition with livestock. Primarily during the 1920s and 1930s (Servheen 1999), the grizzlies' historical range decreased nearly 98% (Mattson et al. 1995). Of the 37 grizzly bear populations known to exist in 1922, 31 were gone by 1975. In the West, grizzly bears were poisoned, shot, and trapped to reduce depredation on domestic cattle, sheep, and poultry. A stockman captured the prevailing attitude in the 1920s: "The destruction of these grizzlies is absolutely necessary before the stock business…could be maintained on a profitable basis" (Bailey 1931).

Yellowstone National Park (YNP) was established in 1872 to protect the area's geysers, thermal features, and scenic wonders. However, due to its remoteness and the protections afforded by national park status, it also became one of the last refuges for grizzlies in the lower 48 states (Craighead and Craighead 1967). Grizzly and black bears became one of the park's most popular attractions (Schullery 1992). By the 1880s park visitors enjoyed watching bears that gathered to feed at garbage dumped behind the hotels. As early as 1907, park staff were killing some black and grizzly bears because of conflicts with people (Craighead and Craighead 1967). By 1910, black bears

had learned to panhandle for food from tourists traveling in horse-pulled wagons (Schullery 1992). The first recorded bear-caused fatality occurred in 1916, when a grizzly bear killed a wagon teamster in a roadside camp (Schullery 1992).

When cars replaced horses and wagons, the number of park visitors and the amount of garbage they left behind increased. More garbage attracted more bears and park managers even encouraged bear viewing at some dumps by providing log bleachers and interpretive rangers (Schullery 1992). Unfortunately, this mix of people interacting with food-conditioned bears created problems. From 1931 through 1969, bears caused an annual average of 48 human injuries and 138 incidents of property damage (Gunther 1994). After a bear killed a woman in the Old Faithful Campground in 1942, Congress criticized park managers for failing to solve the bear problems (Schullery 1992).

In 1960, in response to public complaints of personal injury and property damage by black bears in many national parks, the National Park Service implemented a Bear Management Program and Guidelines (National Park Service 1960). This program included: (1) expanded visitor education about bear behavior, ways to reduce conflicts, and proper storage of food, garbage, and other attractants; (2) prompt and efficient garbage removal to make bears less dependent on garbage as a food source; (3) strict enforcement of regulations prohibiting bear feeding; (4) use of tip-proof garbage cans and development of better bear-proof garbage cans; and (5) removal of bears that were potentially dangerous, habitual beggars, or damaging property in search of human food. Although these guidelines reduced the availability of garbage, they did not eliminate it. Because bears were still attracted to roadsides and developments by human foods and garbage, the 1960s program did not significantly reduce human injuries or property damages.

A New Bear Management Program

In 1963, an Advisory Committee to the National Park Service issued a report titled "Wildlife Management in the National Parks" that recommended maintaining park biotic communities in as near a primitive state as practical (Leopold et al. 1963) and nearly complete removal of human influence on wildlife populations to allow natural processes to work. In 1968, YNP closed two of its dumps, one at West Thumb and one at Tower. The Leopold report, in combination with the fatal mauling of two women by grizzly bears in separate incidents in Glacier National Park, the frequency of bear-caused injuries and property damages in YNP, and new environmental regulations for open-pit garbage dumps, led to the implementation of a more intensive Bear Management Program in YNP in 1970. Its goals were to: (1) maintain populations of grizzly and black bears as part of the native fauna at levels that were naturally sustainable; (2) eliminate human food and garbage from the bears' diet; (3) reduce bear-inflicted human injuries and bear-caused property damage; and (4) reduce the number of bears removed from the park in management actions (Cole

Table 1. Comparison of demographic and reproductive data between the pre-dump (1959–1970) and post-dump (1983–2002) closure grizzly bear population in the Greater Yellowstone Ecosystem.

Reproductive and Demographic Parameters	Time Period: Pre-dump closure, 1959–1970	Time Period: Post-dump closure, 1983–2002
Age of first pregnancy	5.3 years[a]	5.8 years[b]
Inter-litter interval	3.29 years/litter[c]	3.16 years/litter[d]
Average litter size	2.10 cubs/litter[e]	2.04 cubs/litter[f]
Average number of females producing cubs annually	14 females/year[g]	25 females/year[h]
Average total number of cubs produced annually	31 cubs/year[i]	51 cubs/year[j]
Reproductive rate	0.61 cubs/year/female[k]	0.636 cubs/year/female[l]
Ecosystem population estimate	312[m]	571[n]
Population density	1 grizzly per 25 mi^2 [o]	1 grizzly per 23–35 mi^2 [p]
Area occupied	5 million acres[q]	8.5 million acres[r]

[a]Craighead et al. 1995:178
[b]Schwartz et al. 2006*b*:19
[c]Craighead et al. 1995:175
[d]Schwartz et al. 2006*b*:20
[e]Craighead et al. 1995:173
[f]Schwartz et al. 2006*b*:19
[g]Craighead et al. 1974:14
[h]Haroldson 2006:12
[i]Craighead et al. 1974:14
[j]Haroldson 2006:12
[k]Craighead et al. 1995:176
[l]Schwartz et al. 2006*b*:22
[m]Craighead et al. 1995:81
[n]Haroldson: in press
[o]Craighead et al. 1995:81
[p]Ruth et al. 2003:1152
[q]Craighead et al. 1995:81
[r]Schwartz et al. 2002:209

John and Frank Craighead – Pioneers in Grizzly Bear Research

IN 1959, brothers John and Frank Craighead and their dedicated team began their research of grizzly bears in the Yellowstone ecosystem. Their innovative approaches led to the development of methods to safely capture, immobilize, age, and mark grizzly bears. Nearly 50 years ago, they developed the first radio-transmitter collar and directional receiver used on wide-ranging animals and tracked two grizzlies to their winter dens. Today, radio telemetry is one of the most important tools used by wildlife biologists. It enabled the Craigheads and their graduate students at the University of Montana to learn about bear behavior and movements, and to document grizzly bear social structure, reproduction, survivorship, mortality, population dynamics, food habits, habitat use, and spatial requirements. They experimented with and eventually perfected the mapping of grizzly bear habitat using LANDSAT satellite imagery data. They studied grizzly bear intra-specific behavior in the large aggregations at the Trout Creek and Rabbit Creek garbage dumps. With the data that they collected, the Craighead brothers' team was able to calculate the age of first reproduction, inter-birth interval, average litter size, and reproductive rate for grizzly bears as well as how population age structure influenced population dynamics. This information would later enable biologists to make valuable demographic comparisons between the pre-dump closure (and pre-threatened species status) population and the population that was delisted in 2007 (Table 1).

In 1988, John and Frank received the National Geographic Centennial Award (along with Jane Goodall, Jacques Yves Cousteau, and Richard Leakey). In 2001, the brothers were presented with the U.S. Fish and Wildlife Service Great Bear Stewardship Award at the International Bear Biology Association meetings held in Jackson, Wyoming. They were also inducted into the Wyoming Outdoor Hall of Fame in 2006. Frank Craighead died October 21, 2001, in Jackson, Wyoming, at the age of 85. John is retired, in good health, and resides in Missoula, Montana.

CRAIGHEAD COLLECTION

John (left) and Frank Craighead, August 1966.

USGS/STEVE ARD

Ten of the 20 grizzly bears seen on a bison carcass *at the same time* on August 3, 2007, at Alum Creek in Hayden Valley.

1976). In addition to strict enforcement of regulations prohibiting the feeding of bears, the new program called for bear-proof garbage cans and dumpsters and the closure of all the park's garbage dumps (Cole 1976, Meagher and Phillips 1983).

Today most people would agree that the new Bear Management Program was a success. However, in 1970, the decision to close the park's last two garbage dumps was highly controversial and very unpopular. Park visitors expected to see and photograph panhandling black bears lining the roads and grizzly and black bears feeding at garbage dumps in and around park developments. Brothers John and Frank Craighead, pioneers of grizzly bear research, agreed that the dumps were inconsistent with National Park Service management philosophy, but believed they played a crucial role in reducing human-caused bear mortality. The highest proportion of grizzly bear mortality in the GYE occurred outside YNP (Craighead and Craighead 1967). Park dumps, especially the Trout Creek dump located in the center of bear range, attracted the largest concentration of bears, including many from outside the park (Craighead and Craighead 1967). When inside the park these bears were not exposed to hunting or killed due to depredations on livestock or conflicts with people and property on private land. The Craighead brothers recommended that the National Park Service leave the Trout Creek dump open indefinitely (Craighead and Craighead 1967). The Craigheads also recommended that if the dumps were to be closed, they be closed gradually over a period of 8–10 years or longer, and that the park provide elk and/or bison carcasses to the bears to ease their transition to a natural diet (Craighead and Craighead 1967, Craighead et al. 1995). They opposed a rapid phase-out of the dumps, especially the Trout Creek dump. They believed an immediate closure of all dumps would not allow bears adequate time to develop new feeding habits. They believed that rapid closure would increase conflicts, management removals, and mortality both inside and outside the park (Craighead and Craighead 1967, Craighead et al. 1995).

Today most people would agree that the new Bear Management Program was a success. However, in 1970, the decision to close the park's last two garbage dumps was highly controversial and very unpopular.

The National Park Service believed a gradual phasing out of dumps would result in several more generations of bears becoming dependent on human foods, leading to more bear–human conflicts over time (National Academy of Sciences 1974, Schullery 1992). Park managers wanted to shorten the adjustment period and reduce the time required for emergency measures to prevent injury to people and damage to property (National Academy of Sciences 1974). The current belief was that there were two populations of bears: garbage bears and "backcountry" bears. It was felt that backcountry bears would not be affected by dump closures. After obtaining the advice of the National Sciences Advisory Committee (Leopold et al. 1969), park authorities chose to close the park's remaining

two dumps quickly (Craighead et al. 1995) in 1970 and 1971 (Meagher and Phillips 1983). The state of Montana closed the three dumps in the park gateway communities of West Yellowstone, Gardiner, and Cooke City in 1970, 1978, and 1979, respectively (Meagher and Phillips 1983).

Within 12 years (1968–1979), all municipal dumps in the GYE that had aggregations of grizzly bears were closed and many bears that previously ate garbage dispersed in search of alternative foods (Craighead et al. 1995). Many of the bears that came into conflict with people at developed sites, campgrounds, private homes, and on cattle and sheep allotments were removed by the National Park Service and the state fish and game agencies from Wyoming, Montana, and Idaho, or were killed by private citizens (Craighead et al. 1988). At least 140 grizzly bear deaths were attributed to human causes during 1968–71 (Craighead et al. 1988). Bears that were trapped but not killed generally had their ear tags and/or radio collars removed. Due to the disagreement between the Craighead brothers and the park over the dump closures and restrictions placed on their research and publications that the brothers did not accept, their research permit in Yellowstone was not renewed after 1971 (Schullery 1992, Craighead et al. 1995).

As a consequence of the high grizzly bear mortality following the dump closures, the lack of current information about the population after the Craigheads' research ended, and increasing concerns about the future welfare of grizzly bears, Secretary of the Interior Rogers C. B. Morton established a Committee on the Yellowstone Grizzlies led by the National Academy of Sciences in February 1973. This committee was asked to "study and evaluate data on the population dynamics of the grizzly bears in Yellowstone National Park and to make recommendations concerning the scientific and technical implications of those data." Some key conclusions of the committee included: (1) the ecosystem supported one grizzly bear population and should be managed as such; (2) prior to dump closures the population was relatively stable, with a conservative estimate of 234 bears; (3) the population was reduced substantially during 1968–73; (4) it was necessary to mark an element of the population in order to estimate new biological parameters; (5) there was no convincing evidence that the population was in immediate danger of extinction; and (6) a conservative policy of removals should be pursued until better information on population parameters was available.

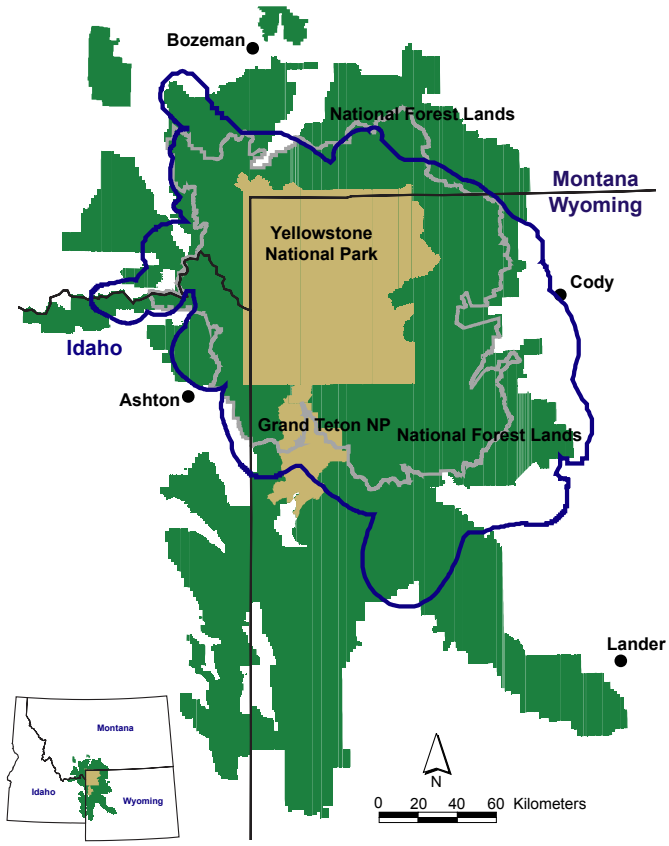


Figure 1. The current occupied range for grizzly bears in the Greater Yellowstone Ecosystem is shown in blue and encompasses approximately 37,000 km^2. The Primary Conservation Area (formerly the Yellowstone Grizzly Bear Recovery Zone) is shown in gray.

USGS/STEVE ARD

Female grizzly bear with cubs-of-the-year in tow, June 2006.

Creation of the Interagency Grizzly Bear Study Team

The need for better information after the Craigheads' study was motivation for the creation of the Interagency Grizzly Bear Study Team (IGBST) in 1973. The study team initially had representatives from the National Park Service, the Forest Service, and the U.S. Fish and Wildlife Service; representatives from the states of Wyoming, Montana, and Idaho were added later. Dr. Richard Knight was named the study team leader

Interagency Grizzly Bear Study Team Estimating Population Trend

When the Interagency Grizzly Bear Study Team was first created in 1973, its primary objective was to determine the status and trend of the grizzly bear population. At the time, methods for estimating population size for grizzly bears with reasonable confidence were extremely difficult and costly. Thus, the team concentrated their efforts on ways of determining population trend. Scientists estimate population change with some fairly complicated mathematical equations. A simple analogy may make this more understandable. We can think about the grizzly bear population in Yellowstone as a bank account. The population represents the amount of money in this account. Reproduction in the population is the same as interest paid on the principal.

NPS

Grizzly bear sow and three cubs.

New money added increases the size of the deposit and withdrawals reduce the account. Estimating population change is simply tracking new bears entering the population (reproduction) and bears leaving (mortality). The best expression of trend for a population is Lambda (λ) or "finite rate of change" (Caughley 1977). Estimates of λ tell us whether, on average, numbers of births and recruitments for a population are greater than deaths or vice versa. Thus, $\lambda > 1$ indicates an increasing population, $\lambda = 1$ stable, and $\lambda < 1$ a decreasing population. A population that remains stable (neither grows nor declines), has a trajectory of 1.0. This would be equivalent to a bank account where withdrawals equal the interest paid to the account. A declining population has a trajectory of less than 1.0. A population with an estimated trajectory of 0.9 is declining at 10% per year; we've withdrawn the interest paid to the account plus 10% of the principal. However, population change is much more sensitive to the loss of an adult female than the loss of a cub because adult females are currently producing cubs, whereas a cub must remain in the population for at least five years before it can produce offspring. If we put this into dollar terms, the loss of an adult female is equivalent to withdrawing 73¢, whereas the loss of a cub is only about 13¢, or the loss of one adult female has the same potential impact on the population as the loss of five cubs. It's like getting interest paid on the account each year or waiting five years before any is paid. Obviously, the account with annual interest grows faster. Biologists estimate reproductive and mortality rates from radio-collared animals and can determine population trajectory, just like you do when you check your bank account statements.

by Assistant Secretary of the Interior Nathaniel Reed. The primary objectives of the team were to determine the status and trend of the grizzly bear population, the use of habitats by bears, and the relationship of land management activities to the welfare of the bear population.

Due in part to uncertainty about the status of Yellowstone bears and declines in other grizzly bear populations, the U.S. Fish and Wildlife Service listed grizzly bears in the lower 48 states as a threatened species under the Endangered Species Act in 1975. Indeed, early research conducted by the study team indicated that bear numbers in the GYE likely declined through the late 1970s and into the mid-1980s (Knight and Eberhardt 1984, Knight and Eberhardt 1985, Knight and Eberhardt 1987). Much of this early work pointed to a decline in litter size following the dump closures and lower survival rates for female bears. At the time, reducing adult female mortality by one or two bears per year would likely have been enough to stabilize the population. Action was needed to reverse the trend, and in 1983 the Interagency Grizzly Bear Committee (IGBC) was formed to address mortality and other issues facing the grizzly population in Yellowstone and other populations in the conterminous states.

The IGBC was comprised of high-level administrators from most federal and state agencies with authority and responsibility for management of bears or their habitat. To improve bear survival, they initiated better garbage management in communities throughout the GYE, removal of sheep grazing on Forest Service lands within the Yellowstone Grizzly Bear Recovery Zone (Figure 1), backcountry food storage requirements in grizzly habitat, and a reward system for those turning in poachers.

Estimating Population Trend

Females with Cubs. For the first two years (1973–1974) after its formation, the IGBST was not permitted to

capture and/or mark bears in YNP (Knight et al. 1995). This early prohibition against marking individuals eventually led the study team to develop two methods for assessing population trend that the team continues to use today, only one of which requires marked bears. Dr. Knight and the study team observed that adult females with cubs were easy to see and that the number of cubs provided clues for distinguishing family groups. Summing the count of unique females over three successive years provided a conservative estimate of how many adult females were in the population. Counts were added over three years because, on average, adult female grizzlies produce a litter every three years (Craighead and Craighead 1967). Hence, this sum represented a reasonable estimate of adult females. Efforts were made to develop other methods, but Knight and Eberhardt (1984) considered this technique the best available index of grizzly abundance in the GYE.

To distinguish unique females from repeated sightings of the same female, the study team developed a rule set for observations (Knight et al. 1995). It was recognized that these rules were not perfect and if errors occurred, two different females were more likely called the same female as opposed to calling two sightings of the same female two different females. Thus, it was felt that employing the rule set returned conservative (or low) estimates for the number of females. This method was adopted as part of the Grizzly Bear Recovery Plan in 1993 (USFWS 1993). A running three-year average of females with cubs was used to establish a minimum population number and set allowable mortality limits (USFWS 1993). However, using counts of unique females with cubs was criticized by some scientists because (1) the rules to differentiate females had not been verified, (2) the technique did not account for variation in observer effort (number of people looking for females) or the sightability of bears in area and time (bears tend to be more easily seen in dry years), and (3) the estimate was a minimum count not an estimate of the total population (Craighead et al. 1995, Mattson 1997).

During the late 1990s, the study team and numerous collaborators began investigating methods to address these concerns. An evaluation of the rule set used to differentiate unique females with cubs confirmed that the method returned conservative (low) estimates and suggested that the negative bias increased as population size increased (Schwartz et al. 2008). Methods to estimate total numbers of females with cubs and account for variation in sightability of bears and observer efforts were also investigated (Boyce et al. 2001, Keating et al. 2002, Cherry et al. 2007). Employing the best of these methods, the estimated trend indicates an increase of about 5% per year during 1983–2007 (Figure 2; IGBST 2006, Harris et al. 2007). The requisite assumption for considering the trend in females with cubs as representative of the trend for the entire population is that the population's age distribution is relatively stable. This is a reasonable assumption considering demographic rates derived from monitoring radio-marked females in the GYE, which is the second and arguably more reliable method the study team employs to monitor population trend.

Estimating Vital Rates from Radio-marked Bears. The study team began capturing and radio-collaring grizzly bears in 1975. Early efforts were limited because of the time and expense required to capture, instrument, and monitor the bears. Aircraft were required to locate and monitor the status (i.e., alive or dead) of collared bears and to obtain observations of females for estimates of reproductive performance. The vital rates (i.e., survival and natality) derived from monitoring radioed bears through the early 1980s were not encouraging, and

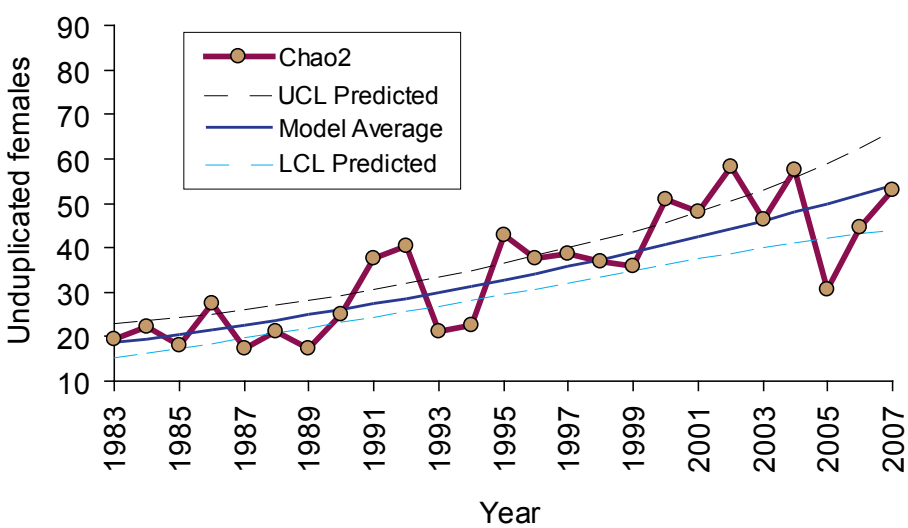
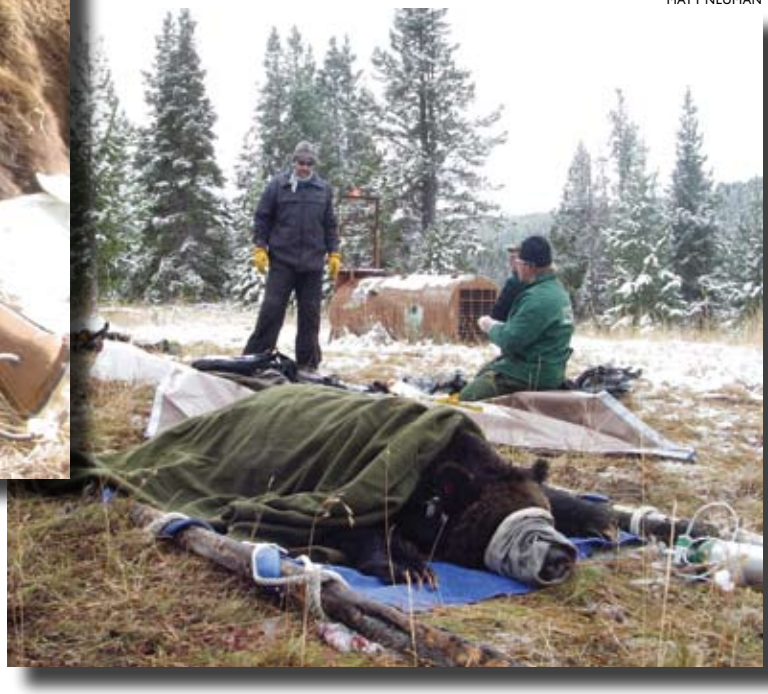


Figure 2. Model-averaged estimates (solid dark blue) for the number of unduplicated female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem for the period 1983–2007, where the linear and quadratic models of $Ln(\hat{N}_{Chao2})$ were fitted. The dashed lines represent a 95% confidence interval on the predicted population size. The linear model has about 75% of the model weights, with an estimated λ of 1.0453.

JOHN MURNANE

Left: Standards of care for drugging and handling grizzly bears have improved. Standard procedures now routinely require providing oxygen and IV fluids, and continuous monitoring of heart rate, oxygen saturation, and temperature. Shown here is Jeremiah Smith and adult male grizzly bear #450.

MATT NEUMAN



Right: Chad Dickinson (standing), Jeremiah Smith (kneeling foreground), Craig Whitmen (kneeling background) and adult female grizzly bear #541.

suggested that the population was still declining (Knight and Eberhardt 1984, Knight and Eberhardt 1985). They pointed to the need for an increase in female survivorship (Knight and Eberhardt 1987) and highlighted the need for unambiguous estimates of survivorship from which the population trend could be estimated. The study team concluded that the best way to obtain this information was to increase the number of female bears monitored.

In 1986 the study team began collaring bears specifically for the purpose of monitoring population trend. The initial target was to monitor 10 adult females that were well-distributed throughout the ecosystem. However, because of their larger home ranges, male bears were captured about four times as often as females, providing additional information on topics including habitat use, movements, and cause of mortality. But it is female bears that drive the demographic vigor of the population.

In the mid-1990s, the target was raised to 25 monitored females to allow more precise estimates and increase confidence in the results. By then, estimates of adult female survival and population trend suggested that the population had stabilized (Eberhardt et al. 1994, Eberhardt 1995) but disagreement persisted over whether the population was likely increasing. An analysis published in 1999 that used data for vital rates obtained from 1975 through 1995 suggested that the population had changed little to none during that period (Pease and Mattson 1999, see also Eberhardt and Cherry 2000). Subsequent work published by the study team and collaborators (Schwartz et al. 2006*a*,) clearly demonstrates that GYE grizzly bear numbers increased at an average annual rate of about 4–7% during 1983–2001. This increase is likely a result of increased female survival and is similar to trend estimates derived from counts of females with cubs. The agreement between these two methods that used independent approaches provides confidence that the increase in the population was real (Harris et al. 2007).

Current Status of Grizzly Bears in the Greater Yellowstone Ecosystem

Over the years, the study team has collected one of the longest running and largest datasets on any grizzly bear population in the world. That information has provided significant

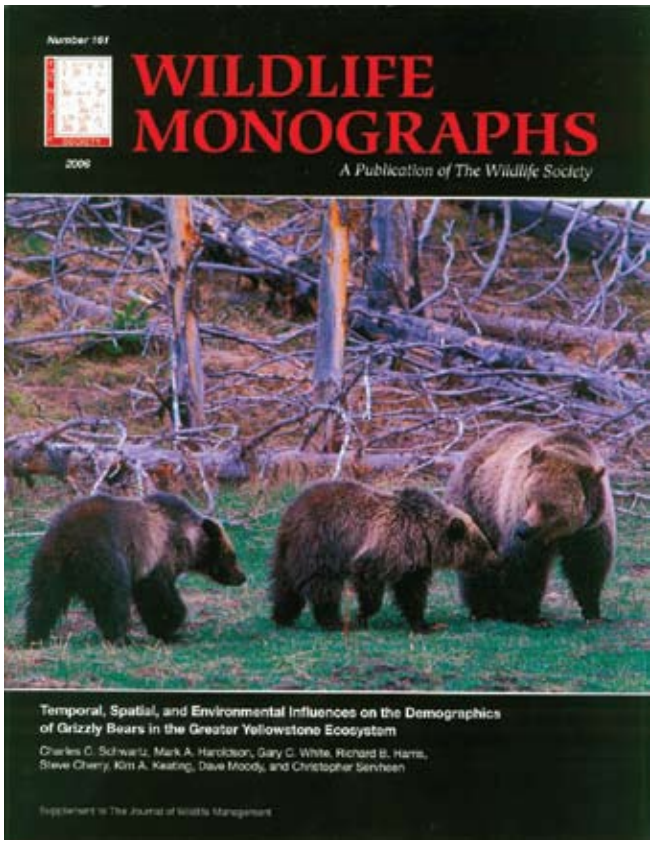
insight into the status and trend of the population, how grizzlies use the ecosystem, major food items, and human impacts on bears.

Additional analyses by the study team reveal that female survival is highest inside YNP and the surrounding Forest Service wilderness areas (Schwartz et al. in prep.), areas with a significant amount of secure habitat. As road density, the number of developed sites, and homes increase, bear survival declines. The study team has been able to establish a clear link between the health of the grizzly bear population and human activities on the landscape.

Another important finding is that bear distribution within the GYE has expanded during the last two decades as bears began to recolonize habitats outside YNP. Bears increased their range by 11% during the 1980s, and an additional 34% during the 1990s (Schwartz et al. 2002). Grizzly bears continue to expand their range and currently occupy more than 8.5 million acres (Schwartz et al. 2006*b*), significantly more than in the 1960s (Figure 1).

As the population of grizzly bears expanded in the ecosystem, bear density inside YNP also increased. Recent studies suggest that bears inside YNP are probably at carrying capacity, a term used to define the limits of available space, food, and other resources in the environment (Figure 3). As a population approaches this limit, juvenile mortality increases, females tend to initiate breeding later in life, and reproduction tends to decline (Eberhardt 2002). The study team has documented a decline in litter size as bear numbers increased, and a higher incidence of starvation and predation of cubs occurred inside YNP (Schwartz et al. 2006*c*).

The study team has also learned a great deal about how bears use the ecosystem. It is well documented that one of the first foods bears consume after emerging from their dens is winter-killed elk and bison. In years following severe winters, more carcasses are available (Podruzny and Gunther 2005) and cub survival tends to improve (Schwartz et al. 2006*c*). This is likely due to less competition for each carcass and a reduced likelihood that females with new cubs will encounter big male bears that may prey on their offspring. In years with few carcasses, cub survival tends to be reduced.



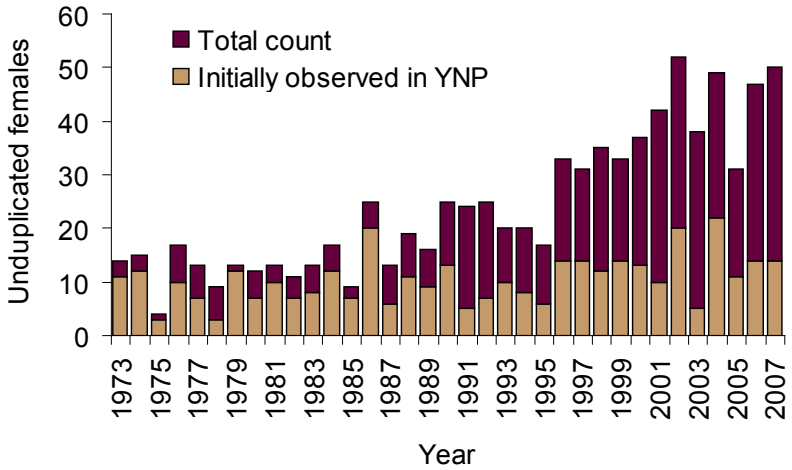


Figure 3. Total number of unduplicated female grizzly bears with cubs-of-the-year observed annually in the GYE during 1973–2007, and the number initially seen within the boundary of Yellowstone National Park. (Bears initially seen within park boundaries are counted as YNP bears.)

Cutthroat trout were previously an important food for grizzly bears living around Yellowstone Lake (Mealey 1975), but their numbers have declined precipitously since the illegal introduction of lake trout there (Koel et al. 2005). Counts of spawning cutthroat trout at Clear Creek declined from more than 70,000 in 1978 to around 500 in 2007. Studies of fish use by bears in the late 1980s relied on detecting fish parts or determining the presence of fish remains in bear scats (Reinhart and Mattson 1990). In the late 1990s, the study team discovered that mercury in the effluent from thermal vents in Yellowstone Lake could be used as an indicator of fish consumption by bears. When a bear eats a fish that has eaten plankton containing this mercury, the mercury is deposited in its hair. Measuring the concentration of mercury in bear hair

provides a direct measure of the number of fish consumed by that bear (Felicetti et al. 2004). Coupling mercury concentrations in bear hair with DNA analyses has allowed biologists to estimate how many bears consume fish (Haroldson et al. 2005), how many fish each bear eats, and the sex of the bears that eat fish. Results showed that in the late 1990s most fish were eaten by male bears (Felicetti et al. 2004). A three-year study, started in 2007, is documenting the extent to which bears have shifted from fish to other foods. Preliminary results confirm that very few bears still eat fish, and that most of the bears that previously ate fish are now focused on preying on elk calves adjacent to the lake (J. Fortin, Washington State University, personal communication). Elk are now calving in the post-fire blow-down resulting from the 1988 fires and studies suggest that the bears have shifted accordingly.

Whitebark pine, a high-elevation conifer, periodically produces abundant crops of high-quality seeds that are readily consumed by bears (Kendall 1983). In years following a good crop of seeds, grizzly bear females tend to produce more three-cub litters than one-cub litters (Schwartz et al. 2006*d*). The opposite is true following poor seed crops. In poor seed years, bears in YNP shift their diets and their survival rate remains high because the park is a secure environment. However, in years of poor seed production outside the park, particularly on the edge of the ecosystem, more bear conflicts occur (Gunther et al. 2004) and mortality rates tend to be higher (Mattson et al. 1992). Whitebark pine is currently under attack by native mountain pine beetles, previous outbreaks of which have resulted in high mortality rates in trees across the West. The study team, in cooperation with the National Park Service's Inventory and Monitoring Program, is tracking mortality rates in the GYE due to both pine beetles and blister rust infection, an exotic fungus that has killed many whitebark pine trees in the Pacific Northwest since it arrived in North America in the late 1920s. It has been less lethal in Yellowstone, but continues to spread. Surveys suggest that about 20% of the whitebark trees in the GYE are infected with rust. We do not yet have statistically rigorous estimates for whitebark pine mortality rates from either blister rust or mountain pine beetles, or for the extent of their impacts on whitebark communities for the entire GYE. However, the impact on some whitebark stands from pine beetles appears to be considerable in portions of the GYE. How the changes in whitebark abundance will affect grizzly bear numbers is not known, but in poor whitebark seed years grizzlies eat more meat (Felicetti et al. 2003). Bioelectrical impedance analysis, which the study team uses to estimate how fat each captured bear is (Schwartz et al. 2003), shows that the bears have been able to attain adequate fat levels for denning in both good and poor seed years.

NPS

Whitebark pine is an important fall food for bears.

Removal from Threatened Species Status

In April 2007, the U.S. Fish and Wildlife Service officially removed the grizzly bear in the GYE from the Endangered Species list (USFWS 2007). As expected, several lawsuits were filed challenging this decision. Proponents for delisting point to the successes that have occurred since 1975, including the increase in bear numbers, the recolonization of previous habitats, high rates of female survival, and the current health of the population. Those opposed to delisting express concerns about the possible effects of climate change and declines in whitebark pine, and whether delisting the Yellowstone population separately from the other U.S. populations was appropriate. The agencies involved in the process prepared numerous documents detailing how the bears will be managed, including monitoring protocols, mortality limits, and habitat management programs. The courts will now determine if all these efforts meet the requirements of the Endangered Species Act. Regardless of that decision, the IGBST will continue to monitor grizzly bears in an effort to understand how the species adapts in a dynamic ecosystem in the face of natural and man-made change. The long-term survival of grizzlies in Yellowstone is intimately linked with humans, how we impact the ecosystem and how much space we leave for bears. To that end, the future of the bear is in our hands.

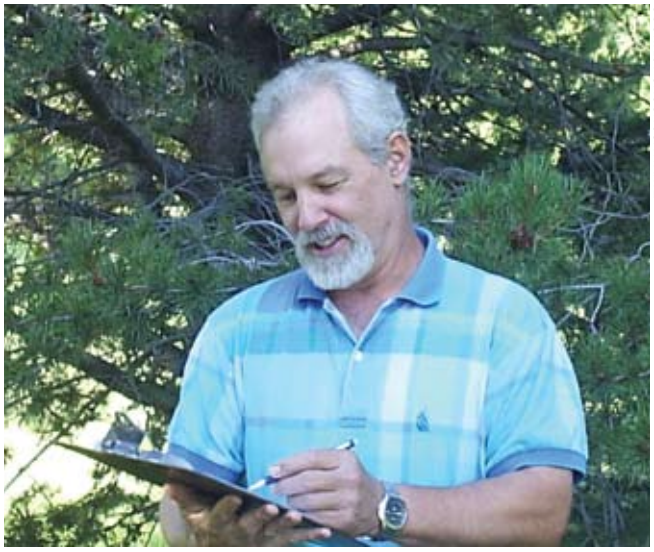
YS

Acknowledgments

We thank the many people who contributed to the study team's data collection effort over the years, especially the field crews who captured and followed the bears, and the pilots who flew in search of them. They are too many to mention here by name, but their efforts contributed greatly to our understanding of grizzly bears in the GYE. We especially thank former study team leader R. R. Knight and team member B. M. Blanchard for their efforts in data collection and program direction from the study team's inception in 1973 through 1997. We thank P. J. White, F. L. Craighead, and P. Schullery for providing editorial suggestions as part of the U. S. Geological Survey Fundamental Science Practices.

For more information:
www.igbconline.org
www.nrmsc.usgs.gov/research/igbst-home.htm

COURTESY MARK HAROLDSON



COURTESY CHUCK SCHWARTZ

Mark A. Haroldson is a supervisory wildlife biologist for the U.S. Geological Survey Interagency Grizzly Bear Study Team, based in Bozeman, Montana. He has been involved in bear research for 33 years, and has worked for the study team in the Yellowstone ecosystem since 1984. Most of his career has been spent as a field biologist capturing and collaring bears. Mark has authored or coauthored more than 30 peer-reviewed publications on grizzly bears. Recent works include several chapters in Wildlife Monographs 161 (2006), and co-authorship of the grizzly bear chapter in Wild Mammals of North America: Biology, Management, and Conservation (Feldhamer et al. 2003). Mark graduated from the University of Montana in 1979 with a BS in Wildlife Biology. Mark lives in Manhattan, Montana, with his wife Cecily (also pictured), and son Zane.

Chuck Schwartz works for the U.S. Geological Survey at the Northern Rocky Mountain Science Center in Bozeman, Montana. He is leader of the Interagency Grizzly Bear Study Team, an interdisciplinary group responsible for long-term research and monitoring of grizzly bears in the Greater Yellowstone Ecosystem. Chuck has worked on programs with grizzly bears in Alaska, Russia, Pakistan, and Japan. His research with large mammals has included moose and brown and black bears and focused on ecological issues of predator-prey dynamics, carrying capacity, nutrition, and physiology. Chuck earned his BS in agriculture from The Ohio State University, and an MS and PhD in Wildlife Biology from Colorado State University. Chuck currently resides in Bozeman, Montana, with his wife Melody.

Literature Cited

Bailey, V. 1931. Mammals of New Mexico. U.S. Department of Agriculture, Biological Survey. Washington, D.C., USA.

Boyce, M. S., D. MacKenzie, B. F. J. Manly, M. A. Haroldson, and D. Moody. 2001. Negative binomial models for abundance estimation of multiple closed populations. *Journal of Wildlife Management* 65:498–509.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York, New York, USA.

Cherry, S., G. C. White, K. A. Keating, M. A. Haroldson, and C. C. Schwartz. 2007. Evaluating estimators for numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. *Journal of Agricultural, Biological, and Environmental Statistics* 12(2):195–215.

Cole, G. F. 1976. Management involving grizzly and black bears in Yellowstone National Park, 1970–1975. U.S. Department of Interior, National Park Service, Yellowstone National Park, Wyoming, USA.

Craighead, J. J., and F. C. Craighead. 1967. Management of bears in Yellowstone National Park. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana, USA.

Craighead, J. J., K. R. Greer, R. R. Knight, and H. Ihsle Pac. 1988. Grizzly bear mortalities in the Yellowstone Ecosystem 1959–1987. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana, USA.

Craighead, J. J., J. S. Sumner, and J. H. Mitchell. 1995. The grizzly bears of Yellowstone, their ecology in the Yellowstone Ecosystem, 1959–1992. Island Press, Washington, D.C., USA.

Craighead, J. J., J. R. Varney, and F. C. Craighead Jr. 1974. A population analysis of the Yellowstone grizzly bears. Montana Forest and Conservation Station Bulletin 40. School of Forestry, University of Montana, Missoula, Montana, USA.

Eberhardt, L. L. 1995. Population trend estimates from reproductive and survival data. Pages 13–19 *in* R. R. Knight and B. M. Blanchard, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Study Team, 1994. National Biological Service, Bozeman, Montana, USA.

———. 2002. A paradigm for population analysis of long-lived vertebrates. *Ecology* 83:2841–2854.

Eberhardt, L. L., B. M. Blanchard, and R. R. Knight. 1994. Population trend of the Yellowstone grizzly bear as estimated from reproductive and survival rates. *Canadian Journal of Zoology* 72:360–363.

Eberhardt, L. L., and S. Cherry. 2000. Demography of the Yellowstone grizzly bear: comment. *Ecology* 81:3256–3259.

Felicetti, L. A., C. C. Schwartz, R. O. Rye, K. A. Gunther, J. G. Crock, M. A. Haroldson, L. Waits, and C. T. Robbins. 2004. Use of naturally occurring mercury to determine the importance of cutthroat trout to Yellowstone grizzly bears. *Canadian Journal of Zoology* 82:493–501.

Felicetti, L. A., C. C. Schwartz, R. O. Rye, M. A. Haroldson, K. A. Gunther, and C. T. Robbins. 2003. Use of sulfur and nitrogen stable isotopes to determine the importance of whitebark pine nuts to Yellowstone grizzly bears. *Canadian Journal of Zoology* 81:763–770.

Gunther, K. A. 1994. Bear management in Yellowstone National Park, 1960–93. International Conference on Bear Research and Management 9(1):549–560.

Gunther, K. A., M. A. Haroldson, K. Frey, S. L. Cain, J. Copeland, and C. C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone ecosystem, 1992–2000. *Ursus* 15(1):10–22.

Haroldson, M. A. 2006. Unduplicated females. Pages 11–16 *in* C. C. Schwartz, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2005. U.S. Geological Survey, Bozeman, Montana, USA.

Haroldson, M. A. In press. Assessing trend and estimating population size from counts of unduplicated females. *In* C. C. Schwartz, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2007. U.S. Geological Survey, Bozeman, Montana, USA.

Haroldson, M. A., K. A. Gunther, D. P. Reinhart, S. R. Podruzny, C. Cegelski, L. Waits, T. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary steams of Yellowstone Lake and estimates of grizzly bear visiting streams from DNA. *Ursus* 16(2):167–180.

Harris, R. B., G. C. White, C. C. Schwartz, and M. A. Haroldson. 2007. Population growth of Yellowstone grizzlies: uncertainty, correlation, and future monitoring. *Ursus* 18(2):167–177.

Interagency Grizzly Bear Study Team. 2006. Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone grizzly bear: workshop document supplement. U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

Keating, K. A., C. C. Schwartz, M. A. Haroldson, and D. Moody. 2002. Estimating number of females with cubs-of-the-year in the Yellowstone grizzly bear population. *Ursus* 13:161–174.

Kendall, K. C. 1983. Use of pine nuts by grizzly and black bears in the Yellowstone area. International Conference on Bear Research and Management 5:166–173.

Knight, R. R., B. M. Blanchard, and L. L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the year. *Wildlife Society Bulletin* 23(2):245–248.

Knight, R. R., and L. Eberhardt. 1984. Projected future abundance of the Yellowstone grizzly bear. *Journal of Wildlife Management* 48(4):1434–1438.

———. 1985. Population dynamics of the Yellowstone grizzly bear. *Ecology* 66(2):323–334.

———. 1987. Prospects for Yellowstone grizzly bears. International Conference on Bear Research and Management 7:45–50.

Koel, T. M., P. E. Bigelow, P. D. Doepke, B. Hertel, and D. L. Mahony. 2005. Nonnative lake trout result in Yellowstone cutthroat trout decline and impacts to bears and anglers. *Fisheries* 30(11):10–19.

Leopold, A. S., S. A. Cain, C. Cottam, I. N. Gabrielson, and T. L. Kimball. 1963. Wildlife management in the national parks. Advisory Committee to the National Parks, United States Department of the Interior, National Park Service, Washington D.C., USA.

Leopold, A. S., S. A. Cain, C. E. Olmsted. 1969. A bear management policy and program for Yellowstone National Park. Natural Sciences Advisory Committee of the National Park Service, United States Department of the Interior, National Park Service, Washington D.C., USA.

Mattson, D. J. 1997. Sustainable grizzly bear mortality calculations from counts of females with cubs-of-the-year: an evaluation. *Biological Conservation* 81:103–111.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *Journal of Wildlife Management* 56(3):432–442.

Mattson, D. J., R. G. Wright, K. C. Kendall, and C. J. Martinka. 1995. Grizzly bears. Pages 103–105 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D. C., USA.

Meagher, M. M., and J. R. Phillips. 1983. Restoration of natural populations of grizzly and black bears in Yellowstone National Park. International Conference on Bear Research and Management 5:152–158.

Mealey, S. P. 1975. The natural food habits of free-ranging grizzly bears in Yellowstone National Park, 1973–1974. Masters Thesis, Montana State University, Bozeman, Montana, USA.

National Academy of Sciences. 1974. Committee on the Yellowstone Grizzlies. Division of Biological Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences, U.S. Department of the Interior, Washington, D.C., USA.

National Park Service. 1960. National Park Service Bear Management Program and Guidelines. U. S. Department of the Interior, National Park Service, Washington, D.C., USA.

Pease, C. M., and D. J. Mattson. 1999. Demography of the Yellowstone grizzly bears. *Ecology* 80:957–975.

Podruzny S., and K. A. Gunther. 2005. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 30–33 *in* C. C. Schwartz, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2004. U.S. Geological Survey, Bozeman, Montana, USA.

Rausch, R. L. 1963. Geographic variation in size of North American brown bears, *Ursus arctos* L., as indicated by condylobasal length. *Canadian Journal of Zoology* 41:33–45.

Reinhart, D. P., and D. J. Mattson. 1990. Bear use of cutthroat trout spawning streams in Yellowstone National Park. International Conference on Bear Research and Management 8:343–350.

Ruth, T. E., D. W. Smith, M. A. Haroldson, P. C. Buotte, C. C. Schwartz, H. B. Quigley, S. Cherry, D. Tyers, and K. Frey. 2003. Large carnivores response to recreational big game hunting along the Yellowstone National Park and Absaroka-Beartooth Wilderness boundary. *The Wildlife Society Bulletin* 31(4):1150–1161.

Schullery, P. 1992. The bears of Yellowstone. High Plains Publishing Company, Inc., Worland, Wyoming, USA.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990–2000. *Ursus* 13:203–212

Schwartz, C. C., M. A. Haroldson, and C. Dickinson. 2003. Grizzly bear body composition. Page 44 *in* C. C. Schwartz and M. A. Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2002. U.S. Geological Survey, Bozeman, Montana, USA

Schwartz, C. C., M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen. 2006*a*. Temporal, spatial, and environmental influences on the demographics of the Yellowstone grizzly bear. Wildlife Monographs 161.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2006*b*. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. *Ursus* 17(1):63–66.

Schwartz, C. C., M. A. Haroldson, and G. C. White. 2006*c*. Survival of cub and yearling grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Pages 33–43 *in* C. C. Schwartz, M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161.

Schwartz, C. C., M. A. Haroldson, and S. Cherry. 2006*d*. Reproductive performance for grizzly bears in the Greater Yellowstone Ecosystem, 1983–2002. Pages 18–23 *in* C. C. Schwartz, M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, D. Moody, and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of the Yellowstone grizzly bear. Wildlife Monographs 161.

Schwartz, C. C., M. A. Haroldson, S. Cherry, and K. A. Keating. 2008. Evaluation of rules to distinguish unique females grizzly bears with cubs-of-year in Yellowstone. *Journal of Wildlife Management* 72(2):543–554

Schwartz, C. C., M. A. Haroldson, G. C. White, and S. Cherry. In prep. Source-sink dynamics: hazards affecting grizzly bear survival in the Greater Yellowstone Ecosystem. Wildlife Monographs.

Servheen, C. 1999. Status and management of the grizzly bear in the lower 48 United States. Pages 50–54 *in* C. Servheen, S. Herrero, and B. Peyton, compilers. Bears: status survey and conservation action plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

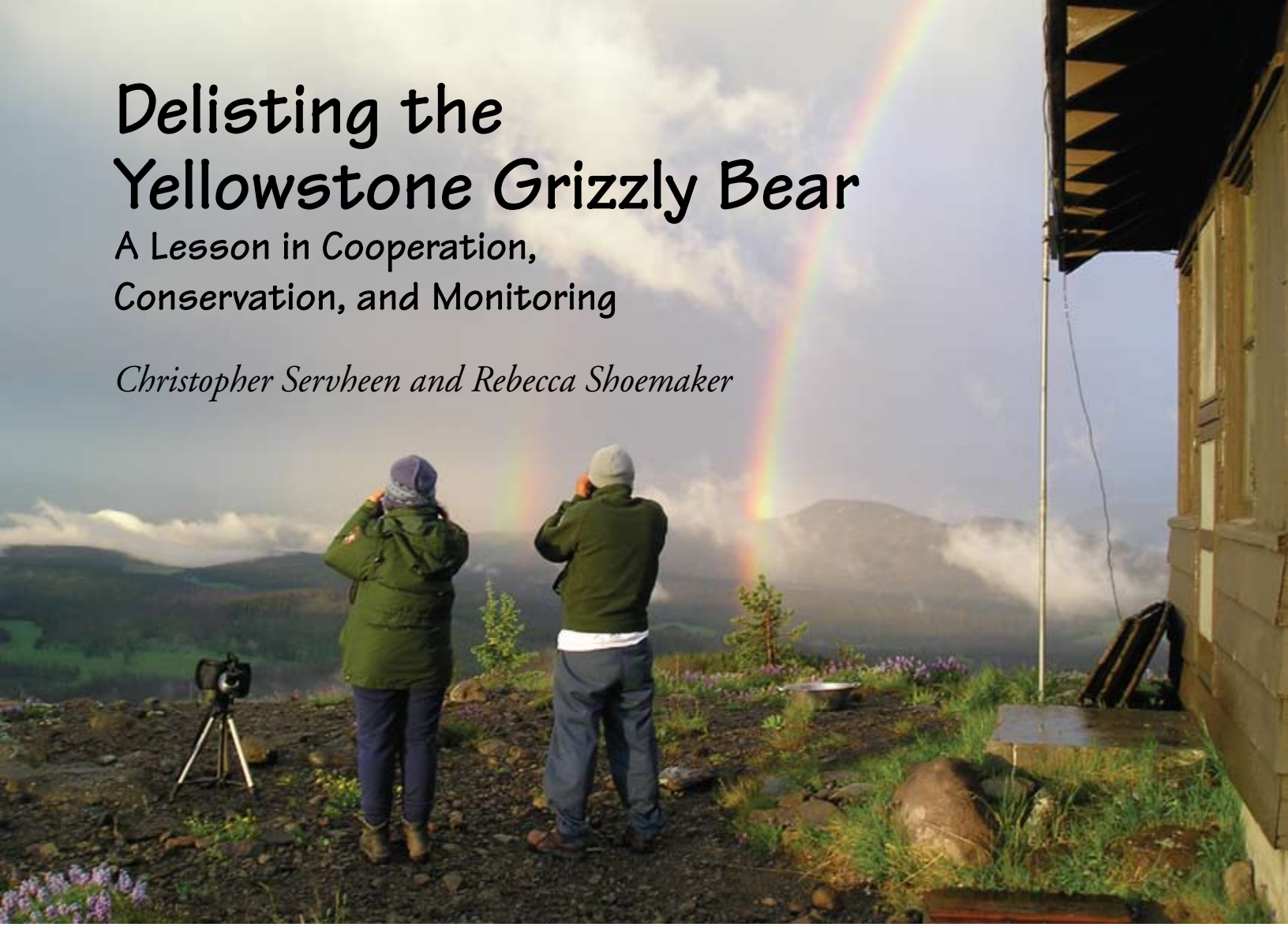
U.S. Fish and Wildlife Service (USFWS). 1993. Grizzly bear recovery plan. Missoula, Montana, USA.

——— (USFWS). 2007. Final Rule designating the GYA population of grizzly bears as a Distinct Population Segment and removing the Yellowstone Distinct Population Segment of grizzly bears from the Federal List of Endangered and Threatened Wildlife. 72 FR 14866. Available at http://www.fws.gov/mountain-prairie/species/mammals/grizzly/yellowstone.htm.

Delisting the Yellowstone Grizzly Bear

A Lesson in Cooperation, Conservation, and Monitoring

Christopher Servheen and Rebecca Shoemaker



NPS

Grizzly bear monitoring by National Park Service staff on Pelican Cone in Yellowstone.

TWENTY-SIX YEARS of cooperative, careful management and monitoring by state, federal, tribal, county, and non-governmental partners led to the recovery of the Yellowstone grizzly bear population and its removal from the Federal List of Endangered and Threatened Wildlife in April 2007. Robust population growth, cooperative management of mortality and habitat, widespread public support for grizzly bear recovery, and the development of a comprehensive Conservation Strategy brought the Yellowstone grizzly bear population to the point where delisting was appropriate. State wildlife agencies, national parks, national forests, and the Interagency Grizzly Bear Study Team led by the U.S. Geological Survey worked together to bring the Yellowstone grizzly bear population back from the brink of extinction. It is heartening to know these agencies will continue to manage and monitor the bear and its habitat in perpetuity.

By the 1930s, the range and numbers of grizzlies in the lower 48 states had been reduced to less than 2% of their historic levels (USFWS 1993, Mattson et al. 1995, Servheen 1999). By the 1950s, with little or no conservation effort or management directed at maintaining grizzly bears anywhere in their range, the Yellowstone grizzly bear population had been reduced in numbers and its range was largely limited to Yellowstone National Park and some surrounding areas (Craighead et al. 1995, Schwartz et al. 2003). High grizzly bear mortality in 1970 and 1971, following the closure of the open-pit garbage dumps in Yellowstone National Park (Gunther 1994, Craighead et al. 1995) and Montana, and concern about grizzly population status throughout its remaining range prompted the 1975 listing of the grizzly bear as a threatened species in the lower 48 states under the Endangered Species Act. The population estimate in the Greater Yellowstone Area (GYA) at that time ranged from 136 to 312 individuals (Cowan et al. 1974, Craighead et al. 1974, McCullough 1981).

The U.S. Fish and Wildlife Service (USFWS) hired a grizzly bear recovery coordinator in 1981 and helped establish the Interagency Grizzly Bear Committee (IGBC) in 1983, which became a key factor in the cooperative efforts that brought Yellowstone grizzlies back from the brink. The agreement to create the IGBC was signed by the governors of Wyoming,

Idaho, Montana, and Washington and the Assistant Secretaries of Agriculture and Interior. Made up of upper level managers from all of the state and federal agencies responsible for managing grizzly bears and their habitat, the IGBC was created to implement the Grizzly Bear Recovery Plan that had been developed by the USFWS and to coordinate management efforts and research actions across multiple state and federal jurisdictions. A primary early focus of the IGBC was on habitat management in order to change land management practices to more effectively provide security and maintain or improve habitat conditions for the grizzly bear.

The Yellowstone Ecosystem Subcommittee of the IGBC, which was formed in 1983 to coordinate recovery efforts specific to the GYA, included representatives from the USFWS; six national forests (Shoshone, Custer, Beaverhead-Deerlodge, Bridger-Teton, Gallatin, and Targhee); Yellowstone National Park; Grand Teton National Park; the Wyoming Game and Fish Department; the Montana Department of Fish, Wildlife and Parks; the Idaho Department of Fish and Game; the Bureau of Land Management; the Interagency Grizzly Bear Study Team (Study Team); county governments; the Northern Arapahoe Tribe; the Eastern Shoshone Tribe; and the Shoshone-Bannock Tribes. This subcommittee developed a comprehensive management system and assisted in developing the Yellowstone Conservation Strategy, which is the management and monitoring plan that state and federal agencies have been following since delisting.

After countless meetings, decades of data collection, and tireless coalition building; our knowledge of the health and status of the Yellowstone grizzly bear population is promising. Counts of unduplicated females with cubs-of-the-year have increased (Haroldson 2007), as have the number of cubs. Grizzly bear range and distribution have expanded by nearly 50% since the 1970s (Basile 1982, Blanchard et al. 1992, Schwartz et al. 2002, Pyare et al. 2004, Schwartz et al. 2006). Calculations of population trajectory derived from radio-monitored female bears demonstrate an annual population growth of 4 to 7% per year between 1983 and 2002 (Eberhardt et al. 1994, Knight and Blanchard 1995, Harris et al. 2006). From low estimates of 136 in 1975, this population increased to more than 571 grizzlies in 2007.

However, in addition to population increases, delisting of a species requires that the threats to the species and its habitat be sufficiently minimized through regulatory mechanisms that will remain in effect after the protections of the Endangered Species Act are removed. In order to set up these mechanisms and ensure the long-term maintenance of a recovered population, an Interagency Conservation Strategy Team was established in 1993. This team included biologists from the USFWS, the National Park Service, the USDA Forest Service, the Wyoming Game and Fish Department, the Montana Department of Fish, Wildlife and Parks, and the Idaho Department of Fish and Game.

In March 2000, a draft Conservation Strategy for the GYA was released for public review and comment. Also in 2000, a Governors' Roundtable was organized to provide recommendations from the perspectives of the three states that would be involved with grizzly bear management after delisting. In 2003, the draft Final Conservation Strategy for the Grizzly Bear in the GYA was released, along with drafts of state grizzly bear management plans (all accessible at http://mountain-prairie.fws.gov/species/mammals/grizzly/yellowstone.htm). After considering all comments received, the Final Conservation Strategy with the three state management plans was released in March 2007.

The purposes of the Conservation Strategy and associated state and federal plans are to: (1) specify the population, habitat, and nuisance bear standards needed to maintain a recovered grizzly bear population for the foreseeable future; (2) describe a comprehensive population and habitat monitoring plan; and (3) document the commitment and specific management and monitoring responsibilities of participating agencies. The strategy is an adaptive, dynamic document that establishes a framework that will incorporate new and better scientific information as it becomes available or as necessary in response to environmental changes.

The overall population goal set forth in the Conservation Strategy is to maintain the Yellowstone grizzly bear population at or above 500 animals. The Study Team will continue to monitor the number of females with cubs and their distribution, survival rates for all sex and age classes, all sources of mortality, cub production, distribution, and movements. This information will be used to estimate the total population and determine how much mortality the bear population can sustain. The Study Team will monitor grizzly bear mortalities from all sources to confirm that sustainable mortality limits are not exceeded. In their annual reports, the Study Team will analyze the spatial distribution of both mortalities and grizzly bear–human conflicts.

The strategy identifies and provides a framework for managing habitat inside the Primary Conservation Area (PCA) and adjacent areas of suitable habitat where occupancy by grizzly bears is anticipated in the next several decades. The PCA boundaries encompass nearly 6 million acres (9,210 sq mi) and correspond to those of the former Yellowstone Recovery Zone (USFWS 1993). It was designed to include approximately 51% of the suitable habitat within the GYA and approximately 84 to 90% of the population of female grizzly bears with cubs, based on data compiled from 1990 to 2004 (Schwartz et al. 2006).

The PCA is a secure area for grizzlies in which the goal is to limit human impacts on habitat conditions to those that existed in 1998 (USFWS 2007). This means that the number of developed sites, livestock allotments, and human activities that reduce secure habitat will not increase above the levels that existed in 1998. This baseline was selected because the grizzly

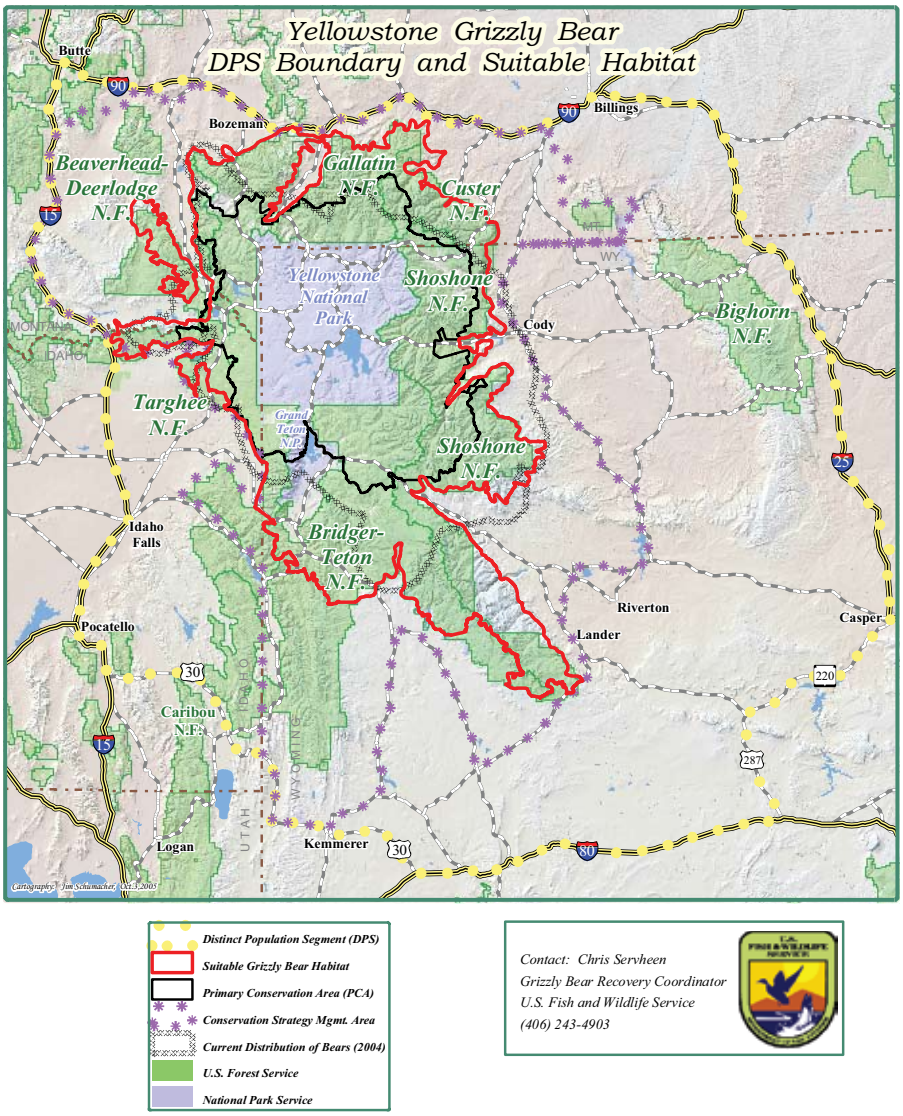
population had been increasing at a rate of 4 to 7% per year for several years in 1998, suggesting that the grizzly population may continue to expand if human activities are kept at this level.

Currently, there are 5,630,080 acres (8,797 sq mi) of suitable habitat that are outside of the PCA but within the GYA. Of this area, 4,272,640 acres, (6,676 sq mi) are on national forest lands. Only about 10 to 16% of female grizzly bears with cubs occur outside the PCA (Schwartz et al. 2006). Approximately 79% of suitable habitat outside the PCA on national forest lands is currently designated a Wilderness Area (1,680,069 acres, 2,625 sq mi), a Wilderness Study Area (174,950 acres, 273 sq mi), or an Inventoried Roadless Area (1,526,864 acres, 2,386 sq mi). This large amount of widely distributed, secure habitat will allow continued population expansion and provides additional resiliency to environmental change.

Decisions about nuisance bears will continue to be made with consistent, coordinated criteria that consider the sex, age, and conflict history of the bear. Effective nuisance bear management benefits the conservation of the Yellowstone grizzly bear population by promoting tolerance of grizzly bears and minimizing illegal killing of bears. The strategy's nuisance bear criteria are consistent with the protocol used when the grizzly bear was listed under the Endangered Species Act. These criteria emphasize the individual's importance to the entire population, with females continuing to receive a higher level of protection than males. Location, cause of incident, severity of incident, history of the bear, health, age, and sex of the bear, and demographic characteristics are all considered in any relocation or removal action.

Another key component of the Conservation Strategy's approach to nuisance bear management is the prevention of conflicts through information and education. This approach emphasizes removal of attractants that are left out by people, including garbage, pet food, bird seed, livestock feed, and compost. Removing or securing such attractants prevents bears from learning to associate human residences and structures with a free meal resulting in fewer problem bears and increased public tolerance of bears. An outreach team will continue to coordinate the development, implementation, and dissemination of programs and materials to aid in preventing human–bear conflicts. The strategy recognizes that successful management of grizzly bear–human conflicts is critical to keeping bear mortality within sustainable levels.

To be sure that genetic issues are not going to be a threat to the Yellowstone grizzly population, the agencies relied on research and advice from university genetics scientists. Their published work (Miller and Waits 2003) shows that the population is not presently threatened by genetic inbreeding problems and that viability of the Yellowstone population will not be affected by genetic factors for at least the next few decades. However, if no grizzly bears move into the GYA from other populations in the next 20 years, the Conservation Strategy



The Yellowstone grizzly bear distinct population segment boundary and suitable habitat.

requires agencies to transplant one or two grizzlies into the GYA population every 10 years so that genetic diversity does not decrease in the future. Transplanting grizzly bears has been successful in increasing the genetic diversity (Kasworm et al. 2007). This will very effectively combat any negative effects genetic isolation may have on the Yellowstone population until they reconnect naturally.

The vision of the agencies is that grizzlies and other species in Yellowstone and all the other large blocks of habitat in the Northern Rockies will eventually have the opportunity to move between these areas. To accomplish this, we are involved with the IGBC agencies and state highway departments in cooperative efforts in the linkage zones to: (1) maintain vegetative cover, limit increases in road density, and limit new site developments such as public campgrounds; (2) improve the permeability of highways where possible; and (3) work with land owners to make it economically attractive for them to keep their land open so that animals can move across it. These efforts to maintain movement opportunities for wildlife will continue regardless of the listed status of Yellowstone grizzlies.

The states of Wyoming, Idaho, and Montana may create limited hunting seasons for grizzly bears in the GYA. Such hunting seasons would occur only after the best available scientific data indicates that the Yellowstone grizzly bear population can sustain mortality from hunting in addition to all other causes. Hunting of females accompanied by offspring would be prohibited. Because any hunting mortalities would have to be within the limits of sustainable mortality, hunting will never threaten the Yellowstone grizzly population.

The Endangered Species Act requires the U.S. Fish and Wildlife Service, in cooperation with the states, to implement a monitoring program for at least five years after a species is delisted. The monitoring program for grizzly bears described in the Conservation Strategy will continue in perpetuity. The primary focus of the monitoring program is to assess whether the demographic standards and habitat criteria described in the strategy are being maintained.

NPS

Whitebark pine cone production, an important habitat parameter, will continue to be monitored during surveys.

A suite of indices will provide a highly sensitive system to evaluate the health of the population and its habitat. Monitoring efforts will document population trends, size, distribution, survival rates, litter size, litter interval, and the presence of genetic signatures from grizzly bears that have moved into the GYA from other populations. The Study Team will document and analyze all grizzly bear mortalities and conflicts throughout the GYA for inclusion in their annual report. Several important habitat parameters are also being monitored intensively, including: (1) the amount of secure habitat in each bear management unit; (2) road densities; (3) the number and type of developed sites; (4) the number and capacity of livestock allotments; (5) relative values of habitat quality; (6) the abundance of winter-killed ungulates; (7) the abundance of cutthroat trout and non-native lake trout; (8) whitebark pine cone production, presence of white pine blister rust fungus, presence of mountain pine beetles; and (9) grizzly bear use of army cutworm moths. This rigorous monitoring program will identify any threats to the long-term conservation of the population and provide a sound scientific basis to respond to any changes or needs with adaptive management actions.

The long-term future of the Yellowstone grizzly population is good due to the cooperation and commitment of the agencies, and the support of the people who live, work, and recreate in grizzly habitat. The recovery effort in Yellowstone was built on mortality control that requires managing habitat and attractants to limit mortality sources such as garbage, improper backcountry food storage, and vulnerable livestock such as domestic sheep. This commitment to mortality control will continue under the Conservation Strategy. The scientific basis for decisions on grizzlies in the Yellowstone ecosystem is built on the knowledge of the Interagency Grizzly Bear Study Team whose research and publications over the past 32 years have made the Yellowstone grizzlies the most comprehensively studied bear population on Earth. The detailed scientific monitoring of the Yellowstone grizzlies and their habitats and foods will continue under the direction and leadership of the Study Team.

There is concern that climate change in the Yellowstone ecosystem will impact bear foods. The Yellowstone ecosystem will, in any event, continue to change; the question is how the bears will respond to the changes. The brown bears that we call grizzlies live in the widest range of habitats of any of the world's eight bear species and are a generalist species adaptable to a wide range of environmental and food conditions. Successful conservation will require that we closely monitor the vital rates of the bears and relate any changes in survival and reproduction to any changes in their foods and to changing environmental variables. Continued monitoring by the Study Team will assure that we know how the bears are responding to environmental change. The agencies' adaptive management

program will incorporate the results of the Study Team monitoring into state and federal management actions as necessary to meet the needs of the grizzlies in Yellowstone.

It has taken care and commitment over more than 26 years to recover the Yellowstone grizzlies. As managers, we have been entrusted with a great responsibility to assure the future of this magnificent icon of the wild places left in America. We take this responsibility very seriously and pledge to continue to care for the Yellowstone bears so that our grandchildren can watch them in wonder in the special place that is the Yellowstone ecosystem.

YS

COURTESY CHRIS SERVHEEN

Christopher Servheen holds a BA/BS in Zoology/Wildlife Biology from the University of Montana, an MS in Wildlife Biology from the University of Washington, and a PhD in Forestry/Wildlife Biology from the University of Montana. He is currently the Grizzly Bear Recovery Coordinator for the U.S. Fish and Wildlife Service and has led the recovery effort for the Yellowstone grizzly population for the past 26 years. He is also an Adjunct Associate Professor in the College of Forestry and Conservation, University of Montana. He is responsible for coordinating all the research and management on grizzly bears in the lower 48 states and working with biologists on grizzly bears in Alberta and British Columbia. He organizes projects to re-link the large blocks of public land on the Northern Rocky Mountains using the application of Global Positioning Systems (GPS) collars on grizzly bears and black bears to learn more about their detailed movements in relationship to human activity, particularly highways.

COURTESY REBECCA SHOEMAKER

Rebecca Shoemaker graduated magna cum laude from the University of Montana with a BS in Wildlife Biology and a BA in Biology in 2004. Since then she has worked on research projects monitoring wildlife use of highway underpasses, surveying remote areas for grizzly bears using non-invasive techniques, and implementing grizzly bear recovery in the Northern Rockies for the U.S. Fish and Wildlife Service. She is fascinated with water-wise forbs native to the Rocky Mountains and is establishing a native plant seed farm in Arlee, Montana.

Literature Cited

Basile, J. V. 1982. Grizzly bear distribution in the Yellowstone area, 1973–79. U.S. Forest Service Research Note INT-321.

Blanchard, B. M., R. R. Knight, and D. J. Mattson. 1992. Distribution of Yellowstone grizzly bears during the 1980s. *American Midland Naturalist* 128:332–338.

Cowan, I. McT., D. G. Chapman, R. S. Hoffmann, D. R. McCullough, G. A. Swanson, and R. B. Weeden. 1974. Report of the Committee on the Yellowstone grizzlies. National Academy of Sciences Report.

Craighead, J. J., J. S. Sumner, and J. H. Mitchell. 1995. The grizzly bears of Yellowstone, their ecology in the Yellowstone Ecosystem, 1959–1992. Island Press, Washington, D.C., USA.

Craighead, J. J., J. R. Varney, and F. C. Craighead, Jr. 1974. A population analysis of the Yellowstone grizzly bears. Bulletin 40, Montana Forest and Conservation Experiment Station, University of Montana, Missoula, USA.

Eberhardt, L. L., B. M. Blanchard, and R. R. Knight. 1994. Population trend of the Yellowstone grizzly bear as estimated from reproductive and survival rates. *Canadian Journal of Zoology* 72:360–363.

Gunther, K. A. 1994. Bear management in Yellowstone National Park, 1960–93. Pages 549-560 *in* Bears: their biology and management. Proceedings of the 9th International Conference on Bear Research and Management, Missoula, Montana, USA.

Haroldson, M. A. 2007. Unduplicated females. Pages 8–10 *in* C. C. Schwartz , M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2006. U.S. Geological Survey, Bozeman, Montana, USA.

Harris, R. B., C. C. Schwartz, M. A. Haroldson, and G. C. White. 2006. Trajectory of the Yellowstone grizzly bear population under alternative survival rates. Pages 44–56 *in* C. C. Schwartz, M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen, eds. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161.

Kasworm, W. F., M. F. Proctor, C. Servheen, and D. Paetkau. 2007. Success of grizzly bear population augmentation in northwest Montana. *Journal of Wildlife Management* 71:1261–1266.

Knight, R. R., and B. M. Blanchard. 1995. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1994. National Biological Service, Bozeman, Montana, USA.

Mattson, D. J., R. G. Wright, K. C. Kendall, and C. J. Martinka. 1995. Grizzly bears. Pages 103–105 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C.

McCullough, D. R. 1981. Population dynamics of the Yellowstone grizzly bear. Pages 173–196 *in* C. W. Fowler and T. D. Smith, editors. Dynamics of large mammal populations, John Wiley and Sons, New York, New York, USA.

Miller, C. R., and L. P. Waits. 2003. The history of effective population size and genetic diversity in the Yellowstone grizzly (*Ursus arctos*): Implications for conservation. Proceedings of the National Academy of Sciences 100:4334–4339.

Pyare, S., S. Cain, D. Moody, C. Schwartz, and J. Berger. 2004. Carnivore re-colonisation: reality, possibility and a non-equilibrium century for grizzly bears in the southern Yellowstone Ecosystem. *Animal Conservation* 7:1–7.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990–2000. *Ursus* 13:203–212.

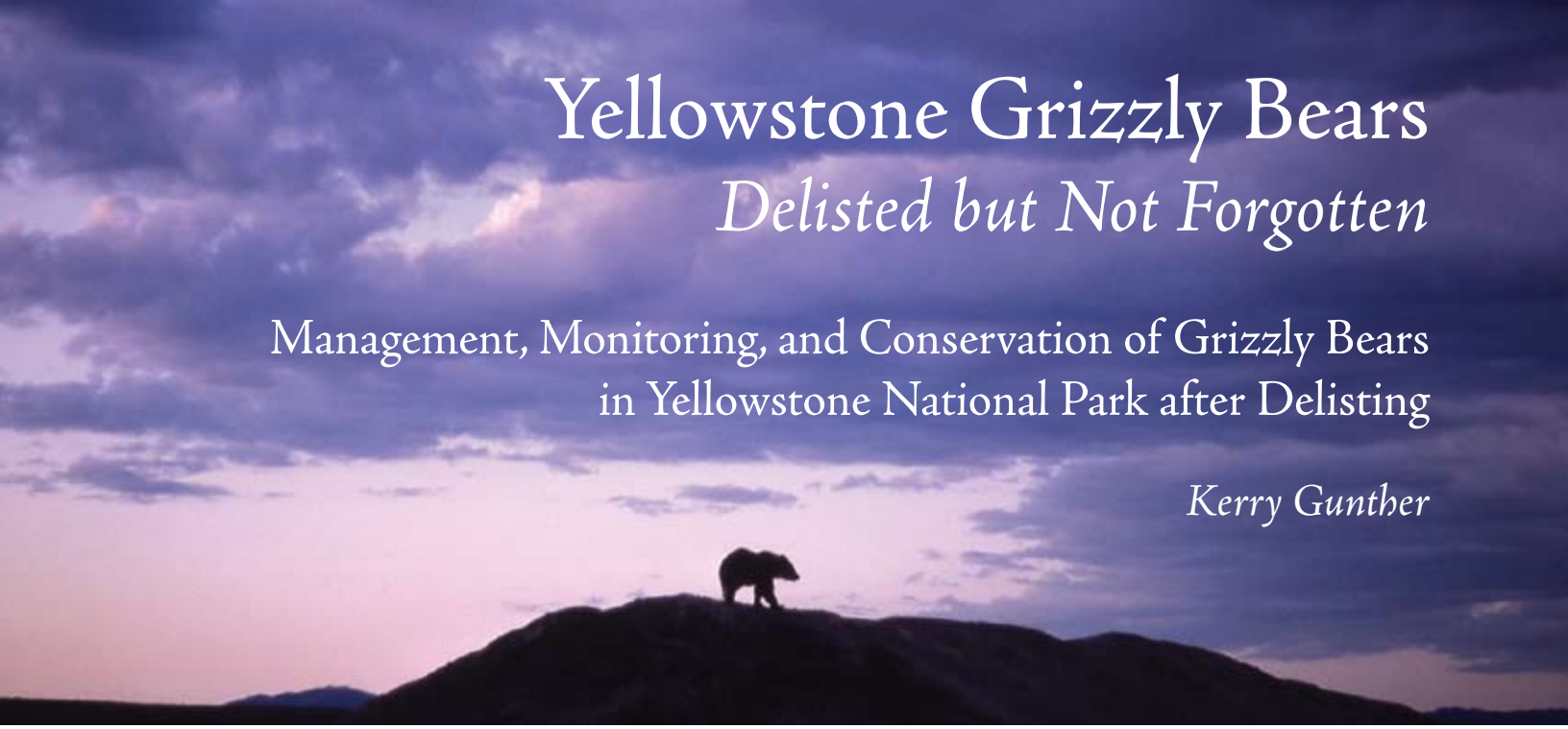
———. 2006. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. *Ursus* 17:63–66.

Schwartz, C. C., S. D. Miller, and M. A. Haroldson. 2003. Grizzly/brown bear. Pages 556–586 *in* G. Feldhamer, B. Thompson, and J. Chapman, editors. Wild mammals of North America: biology, management, and conservation. Johns Hopkins University Press, Baltimore, Maryland, USA.

Servheen, C. 1999. Status and management of the grizzly bear in the lower 48 United States. Pages 50–54 *in* C. Servheen, S. Herrero, and B. Peyton, compilers. Bears: Status survey and conservation action plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland.

U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. Missoula, Montana, USA.

———. 2007. Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area. Available at http://www.fs.fed.us/r1/wildlife/igbc/.



Yellowstone Grizzly Bears
Delisted but Not Forgotten

Management, Monitoring, and Conservation of Grizzly Bears in Yellowstone National Park after Delisting

Kerry Gunther

NPS/RICHARD LAKE

On April 30, 2007, after more than 30 years of receiving special protection, the U.S. Fish and Wildlife Service (USFWS) removed the Greater Yellowstone Area (GYA) grizzly bear population from threatened species status. The grizzly bear was listed as a threatened species under the Endangered Species Act (ESA) in 1975 because of unsustainable levels of human-caused mortality, loss of habitat, and significant habitat alteration. Since then, with state and federal public land and wildlife managers as well as non-government organizations working together for the conservation of grizzly bears and their habitat, the species has made a remarkable recovery, probably one of the greatest conservation successes in the history of the United States.

In the GYA, grizzly bear cub production and survival have been high in recent decades and human-caused mortality has been kept at sustainable levels, allowing the population to increase from an estimated 136 bears in 1975 (Craighead et al. 1974) to approximately 571 bears in 2007. In addition, grizzly bears have expanded the range they occupy by over 48% in the last two decades (Schwartz et al. 2002).

Although grizzly bear recovery is a great success story, removal from threatened species status does not mean that grizzly bear monitoring and protection of bear habitat will no longer be a priority. The grizzly bear population will likely always need to be closely monitored and carefully managed, including efforts to control human-caused mortality. Prior to delisting, the state and federal managers responsible for managing the grizzly bear population and habitat in the GYA completed a *Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area* (USFWS 2007). The document will guide grizzly bear management by eight state and federal agencies: the Wyoming Game and Fish Department; Montana Fish, Wildlife and Parks; the Idaho Department of Fish and Game; the U.S. Forest Service (Beaverhead-Deerlodge, Bridger-Teton, Caribou-Targhee, Custer, Gallatin, and Shoshone national forests); the National Park Service (Yellowstone and Grand Teton national parks); the Bureau of Land Management; the U.S. Fish and Wildlife Service; and the U.S. Geological Survey (USGS) Biological Research Discipline. The plan describes the agencies' coordinated efforts to manage the GYA grizzly bear population and its habitat to ensure its continued conservation. It specifies the population, habitat, information and education, and nuisance bear standards necessary to maintain a recovered grizzly population for at least the next century.

The conservation strategy also documents the regulatory mechanisms and legal authorities, policies, management, and monitoring programs that are in place to maintain the recovered GYA grizzly bear population. The foundation of the plan will protect grizzly bear habitat inside a 9,210-square-mile core area (the Primary Conservation Area, Figure 1) as a secure area for grizzly bears, maintaining the habitat conditions that have allowed the grizzly bear population to reach recovery goals, increase population numbers, and expand its range. All of Yellowstone National Park (YNP) and about half of Grand Teton National Park are within the Primary Conservation Area. The states of Wyoming, Montana, and Idaho have each completed plans that will guide grizzly bear management on lands outside the Primary Conservation Area and allow grizzly bears to expand into areas that are biologically suitable and socially acceptable. The Interagency Grizzly Bear Study Team (IGBST), initiated in 1973, is a cooperative effort of the USGS Biological Resources Discipline, National Park Service, Forest Service, and since 1974 the states of Idaho, Montana, and Wyoming. The IGBST conducts research that provides information needed by various agencies for immediate and long-term management of grizzly bears inhabiting the GYA.

Population Standards and Monitoring

Conserving a recovered grizzly bear population in the GYA will require having an adequate number of widely distributed bears and maintaining a balance between reproduction and mortality. Grizzly bears are highly susceptible to human-caused mortality and have a low reproductive rate; females rarely breed until at least age five and then typically give birth to two cubs every three years (Schwartz et al. 2002). Under the conservation strategy, YNP is committed to the following monitoring activities and population standards:

- The number of female grizzly bears that produce cubs-of-the-year will be monitored through fixed-wing observation flights, radio telemetry flights, and ground observations by qualified observers and remote cameras.
- Park staff will provide YNP data on observations of females with cubs, reproduction, and female mortality to the IGBST for calculation of a GYA population estimate and trends.
- To ensure its genetic integrity, the total GYA grizzly bear population is to be maintained at no less than 500.
- At least 16 of the 18 Bear Management Units within the Primary Conservation Area are to be occupied by females with young at least one year in every six, and no two adjacent Bear Management Units are to remain unoccupied over any six-year period. YNP staff will monitor females with young in the portions of the 13 Bear Management Units that are located in the park.
- Park staff monitor all known and probable causes of mortality in the park and take steps as necessary to keep the mortality rate from all causes within the following limits:
  1) for female grizzly bears ≥2 years, the total mortality rate is not to exceed 9% of the estimated size for this segment of the population in two consecutive years;
  2) for males ≥2 years, the total mortality rate is not to exceed 15% of the estimated male population in three consecutive years;
  3) for dependent young (cubs and yearlings), the known and probable human-caused mortality rate is not to exceed 9% of the total number of dependent young in three consecutive years.
- Over time, the isolation of the GYA grizzly bear population from other known grizzly bear populations could result in the loss of genetic diversity due to inbreeding. Genetic diversity will be monitored by collecting DNA samples from all captured grizzly bears and from bear carcasses. The addition of one or two grizzly bears from the northern Montana or Canadian populations through range expansion (or the artificial relocation of bears if necessary) into the GYA gene pool would increase or at least help maintain the level of genetic diversity in the Yellowstone population. Movements of grizzly bears into the GYA could occur from either natural movements or artificial transportation from other populations if needed.

Habitat Standards and Monitoring

The goal of the habitat management agencies is to maintain or improve grizzly bear habitat as it existed as of 1998 because the conditions at that point allowed grizzly bears to

Figure 1. The Primary Conservation Area showing bear management unit and subunit boundaries.

expand in range and meet the population thresholds stipulated in the *U.S. Fish and Wildlife Service Grizzly Bear Recovery Plan* (USFWS 1993). However, the habitat standards in the conservation strategy will be periodically reviewed and updated as necessary based on further research and experience. Under the conservation strategy, YNP is committed to the following habitat standards and monitoring:

- Maintenance of secure habitat at 1998 levels (Figure 1, Table 1). Secure habitat is defined as habitat that is larger than 10 acres and more than 500 meters from a motorized access route or reoccurring helicopter flight line. (Maintenance and improvement of existing roads is allowed.)
- Limitation of developed sites in the park to 1998 levels, with some exceptions for administrative and maintenance needs.
- Monitoring motorized access route density in the park.
- Monitoring the four major high quality concentrated grizzly bear food items in the GYA: winter-killed ungulate carcasses, spawning cutthroat trout, army cutworm moths, and whitebark pine seeds. The incidence of white pine blister rust and mountain pine beetle infestation, which are killing whitebark pine trees, will also be monitored.
- Monitoring habitat effectiveness in the park using the vegetation cover type, ungulate and fish protein, and human activity databases from the Yellowstone Grizzly Bear Cumulative Effects Model.
- Ensuring that habitat connectivity is addressed as part of any new road construction or reconstruction in the park.

Grizzly Bear–Human Conflicts Management and Monitoring

Nuisance grizzly bear management both inside and outside the primary conservation area will be designed to prevent bear–human conflicts from occurring rather than just reacting to conflicts after they occur (Gunther et al. 2004). YNP staff will continue to emphasize prevention of bear–human conflicts and confrontations through visitor education, sanitation, storage of human food, garbage, and other bear attractants in a bear-proof manner, use of bear-proof dumpsters, garbage cans, food storage boxes, and food hanging poles, and strict enforcement of food and garbage storage regulations in both frontcountry and backcountry areas. Management of all nuisance bear situations will emphasize resolving the human cause of the conflict. Management actions may be taken against nuisance bears when the human causes of conflict cannot be resolved or bears persist in causing conflict after human causes have been corrected, or in incidents where bears pose a significant threat to human safety.

Information and Education

Information and education are key components in implementing the conservation strategy. The long-term survival of

Table 1. The 1998 baseline values for the percentage of secure habitat for the 40 Bear Management Subunits in the Greater Yellowstone Area. Subunits highlighted in bold are wholly or partially inside YNP.

Subunit Name	% Secure Habitat
Bechler/Teton	78.1
Boulder/Slough #1	96.6
Boulder/Slough #2	**97.7**
Buffalo/Spread Creek #1	88.3
Buffalo/Spread Creek #2	81.1
Crandall/Sunlight #1	81.1
Crandall/Sunlight #2	82.3
Crandall/Sunlight #3	80.4
Firehole/Hayden #1	**88.4***
Firehole/Hayden #2	**88.4***
Gallatin #1	**96.3***
Gallatin #2	**90.2***
Gallatin #3	55.3
Hellroaring/Bear #1	**77.0**
Hellroaring/Bear #2	**99.5**
Henrys Lake #1	45.4
Henrys Lake #2	45.7
Hilgard #1	69.8
Hilgard #2	71.5
Lamar #1	**89.4***
Lamar #2	**100***
Madison #1	**71.5**
Madison #2	**66.5**
Pelican/Clear #1	**97.8***
Pelican/Clear #2	**94.1***
Plateau #1	**68.9**
Plateau #2	**88.7**
Shoshone #1	98.5
Shoshone #2	98.8
Shoshone #3	97.0
Shoshone #4	94.9
South Absaroka #1	99.2
South Absaroka #2	99.9
South Absaroka #3	96.8
Thorofare #1	**100**
Thorofare #2	100
Two Ocean Lake #1	**96.3**
Two Ocean Lake #2	**100**
Washburn #1	**83.0***
Washburn #2	**92.0***

*Entire subunit located inside YNP.

NPS/WILLIAM S. KELLER

Grizzly bear at Trout Creek.

bears in the GYA depends on people that live, work, visit, and recreate in the area understanding bear behavior and bear management practices. Excessive human-caused mortality, habitat alteration, and habitat destruction were the major factors that led to the grizzly bear population decline in the GYA. Addressing the causes and sources of grizzly bear human conflicts is critical to an effective public outreach plan. Public attitudes will play a large role in determining the success of grizzly bear conservation efforts. YNP will continue to participate in the Information and Education Working Group with the other government agencies that have jurisdiction over grizzly bears and their habitat in the GYA. The working group will develop a campaign to cultivate an appreciation of grizzly bears as a wildlife resource and teach people how to coexist with them.

Implementation and Evaluation

Oversight and implementation of the conservation strategy will be coordinated by a new committee, the Yellowstone Grizzly Coordinating Committee (YGCC), which will have representatives from the eight government agencies participating in the conservation strategy as well as tribal and county representation. YGCC meetings will be open to the public. The primary activities of the YGCC will be to:

- Coordinate implementation of the conservation strategy.
- Ensure that population and habitat data are collected annually by the IGBST, as specified in the conservation strategy, and evaluated to assess the status of the grizzly bear population.
- Evaluate the effectiveness of the grizzly bear conservation measures detailed in the conservation strategy.
- Share information and implement management actions in a coordinated manner.
- Identify management, research, and financial needs to successfully implement the conservation strategy.
- Implement a biology and monitoring review process and submit petitions for re-listing, if necessary, to ensure agency responsiveness to changing circumstances of the grizzly bear population or its habitat.

Biology and Monitoring Review

The Interagency Grizzly Bear Study Team will carry out a Biology and Monitoring Review if the population or habitat standards stipulated under the conservation strategy are not met or if requested by a YGCC member. The Biology and Monitoring Review will be used to:

- Determine why particular demographic or habitat objectives have not been achieved and recommend modifications in the conservation strategy to the YGCC as necessary.
- Consider the potential impacts of a proposed action that is of concern to one or more YGCC members.
- Consider departures by one or more agencies from the monitoring effort required under the conservation strategy.
- Consider and establish a scientific basis for possible changes in management due to changing conditions in the ecosystem and make appropriate recommendations to the YGCC.
- Consider whether conditions warrant submitting a petition for re-listing and make recommendations to the YGCC accordingly.

Petition for Re-listing

The USFWS will initiate a status review if it believes one is warranted or if petitioned by the YGCC, a local or tribal government, or a private citizen or organization to re-list the GYA grizzly bear population. Any such petition by the YGCC would be accompanied by the available specific biological data on the population and its habitat sufficient to judge its status as a recovered population as per the requirements of the conservation strategy. A status review will evaluate all factors affecting the GYA grizzly bear population and result in a summary of its current status.

The Future

Although the Yellowstone grizzly bear population is currently increasing and expanding its range, habitat conditions are not static and are expected to change over time. In addition, there are some potential threats to grizzly bears and their habitat in the GYA (Gunther et al. 1995). Climate change could lead to increases in some bear food resources and declines in others. The introduction of exotic vegetation, diseases, and organisms will also influence the distribution and abundance of bear foods (Reinhart et al. 2001). Although some non-native vegetation, including certain clover species, is highly preferred by bears, other non-native species are not consumed by bears at all or will compete with or replace preferred bear foods. Drought, whirling disease, and non-native lake trout have significantly reduced the cutthroat trout population in Yellowstone Lake (Haroldson et al. 2005), a preferred food for grizzly bears with home ranges adjacent to the lake. Bear food sources can also be significantly reduced by native

species such as the mountain pine beetle, which has killed many whitebark pine trees in the GYA. Whitebark pine seeds are a highly preferred fall food for grizzly bears and influence reproduction and survival (Schwartz et al. 2006). There is also potential for wildlife diseases to temporarily but significantly reduce the GYA's large ungulate herds. Ungulate meat is much more prevalent in the diet of GYA grizzly bears than in that of most other brown bear populations (Mattson et al. 1991). The increasing human dominance of the landscape is changing habitat, altering climate and abundance of bear foods, introducing exotic diseases and organisms, and determining the behavior of bears that can coexist with people. These factors may even be altering the evolution of grizzly bears and other wildlife.

The grizzly bear is an omnivore generalist capable of adapting to most environmental changes—it is usually human factors and values that determine where bears can and cannot persist. Managing grizzly bears as a threatened species brought them back from the brink of extirpation in the GYA. Human tolerance, acceptance, and a willingness to coexist with bears are needed to allow bears to persist long into the future. The conservation strategy that will guide grizzly bear management into the future was written as a flexible, adaptive management document. As habitat conditions change, the YGCC can modify population and habitat standards, monitoring protocols, information and education programs, and nuisance bear management techniques based on the most recent advances in science and technology. More than 30 years of managing grizzly bears as a threatened species has taught state and federal land and wildlife management agencies as well as non-government organizations how to work together for the successful conservation of grizzly bears in the GYA. The adaptability of grizzly bears combined with the flexibility of the conservation strategy and the dedication and commitment of state and federal land managers, non-government organizations, and bear advocacy groups should ensure a viable grizzly bear population well into the future.

YS

COURTESY KERRY GUNTHER

Kerry Gunther is the Bear Management Biologist for Yellowstone National Park and a member of the Interagency Grizzly Bear Study Team for the Greater Yellowstone Ecosystem. He has worked in grizzly and black bear research and management for more than 30 years, the last 25 years in Yellowstone. Prior to working for the National Park Service, he worked in bear research and management for the U.S. Forest Service, Superior National Forest. Kerry received his BS in biology and earth science from Northland College in Wisconsin, and his MS in Fish and Wildlife Management from Montana State University. His interests include the conservation of bears and finding practical solutions for reducing bear–human conflicts.

NPS/JIM PEACO

A crowd gathers to watch grizzly sow #264 dig for food near Obsidian Creek.

Literature Cited

Craighead, J. J., J. R. Varney, and F. C. Craighead, Jr. 1974. A population analysis of the Yellowstone grizzly bears. Bulletin #40. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, Montana, USA.

Gunther, K. A., M. J. Biel, K. A. Churchill, and R. L. Danforth. 1995. Changing problems in bear management, 23 years after the dumps. Pages 85–110 *in:* A. P. Curlee, A. M. Gillesberg, and D. Casey, editors. *Greater Yellowstone predators: ecology and conservation in a changing landscape*. Proceedings of the Third Biennial Conference on the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyoming, and Yellowstone National Park, Wyoming, USA.

Gunther, K. A., M. A. Haroldson, K. Frey, S. L. Cain, J. Copeland, and C. C. Schwartz. 2004. Grizzly bear–human conflicts in the Greater Yellowstone Ecosystem, 1992–2000. *Ursus* 15(1):10–22.

Haroldson, M. A., K. A. Gunther, D. P. Reinhart, S. R. Podruzny, C. Cegelski, L. Waits, T. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary streams of Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. *Ursus* 16(2):167–180.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991. Food habits of Yellowstone grizzly bears, 1977–87. *Canadian Journal of Zoology* 69:1619–1629.

Reinhart, D. P., M. A. Haroldson, D. J. Mattson, and K. A. Gunther. 2001. Effects of exotic species on Yellowstone's grizzly bears. *Western North American Naturalist* 61:277–288.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990–2000. *Ursus* 13:203–212.

Schwartz, C. C., M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen. 2006. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161.

U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. U.S. Fish and Wildlife Service, Missoula, Montana, USA.

———. 2007. Final conservation strategy for the grizzly bear in the Greater Yellowstone Area. U.S. Fish and Wildlife Service, Missoula, Montana, USA.

Human Habituated Bears

The Next Challenge in Bear Management in Yellowstone National Park

Kerry A. Gunther and Travis Wyman

POSTCARD BY FRANK J. HAYNES, 1900–16

NPS/R. ROBINSON, ca. 1950s

AFTER DECADES WITH numerous bear-inflicted human injuries and bear-caused property damage, the implementation of a new Bear Management Program in 1970 appeared to solve most of Yellowstone National Park's (YNP) bear management problems. Under the 1970 program, bear-inflicted human injuries and bear-caused property damage were significantly reduced, and bears were weaned off of human food handouts and garbage (Cole 1976, Meagher and Phillips 1983). Although the program initially contributed to a population decline (Craighead et al. 1974), by the mid-1980s the grizzly bear population was once again growing in number (Schwartz et al. 2006) and expanding in range (Schwartz et al. 2002). However, a new management challenge began to emerge at this time because grizzly bears and black bears that were not conditioned to human foods began habituating to the presence of people (Gunther 1994). These bears were tolerating people at very close distances while feeding on natural foods in meadows next to roads. Bears were learning to live in close proximity to people without causing conflicts or injuring people, but could (and should) park visitors and staff learn to co-exist so closely with bears?

Terminology: Food Conditioning Versus Habituation

Bears and other wildlife can be habituated to humans, conditioned to human foods, or both (Herrero 1985). Human food conditioning is defined as the attraction to human foods or garbage due to prior food rewards giving positive reinforcement (Herrero 1985). Human food conditioned bears are almost universally considered a problem and dangerous to personal property and human safety by most bear management agencies. Most bears conditioned to human foods eventually become aggressive in their efforts to obtain human foods and damage property or injure people in the process. Then they must be destroyed by managers. Human habituation in wildlife is defined as the waning of an animal's flight response following repeated exposure to inconsequential stimuli (Jope 1985, Whittaker and Knight 1998, Herrero et al. 2005). Habituation in bears typically refers to the loss of avoidance or escape responses (Smith et al. 2005). For example, bears feeding on high quality, natural foods near park roads are exposed to thousands of park visitors driving by, viewing, and photographing

NPS

Food-conditioning began with early park visitors, 1872–1916.

them, and they are not killed or harmed by the experience. They eventually habituate to the traffic and people associated with roads. Habituation is an adaptive response that reduces energy costs by reducing irrelevant behavior (McCullough 1982). In our example, the irrelevant behavior from the bear would be a flight response from something (people/traffic) that rarely harms or kills them. In areas like YNP, where bears and people come into frequent benign contact (YNP has millions of visitors who are not allowed to hunt or carry loaded guns) and there are few human-caused bear mortalities (mainly management removals of food-conditioned bears and road accidents), bears will readily habituate to people. Human-habituated behavior by bears in YNP is most often observed along road corridors (Gunther et al. 2004), although sometimes habituated bears enter developments to feed on natural foods or forage along popular high-use trails such as the Slough Creek trail. Habituation without food conditioning is not necessarily detrimental to bears or people (Herrero et al. 2005). Habituation of bears to humans in YNP allows them to access and utilize high quality habitat in areas with high levels of human activity without incurring the energetic costs of fleeing every time a park visitor appears (Gunther and Biel 1999). In addition, habituated bears may be less prone to aggression toward people during surprise encounters (Jope 1985).

The Era of Food Conditioned Bears

When bears are in meadows along roads, hundreds of visitors may cause traffic congestion by stopping along (or in) the road to view and photograph the bears; these incidents are referred to as *bear-jams* (Gunther et al. 2004). The first bear-jams along park roads began to occur as early as 1910, when a black bear began panhandling for food handouts from visitors passing by in horse drawn wagons (Schullery 1992). After 1910, the hand-feeding of black bears along park roads quickly became one of the parks most popular attractions. These early roadside bears were both conditioned to human foods and habituated to human presence. However, having large numbers of park visitors hand-feeding bears led to large numbers of bear-inflicted human injuries and property damages. From 1931 through 1969, there were an average of 48 bear-inflicted human injuries and 138 incidents of bear-caused property damage every year in the park (Gunther 1994). To remedy the situation, YNP implemented a new Bear Management Program in 1970 (Leopold et al. 1969). Under the program, regulations prohibiting the hand-feeding of bears were strictly enforced, all garbage cans and dumpsters in the park were converted to a bear-proof design, and garbage dumps in the park where bears had been feeding for more than 80 years were closed (Cole 1976, Meagher and Phillips 1983). Over the next decade (1971–1979), most panhandling bears along roadsides and those that were conditioned to human foods in park developments were captured and euthanized or sent to zoos (Meagher and Phillips 1983). The bears that survived this period were generally the more wary backcountry bears that were not highly conditioned to human foods. These bears were able to choose and utilize the best quality habitat in remote backcountry areas where they were rarely seen by park visitors. Park visitors accustomed to viewing, photographing, and feeding bears along roads were highly disappointed when panhandling bears no longer lined the roadsides and bears could not be seen within park developments on a regular basis.

Habituated Bears, a New Management Challenge

By the early to mid-1980s bear numbers and distribution began to increase in the park. As the density of bears increased, they began to fill in the remaining vacant bear habitat in the park, the high quality meadows adjacent to roads and developments. Bears low in the social hierarchy, black bears, young adult female grizzlies, and subadult male and female grizzlies, were the cohorts most commonly observed along roads. These bears likely could not compete with the high density of prime-age adult grizzly bears (higher in the social hierarchy) in remote backcountry locations. With park visitation averaging more than 2.3 million visitors per year in the 1980s, it was not energetically efficient for the bears relegated to utilizing roadside habitat to run every time a car drove by or a visitor stopped to take their picture, so these bears began to habituate to traffic and people. Since the park was strictly enforcing regulations prohibiting the feeding of bears and educating park visitors on how to behave around bears, the bears using roadside habitat were not becoming conditioned to human foods and were not causing conflicts other than the large traffic jams.

Discouraging Habituation

When habituated (but not food conditioned) bears first began appearing along roads in the early 1980s, the park

managed them much the same way they had been managing food conditioned bears since 1970. Park managers worried that the bears would eventually be thrown food by park visitors and that allowing bears to forage in roadside meadows would increase the risk of their being struck by vehicles. To protect both the bears and park visitors, in the 1980s habituated bears were initially captured and relocated to more remote areas of the park. However, relocation was rarely successful because YNP is not big enough to ensure that a bear will not return after being relocated. Bears have strong fidelity to their home ranges and make every effort to return after being relocated (Murie 1944, Miller and Ballard 1982, Blanchard and Knight 1995). No matter where in YNP a bear is relocated, it can easily return in three to four days. Moving bears outside the park could give enough distance to ensure that the bears could not find their way back, but it is not a viable option. Since the goal of moving bears is to keep them alive and out of conflicts with people, moving them outside of the park where there is a much higher risk of conflict and mortality would defeat the purpose. In addition, if YNP requested another agency to accept a bear for relocation, that agency would expect the park to accept one of its "problem" bears in return. Most problem bears from outside the park are highly food conditioned, not the type of bear the park would want to relocate into an area with millions of visitors.

Since relocating habituated bears was not working, park bear managers tried other techniques to reduce the perceived risks from having habituated bears adjacent to roadsides. Roadside meadows frequented by habituated bears were posted with closure signs so that park visitors would not approach bears too closely. However, these temporary closures failed to solve the problems associated with bear-jams and, if law enforcement rangers were not present, many people simply ignored the signs and walked past them to get closer to the bears. Park managers also attempted to teach bears to avoid roadside meadows by hazing the bears with rubber bullets, cracker shells, and other devices. Unfortunately, bears seemed to learn to recognize park vehicles, staff, and the distance at which rubber bullets could be effectively fired. Bears also had a much greater pain threshold and tolerance to hazing than the park had staff time and budget to counteract. Efforts to haze bears away from the foods that were attracting them to roadsides (including ungulate carcasses, elk calves, whitebark pine seeds, clover, biscuit root, pocket gophers, yampa roots, and rose hips) were just not successful. It seemed nearly impossible to get bears to associate high-quality natural foods along roads with pain. It would take more than rubber bullets and cracker shells to change centuries of bear evolution.

Interestingly, these same failures of aversive conditioning had been apparent in the early 1940s. Murie (1944) reported that "experience has shown that the bear learns to recognize the particular person or car that administers the shock or other punishment, and he simply avoids that person or car in the future, but does not fear other persons or cars." We re-learned these lessons in the 1980s using more modern hazing techniques, concluding that they had very low success rates and were not cost-effective methods of managing habituation on a long-term basis. Park management also realized that visitors wanted to see, photograph, and appreciate bears. Bears that were habituated to people but not conditioned to human foods just did not fit the bear management paradigm of the previous decades.

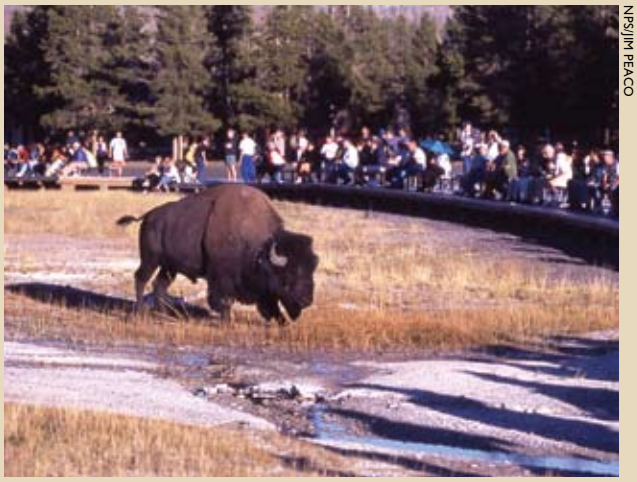
The Period of Tolerance of Habituation

In 1990, under an informal adaptive management strategy, the park decided to try managing the people at bear-jams instead of trying to manage the habituated bears. Instead of trapping and hazing, rangers were dispatched to manage traffic and prevent visitors from approaching bears too closely or throwing food to them. The change came slowly at first, a few habituated (but not food conditioned) black bears in a few areas were allowed to feed in meadows next to park roads. Grizzly bears were still considered too dangerous to allow them to forage in meadows adjacent to roads. Over time, management became more tolerant of black bears along roads throughout the park and began to tolerate grizzly bears in roadside meadows as well.

However, just as bears were habituating to people, park staff and visitors were habituating to bears. When people spend a lot of time near bears with very small overt reaction distances (Herrero et al. 2005), they tend to lose their wariness of bears (Murie 1944, Smith et al. 2005) and the need for people management increases. The park also directed more resources toward managing bear-jams. The Ranger Division began to hire summer seasonal employees just to manage traffic and park visitors at bear-jams. The Interpretation Division began hiring Bear Education Rangers whose primary duty is to teach people about bears and how to behave at bear-jams. The Bear

NPS

Park rangers managing people at a bear-jam, 2004.



NPS/JIM PEACO

People tend to perceive habituated grizzly bears along roads as a significant threat to human safety and yet think nothing of it when bison are grazing next to roads. This may be somewhat misguided, as bison injure more people almost every year in the park than bears do. From 1980 through 2005, 80 people in the park were injured by bison. During that same time span, 37 people were injured by grizzly and black bears combined.

Management Office began seeking and obtaining non-base funds to help the Ranger and Interpretive Divisions fund their efforts to manage people and traffic at bear-jams.

Park Visitation and Bear Habituation Outpace Available Staff

What started out relatively small, with a few habituated bears causing a few dozen bear-jams that required a small proportion of total park staff time each year, has grown exponentially to hundreds of bears-jams requiring thousands of hours of personnel time annually (Figure 1). In 2004, the year with the most recorded bear-jams, park staff spent 2,980 personnel hours managing visitors at 916 bear-jams, providing traffic control and monitoring visitor behavior to prevent visitors from approaching bears too closely or throwing food to them. The number of habituated bears and roadside bear-jams, as well as the staff time required to manage bear-jams is now far greater than anticipated in 1990 when the park began to tolerate habituation in bears. On some days there are so many bears-jams occurring simultaneously that park staff cannot respond to them all. Park visitors are left unattended interacting with grizzly bears and black bears in roadside meadows. For example, in 2007 there were at least 87 bear-jams with no park staff present. We suspect the number was significantly higher since the majority of unstaffed bear-jams probably were not reported. Due to this increase in bear-jams, an evaluation of the costs and benefits of tolerating habituation in bears is warranted and will aid the park in determining the future direction for management of habituated bears.

Evaluating Successes and Failures in Managing Habituated Bears

YNP now has 18 years of data that can be used to analyze the successes and failures of the current management program in which bears are tolerated in roadside meadows and emphasis is placed on managing visitors at bear-jams instead of the bears. During that period (1990–2007), park staff managed visitors at 2,161 bear-jams involving grizzly bears and 3,809 involving black bears. An additional 119 bear-jams were so big that rangers could not determine the species of bear—by the time they had cleared traffic to get close enough to see, the bears had disappeared into the forest. In total, the park has recorded 6,089 bear-jams since 1990 without a single bear-inflicted human injury (including both habituated and wary bears). People, traffic, and bison have turned out to be more dangerous than habituated grizzly bears and black bears. From 1990 through 2007, there have been a couple of fender-benders and at least five people injured when they were run over by vehicles at bear-jams. Interestingly, people tend to perceive habituated bears along roads as a significant threat to human safety and yet rarely react at all when bison are grazing next to roads even though bison in the park injure more people almost every year than bears.

The number of bears being killed by vehicles has also remained low under the current management strategy. An average of 0.4 grizzly bears and 1.1 black bears were killed by vehicles each year from 1990 through 2007, compared to

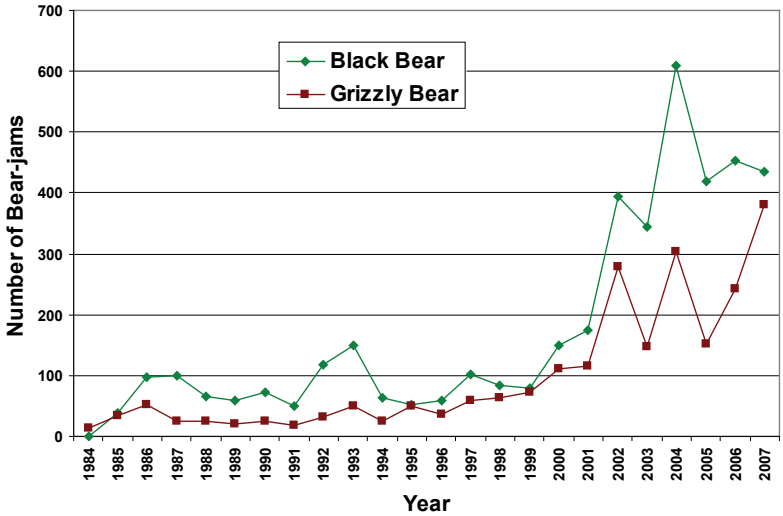


Figure 1. The number of bear-jams each year has been increasing.

Table 1. Comparison of the number of bear–human conflicts, bear-inflicted human injuries, bears removed in management actions, and vehicle strike mortality of bears occurring during two periods with different management policies regarding habituation of grizzly and black bears to people in Yellowstone National Park.

Time Period	Habituation Related Management Goal	Bear–Human Conflicts[a]		Bear-Inflicted Human Injuries		Management Removal of Bears		Vehicle Strike Mortality of Bears	
		Grizzly	Black	Grizzly	Black	Grizzly	Black	Grizzly	Black
1980–1989	Prevent Habituation	9.1/yr	6.0/yr	1.2/yr	0.2/yr	1.1/yr	0.2/yr	0.2/yr	0.9/yr
1990–2007	Tolerate Habituation	5.1/yr	4.1/yr	1.1/yr	0.2/yr	0.3/yr	0.3/yr	0.4/yr	1.1/yr

[a]Incidents where bears damaged property or obtained anthropogenic foods.

an average of 0.2 grizzly bears and 0.9 black bears from 1980 through 1989 when habituation in bears was not tolerated (Table 1). Other than a few black bears in the Tower Subdistrict and grizzly bear #264 between Mammoth and Norris, most of the bears that have been struck by vehicles since 1990 have not been roadside habituated bears. The majority of road-killed bears have been wary, seldom seen bears that dart across roads in areas where bear-jams are not common.

The concern that tolerating habituated bears along roadways would lead to an increase in bear–human conflicts and human-caused bear mortalities has not materialized (Table 1). The average number of bear–human conflicts has actually decreased from 9.1 grizzly and 6.0 black bear per year from 1980 to 1989, to 5.1 grizzly and 4.1 black from 1990 to 2007. The number of bear-inflicted human injuries and management removals of problem bears has not changed significantly. The numbers of bear–human conflicts, bear-inflicted human injuries, and management removals of bears have all remained low despite an increase in park visitation and a significant increase in the number of bear-jams occurring in the park (Table 1).

The park has demonstrated that given adequate staff, it can manage habituated bears along roadsides in a manner that is relatively safe for both park visitors and bears. Under the current management philosophy, thousands of people have been able to view, photograph, and appreciate bears while visiting the park. The opportunity to view bears appears to provide a positive visitor experience. However, the increasing numbers of visitors and bear-jams in the park has strained the ability of park staff to manage bear jams and increased concerns about the safety of park visitors that view habituated bears in roadside meadows (Herrero et al. 2005).

Positive and Negative Aspects of Bear Habituation to People

In determining the extent to which bear habituation is tolerated, managers must weigh several factors. There are several benefits of habituation for bears (Herrero et al. 2005). Habituation allows bears to access high-quality food resources that occur adjacent to roads. Roadside habitat is avoided and underutilized by wary bears (Mattson et al. 1986), so tolerance of habituation may allow the park to support a higher density of bears. Habituation may also increase public appreciation of bears and build support for bear conservation and habitat protection.

Habituation in bears benefits people (Herrero et al. 2005). It provides for public enjoyment by offering opportunities for bear viewing, photography, and filming. Habituated bears also provide excellent opportunities for education of visitors about bears, their ecology, and conservation. Public viewing of habituated bears provides economic benefits to gateway communities, park concessions operations, and the wildlife tour industry. Habituated bears are generally less likely to act aggressively or attack people during surprise encounters (Jope 1985).

There are also negative aspects of bear habituation (Herrero et al. 2005). When habituated bears are foraging near roads and developments they often create significant traffic congestion that can lead to human as well as bear injuries and mortalities. Although habituated bears may be less prone to react aggressively during surprise encounters (Jope 1985), habituation may increase the cumulative likelihood of human–bear encounters and therefore of bear-inflicted human injury (Herrero et al. 2005). Managing park visitors that stop

NPS

A crowd of wildlife watchers lines the roadside.

NPS PHOTOS

GRIZZLY BEAR #264 was probably Yellowstone's most famous habituated (but not food conditioned) roadside bear. She first came to the attention of bear managers as a four-year-old in 1995, when she began foraging in roadside meadows during the day, causing large traffic jams. For the next eight years she was a common sight in the roadside meadows between Golden Gate and Gibbon Meadows, where she attracted large numbers of visitors and caused huge bear-jams. Grizzly bear #264 was a popular attraction during the spring when she scavenged winter-killed ungulate carcasses and in the late spring and early summer when she hunted newborn elk calves. She was a highly successful predator, but she also spent considerable time in roadside meadows digging biscuit root and yampa root, and in open forests adjacent to roads foraging sweet cicely. She was especially popular with photographers during years when she had cubs. She was known to have had three litters of at least two cubs each; in 1997, 1999, and 2000. She was easy to photograph and film and was featured in the Animal Planet episode "Seasons of the Grizzly." Grizzly bear #264 was very tolerant of people, even when visitors misbehaved. In 1997 a visitor walked out into the meadow where she was grazing with her two cubs and petted one of the cubs. The cub bawled and #264 bluff charged the man but did not injure him. Grizzly #264 exemplified both the positives and negatives of habituation. In 2003, she darted out of the forest in front of a truck. The driver braked and swerved to avoid her but she was struck by the right front tire. The collision broke her spine and paralyzed the lower portion of her body. Bear Management Office staff took her to a veterinary clinic but she had to be euthanized. Bear #264 was probably the park's most filmed and photographed bear. She was able to carve out a home range along a busy road corridor where she lived for 12 years and had six cubs in three litters, providing entertainment and education for thousands of park visitors.

Clockwise from top: *#264 with her yearlings near Sheepeater Cliff, June 2002; Gardiner, Montana, residents show their attachment; #264 along the roadside.*

to view habituated bears is staff intensive and expensive. In addition, habituation of bears increases the chances that park visitors might approach, feed, or otherwise behave inappropriately around bears, especially when park rangers are not present. Inappropriate visitor behavior could lead to human injury or death or to the injury or death of the bear.

Where Do We Go from Here?

In 1970, the decision to prevent bears from obtaining human foods and garbage in the park was obvious and management techniques to prevent bears from becoming conditioned to human foods were relatively straightforward. Since habituation without food conditioning is harder to define as good or bad, and the management options for habituated bears are not yet perfected and will be subject to staff limitations, the decision on how to manage habituation is much less obvious. With adequate staff and budgets, roadside viewing of habituated bears can be a safe and enjoyable learning activity with minimal and probably acceptable risks for park visitors (Herrero et al. 2005). Allowing visitors to view habituated bears along roads also builds a constituency of people that may be more likely to support conservation of bears and their habitat (Herrero et al. 2005). However, if staff and budgets to manage visitors viewing roadside bears do not keep pace with visitation, then park visitors and, ultimately, the bears themselves may be at greater risk of injury or death. Under such a scenario, park management may have to choose other options such as removal or intensive aversive conditioning to attempt to prevent habituation of bears to people.

Conclusions

The dilemma for park managers is to balance the needs of bears with the desires of park visitors while providing for visitor safety and remaining within fiscal constraints. The next challenge for park managers is to find innovative, cost-effective ways to manage the large numbers of visitors that want to view and experience habituated bears, or to develop cost-effective methods to prevent habituation. In the meantime, highly intelligent and very adaptable grizzly and black bears are habituating and learning to live and coexist in close proximity to people so that they can survive in a landscape that is ever more increasingly dominated by humans.

YS

NPS

Travis Wyman has worked in Yellowstone National Park since 1990, where he has been a biological science technician for the past eight years in the Bear Management Office. He has also worked for two years as a fireguard, seven years in resource management, and two years in bison management. Travis attended San Diego State University and Iowa State University, from which he received a BS in biology.

Literature Cited

Blanchard, B. M., and R. R. Knight. 1995. Biological consequences of relocating grizzly bears in the Yellowstone Ecosystem. *Journal of Wildlife Management* 59:560–565.

Cole, G. F. 1976. Management involving grizzly and black bears in Yellowstone National Park, 1970–1975. U.S. Department of Interior, National Park Service, Yellowstone National Park, Wyoming, USA.

Craighead, J. J., J. R. Varney, and F. C. Craighead, Jr. 1974. A population analysis of the Yellowstone grizzly bears. Bulletin Number 40. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, Montana.

Gunther, K. A. 1994. Bear management in Yellowstone National Park, 1960–93. International Conference on Bear Research and Management 9(1):549–560.

Gunther, K. A., and M. J. Biel. 1999. Reducing human-caused black and grizzly bear mortality along roadside corridors in Yellowstone National Park. Pages 25–27 *in*: Proceedings of the Third International Conference on Wildlife Ecology and Transportation, FL-ER-73-99.

Gunther, K. A., K. Tonnessen, P. Dratch, and C. Servheen. 2004. Management of habituated grizzly bears in North America: report from a workshop. Transactions of the 69th North American Wildlife and Natural Resources Conference.

Herrero, S. 1985. Bear attacks-their causes and avoidance. Winchester Press, New Century Publishing, Incorporated, Piscataway, New Jersey, USA.

Herrero, S., T. Smith, T. D. Debruyn, K. Gunther, and C. A. Matt. 2005. Brown bear habituation to people – safety, risks, and benefits. *Wildlife Society Bulletin* 33(1):362–373.

Jope, K. L. 1985. Implications of grizzly bear habituation to hikers. *Wildlife Society Bulletin* 13:32–37.

Leopold, A. S., S. A. Cain, C. E. Olmsted. 1969. A bear management policy and program for Yellowstone National Park. Natural Sciences Advisory Committee of the National Park Service, United States Department of the Interior, National Park Service, Washington D.C., USA.

Mattson, D. J., R. R. Knight, and B. M. Blanchard. 1986. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. International Conference on Bear Research and Management 7:259–273.

McCullough, D. R. 1982. Behavior, bears and humans. *Willdlife Society Bulletin* 10:27–33.

Meagher, M. M., and J. R. Phillips. 1983. Restoration of natural populations of grizzly and black bears in Yellowstone National Park. International Conference on Bear Research and Management 5:152–158.

Miller, S. D., and W. B. Ballard. 1982. Homing of transplanted Alaskan brown bears. *Journal of Wildlife Management* 46:869–876.

Murie, O. J. 1944. Progress report on the Yellowstone bear study. National Park Service, Yellowstone National Park, Wyoming, USA.

Schullery, P. 1992. The bears of Yellowstone. High Plains Publishing Company, Inc., Worland, Wyoming, USA.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990–2000. *Ursus* 13:203–212.

Schwartz, C. C., M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen. 2006. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161.

Smith, T. S., S. Herrero, and T. D. Debruyn. 2005. Alaskan brown bears, humans, and habituation. *Ursus* 16(1):1–10.

Whittaker, D., and R. L. Knight. 1998. Understanding wildlife responses to humans. *Wildlife Society Bulletin* 26:312–317.

Nature Notes

Possible Grizzly Cub Adoption in Yellowstone National Park

Mark A. Haroldson, Kerry A. Gunther, and Travis Wyman

We suspect that two females with cubs-of-the-year (COY) that have been observed frequently in the Dunraven Pass-Antelope Creek areas of Yellowstone National Park (YNP) were involved in a COY adoption during early August 2007. One of the females was radio-marked (#125) and has an extensive research history. First radio-collared as a three-year-old in Antelope Creek on August 6, 1986, she was subsequently captured and re-collared five times (1990, 1993, 1995, 2000, and 2006) in the Antelope Creek drainage, and she has been radio-located during 18 of the 21 years since her initial capture. Her life range, computed using VHF (Very High Frequency) telemetry locations (n=272) and employing a fixed kernel estimator (95%), is centered on the Antelope Creek-Mount Washburn area (Fig. 1). We know of four previous litters that she has produced (in 1990, 1994, 1997, and 2002). During 2007 she was observed with three COY during aerial telemetry and observation flights seven times between June 3 and August 3 (Fig. 1, where observation and telemetry locations coincide). She was last seen with three COY during a telemetry flight on

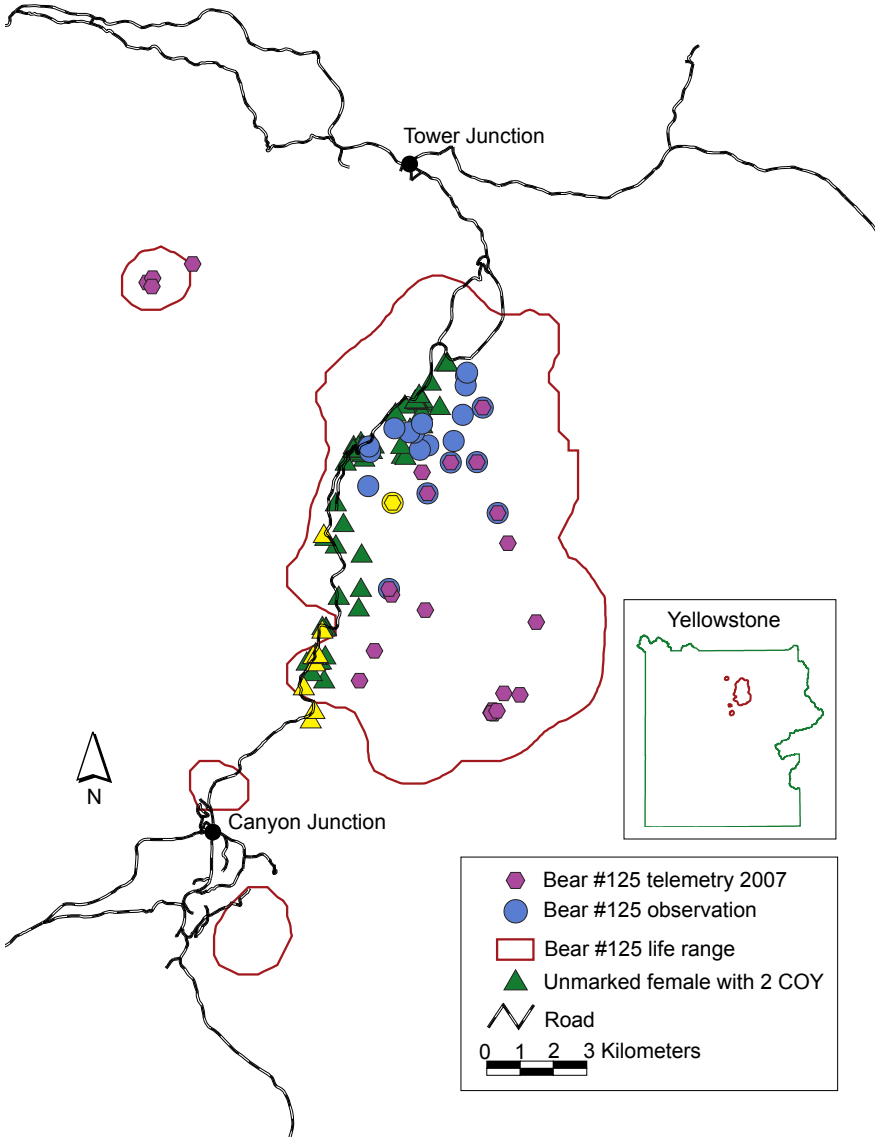


Figure 1. Distribution of observed locations of the female bears apparently involved in an adoption of cubs during August 2007. Yellow shapes depict observations after the number of young accompanying each female changed. Also shown (red polygon) is the 95% fixed kernel life range (272 locations over 18 years) for female #125.

USGS/STEVE ARD

Figure 2. Female grizzly bear #125 accompanied by three cubs-of-the-year on August 3, 2007, in Antelope Creek, Yellowstone National Park.

August 3 (Fig. 2). YNP personnel provided an additional 14 verified observations of a collared female with three COY (Fig. 1) in the Antelope Creek drainage that we considered re-sightings of #125 using the rule set devised by Knight et al. (1995) to differentiate unique females with COY.

The second female (Fig. 3) was not marked but was observed by YNP staff with two cubs on 68 occasions between May 29 and August 7. She was easily distinguishable because she was highly habituated to people, frequently foraged native vegetation within 30 to 100 m of the Dunraven Pass road, and was the only habituated female grizzly bear with cubs that regularly foraged along that section of road. On August 11, a female with four cubs (Fig. 4) was observed frequenting the same roadside habitats (Fig. 1, yellow triangles), exhibiting the same behavior, and identical in physical characteristics as the second female. On August 16, female #125 was seen with only one cub (Fig. 5). There were no further observations of a female with two cubs in the area, suggesting that the second female had adopted or was fostering two of female #125's cubs. We obtained eight additional observations of an unmarked female with four COY after August 11. Although possible, we think it unlikely that a previously unobserved, highly habituated female with four COY would appear in these roadside habitats this late in the season.

On August 19, in an attempt to obtain samples for DNA analysis, we set hair snares and a remote camera at a location between two areas frequented by the female with four COY. We installed one strand of barbed wire at adult bear height (approximately 60 cm) and four strands at cub height (approximately 25 cm). Inside each hair snare we applied one of a variety of call lures to pieces of downed timber debris. Hair samples were collected from the adult- and cub-height hair snares on August 22. Remotely triggered photographs taken on August 20 show a female with four COY inside the wires (Fig. 6). Genetics analyses on the sampled hair and archived samples from the most recent capture of bear #125 (September 25, 2006) are being conducted by Dr. David Paetkau (Wildlife Genetics International, Nelson, B.C., Canada) and may reveal if this was indeed a case of adoption and possibly whether the females are related.

Cub adoption in grizzly bears has been documented in Yellowstone National Park, but not since bears congregated at the open pit dumps during the late 1960s (Craighead et al. 1995). Natural cub adoptions have been observed primarily where bears congregate at abundant food sources, such as salmon streams (Dean et al. 1992). Adoptions are generally thought to result from mistakes made by females with young following the confusion and stress caused by confrontations with other bears (Erickson and Miller

STEVE KOEHLER

Figure 3. Unmarked female grizzly bear accompanied by two cubs-of-the-year on June 11, 2007, near Dunraven Pass, Yellowstone National Park.

STEVE KOEHLER

Figure 4. Unmarked female grizzly bear accompanied by four cubs-of-the-year on August 11, 2007, near Dunraven Pass, Yellowstone National Park.

1963). In this case, there were unconfirmed reports that an antagonistic encounter between a pack of wolves and bear #125 led to her separation from two of her cubs. The adoptive mother may have happened by these cubs and accepted them as her own. Because bears typically occur at low densities, mother-offspring recognition may not be as well developed as with more gregarious species (Lunn et al. 2000). During 2008, we hope to obtain additional observations of these two families that may help determine if this was a case of long-term adoption or temporary fostering.

YS

USGS/STEVE ARD

Figure 5. Female grizzly bear #125 accompanied by one cub-of-the-year on August 16, 2007, in Antelope Creek, Yellowstone National Park.

Figure 6. Remotely taken photograph of four cubs-of-the-year (a) and adult (b) at a hair snagging site on August 20, 2007.

Literature Cited

Craighead, J. J., J. S. Sumner, and J. H. Mitchell. 1995. The grizzly bears of Yellowstone, their ecology in the Yellowstone Ecosystem, 1959–1992. Island Press, Washington, D.C., USA.

Dean, F. C., R. McIntyre, and R. A. Sellers. 1992. Additional mixed-age brown bear, *Ursus arctos,* associations in Alaska. *Canadian Field-Naturalist* 106:257–259.

Erickson, A. W., and L. H. Miller. 1963. Cub adoption in the brown bear. *Journal of Mammalogy* 44:584–585.

Knight, R. R., B. M. Blanchard, and L. L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year. *Wildlife Society Bulletin* 23:245–248.

Lunn, N. J., D. Paetkau, W. Calvert, S. Atkinson, M. Taylor, and C. Strobeck. 2000. Cub adoption by polar bears (*Ursus maritimus*): determining relatedness with microsatellite markers. *Journal of Zoology* 251:23–30.

FROM THE ARCHIVES

This portrayal of Yellowstone bears appeared as the frontispiece in F. Dumont Smith's *Summit of the World: Trip Through Yellowstone Park* (Chicago, Illinois: Rand McNally & Company, 1909). The quickness with which Yellowstone bears became accustomed to the safety of the park following the prohibition of hunting in 1883 was a popular topic of conversation among tourists, concessioners, and managers. The tall bear with spectacles was no doubt a tribute to Theodore Roosevelt, famous as a hunter, conservationist, and national park supporter. —Paul Schullery

YELLOWSTONE ASSOCIATION

The printing of *Yellowstone Science* is made possible through a generous annual grant from the nonprofit Yellowstone Association, which supports education and research in the park. Learn more about science in Yellowstone through courses offered by the Yellowstone Association Institute and books available by visiting www.YellowstoneAssociation.org.

The production of *Yellowstone Science* is made possible, in part, by a generous grant to the Yellowstone Park Foundation from Canon U.S.A., Inc., through *Eyes on Yellowstone* is made possible by Canon. This program represents the largest corporate donation for wildlife conservation in the park.

Canon

Support *Yellowstone Science*

Our readers' generosity helps to defray printing costs.

Please use the enclosed card to make your tax-deductible donation. Make checks payable to the Yellowstone Association, and indicate that your donation is for *Yellowstone Science.*

Thank You!

In this issue

YS

Bears in Transition, 1959–1970s
Garbage, Controversy, and Decline to Recovery
Delisting the Yellowstone Grizzly
Management and Monitoring after Delisting
Human Habituated Bears
Nature Note: Possible Grizzly Cub Adoption

USGS/STEVE ARD

Grizzly bear #533, a 16-year-old, radio-collared female (looking at the camera), emerged from her den this spring with three 3-year-old young. Grizzly cubs typically separate from their mothers and become independent in the spring as 2-year-olds. The Interagency Grizzly Bear Study Team has been radio-marking bears in the Greater Yellowstone Ecosystem since 1975, and this is the second time they have seen a collared female stay with her offspring an additional year. Photo taken May 1, 2008, on Cougar Flats in Yellowstone National Park.

YELLOWSTONE SCIENCE
Yellowstone Center for Resources
PO Box 168
Yellowstone National Park, WY 82190

CHANGE SERVICE REQUESTED

PRSRT STD AUTO
US POSTAGE PAID
National Park Service
Dept. of the Interior
Permit No. G-83