Beaver

The number of active beaver colonies found in bi-annual survey areas increased from 49 in 1996 to 85 in 2003. The 2005 aerial survey was incomplete because poor weather required ending it before 12 riparian areas had been censused, but 65 colonies were tallied in the 16 areas that were surveyed, and most showed increases over the 2003 survey.

Beaver colonies increased significantly during the last two years in the northwest section of the park (from 26 to 41) and along Slough Creek (from 6 to 9), probably because of favorable water conditions (continued drought along mountain streams creates colonization opportunities) and continued re-growth of willows (especially along Slough Creek). The beavers' expansion was also probably intensified by the reintroduction of beavers into the Gallatin National Forest not long before wolves were reintroduced. Some of those beavers migrated downstream into Yellowstone. Where willow has been historically stable, so too have the beaver colonies.

Beaver colonies in the Bechler area declined from 14 to 8. This is difficult to explain, but it is not prime beaver habitat: willow and aspen are not abundant, and forests are primarily unburned and in a climax state. A colony at Harlequin Lake persists despite the absence of deciduous vegetation and a food cache entirely comprised of lodgepole pine, a poor beaver food. This colony likely relies on aquatic vegetation to some degree.

The Yellowstone River area south of Yellowstone Lake as well as the Snake River, Heart Lake, and associated tributary streams were not surveyed, nor were some streams on the northern range due to early ice and snow. A new colony along the Yellowstone River on the northern range was discovered near a recently established but small patch of willow.

Even though the Lamar and Glen Creek areas were not aerially censused, ground observations have indicated the persistence of two colonies that were established there in the last five years, representing beaver range expansion similar to that along Slough Creek and the northwest area of the park.

Birds

A total of 320 bird species have been documented in Yellowstone National Park since its founding. Although no species were added to the list in 2005, the most unusual sighting reported by the park ornithologist was a juvenile ruddy turnstone in Mary Bay on September 15.

Snowstorm Turns Flyovers into Stopovers

Early in the morning on April 27, large amounts of snow fell on the Yellowstone Plateau, particularly in the Canyon area. Many grebes, coots, and waterfowl that were migrating at night tried to escape to openings in the dark that turned out to be the lights of the Canyon development. By daybreak, birds had crashed into buildings, landed on roofs and wet pavement, and become stranded in a snow-covered meadow. Many were unable to take off again and fed upon by common ravens, pine martens, coyotes, bald eagles, and red-tailed hawks. More than 100 dead birds, mostly eared grebes, were counted, but many more birds survived their brief stay in Yellowstone. The park ornithologist observed 100 times more birds than have been recorded at that time of year in the past two decades. It is estimated that the storm blew 6,000 grebes, 1,000 avocets, and 40,000 ducks into Hayden Valley alone.

Great Horned Owl Takes Lake Trout

Although one reason the non-native lake trout do not belong in Yellowstone is that they are not as accessible a food source for many species as is the Yellowstone cutthroat trout, a great horned owl was observed capturing a lake trout on a September night while park staff were electroshocking the fish around Carrington Island in the West Thumb.

Species of Special Interest

Bald Eagle. The U.S Fish and Wildlife Service downlisted the bald eagle from endangered to threatened in 1995 as a result of significant popula-

tions gains made over the last three decades. The species is considered to have ecologically recovered in the GYA and the Greater Yellowstone Bald Eagle Working Group believes it should be delisted here. Despite a decline in the number of fledglings at Yellowstone Lake, one of the species' strongholds for nesting in the park, 2005 saw the largest total number of fledglings on record: 26 eaglets from 34 active nests during 2005.

For the fourth consecutive year, a pair of bald eagles took up residence in a large tree nest located 55 meters from the Madison-to-West Yellowstone road from mid-February through early July. To enable the eagles to obtain nest material and food without human disturbance, park staff set up a temporary closure in the immediate vicinity of the nest. Visitors could stop and observe the eagles from a distance, then travel by the nest without stopping. The chicks were hatched and fledged, and the adult pair continued to add material to the nest throughout the year.

Peregrine Falcon. The peregrine falcon was removed from the federal list of endangered species in 1999 and is now managed as a species of special concern. Yellowstone National Park continues to be a stronghold for peregrines in the Northern Rockies. Four new eyries were found in 2005, bringing the total number of known eyries in the park to 30, and 44 fledglings were counted.

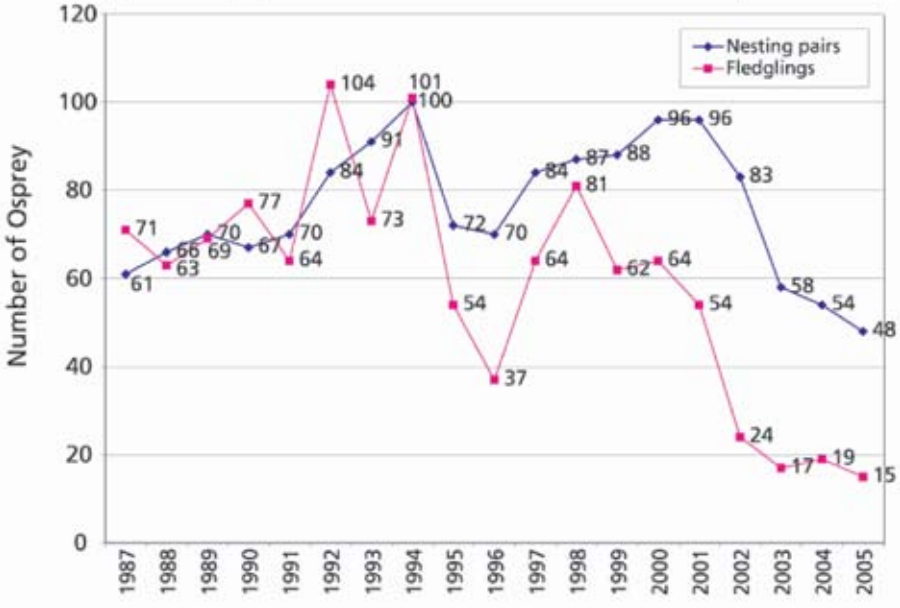
Trumpeter Swan. The park's resident trumpeter swan population, which has shown an overall decline since 1961, numbered only 19 in 2005, including one cygnet that fledged. Swan numbers in Montana's Centennial Valley, previously a major source of recruitment for the park, have declined substantially, but adult recruits from Montana's Paradise Valley have helped maintain the Yellowstone swan population. Adult recruitment was observed on the west side of the park for the second consecutive year.

Documented trumpeter swan nest attempts have ranged from 2 to 10 per year, including three in 2003, four in 2004, and three in 2005, which resulted in one brood of four cygnets. One of the newly hatched cygnets was seen being preyed upon by an adult bald eagle. Egg clutches from two swan territories were destroyed by grizzly bears, and two swans were apparently killed by wolves in separate incidents in May and July. In December, there was one report of a bobcat feeding on an adult swan whose cause of death was unknown, and a subsequent report of a bobcat seen killing a swan.

Molly Islands Colonial Nesting Birds. Aerial and boat surveys were used to census birds at the two Molly Islands in mid-May, early June, early August, and mid-September 2005. This was an average year for colonial nesting bird production, and fledglings left the nests of American white pelicans, double-crested cormorants, and California gulls. Three nests were initiated by Caspian terns, but none produced cygnets.

Osprey. The park's osprey population has been on a downward trend, with 17 fledglings from 58 nests in 2003, 19 from 54 nests in 2004, and 15 from 48 nests in 2005, which was the worst production since detailed data collection began 19 years ago (Fig. 1). A series of strong winds and wet summer weather caused some nests and/or nest trees to fall, resulting in high failure rates again this year.

Figure 1. Osprey Production in Yellowstone National Park, 1987–2005.



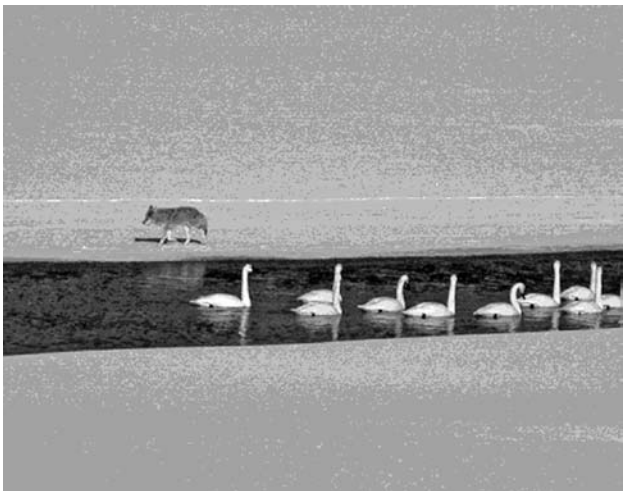
As recently as 2001, 59 nesting pairs and 26 fledglings were documented on Yellowstone Lake; in 2005, only 26 pairs and 2 fledglings were counted. The Frank Island wildfire of 2003 and a severe windstorm in 2005 that blew down most of the potential remaining osprey nest sites are believed to be responsible for the decline. Bald eagles have occasionally been documented taking over previously occupied osprey nests, and the incidence of takeover appears to be gradually increasing due to competition for nest sites. Another factor could be the decline in cutthroat trout, caused in part by predation by non-native lake trout.

Harlequin Duck. The park's harlequin duck population fluctuates from year to year, with generally 16–24 pairs residing in the park. More precise information is not known because the remoteness of many of the areas in which the ducks are found makes monitoring time-consuming and difficult.

Common Loon. The park's common loon population also fluctuates from year to year; adult numbers have ranged from 34 to 51 during the last 17 years. A total of 42 adults, 8 nest attempts, and four fledglings were documented in 2005. As in 2004, many of the nesting loons had to deal with variable water levels and shorelines as a result of weather conditions.

Other Population Monitoring

North American Bird Migration Count. Yellowstone National Park participated in the North American Bird Migration Count for the 30th consecutive year in 2005. Traditionally scheduled on the second Saturday in May, this year the count was done on May 14. Three observers recorded a total of 96 bird species and 3,109 individual birds between Yellowstone Lake and Shields Valley, Montana, 70 miles north of the park. These results were above average due to the wet spring conditions.



Coyote and trumpeter swans. Photo by Terry McEneaney.

Mid-Winter Eagle Survey. The bald eagle/golden eagle survey, which was conducted on January 7 for the 19th consecutive year, documented 27 bald eagles, and 9 golden eagles. Most of the eagles were sighted in the Jardine/Gardiner/Mammoth area. Wintering eagles continued to be most abundant on the northern range outside the park because of the waterfowl, trapper discards, and carrion from elk hunting present there. Carrion left by hunters and wildlife predators is also a winter food source.

Breeding Bird Surveys. Breeding Bird Surveys (BBS), which have been conducted in Yellowstone since 1982, are point counts at 50 stations located at half-mile intervals along a 25-mile transect through varied habitats. Data from the three BBS conducted in 2005 were sent to the database at the Patuxent Wildlife Research Center in Laurel, Maryland, and are available at www.mbr-pwrc.usgs.gov/bbs.

While not definitive, BBS data are the best long-term data available on northern range songbirds. These data points suggest that overall, songbird populations on the northern range are flat-to-somewhat declining. The two BBS points in willow habitat show mixed results, very slight declines, and very slight increases, depending on the site.

Glacier Boulder Route Songbird Survey. The Glacier Boulder survey, which began in 1986, documents birdlife in lodgepole pine habitats in Yellowstone. The point count census is conducted at 30 stations along a transect that begins at the Glacier Boulder trailhead near Inspiration Point. Census routes are being developed away from established roads because traffic noise during the summer is beginning to affect BBS routes.

Christmas Bird Count. On December 18, 2005, the Yellowstone Christmas Bird Count was conducted for the 33rd time in the Gardiner, Montana, and Mammoth, Wyoming, areas. Weather conditions were among the coldest on record for the count, with temperatures ranging from −10 to 15°F, and strong winds, but experience has shown that colder temperatures and above-average snow depth

are the optimum conditions for finding the greatest bird richness and abundance during this count. Slightly above average results were obtained: 40 bird species and 1,749 individual birds were tallied. One abundance record was broken: 34 black-capped chickadees were recorded.

Bison

Yellowstone is the only place in the United States where bison have lived continuously since before Euro-American settlement. When the decision was made to manage bison intensively in Yellowstone at the beginning of the nineteenth century in order to ensure growth of the small herd, it was the first federal program to preserve a wildlife species threatened with extinction. Today, the park's Bison Ecology and Management Office uses very different techniques and draws on a much larger body of scientific expertise in addressing very different challenges: a large bison population, some of which are inclined to seek winter range outside the park and some of which are infected with brucellosis.

In 2000, the National Park Service agreed to an Interagency Bison Management Plan (IBMP) with the Montana Department of Livestock; Montana Fish, Wildlife and Parks; the USDA Animal and Plant Health Inspection Service (APHIS); and the USFS. The Bison Ecology and Management Office continues to work with these agencies and other park divisions to carry out Yellowstone's responsibilities under this plan, a primary goal of which is conservation of the free-ranging bison population. Spatial and temporal separation of bison and cattle minimize any risk that bison may transmit brucellosis to livestock by shedding *Brucella abortus* bacteria outside the park that will survive until cattle return to range they use during the summer.

Population Monitoring

To arrive at population estimates, staff use aerial surveys to count the bison twice a year, mid-summer and mid-winter. The population has increased each year since the severe winter of 1996–97, when more than a third of the herd died as a result of boundary control operations or natural winterkill. Since implementation of the IBMP in 2000, the population has grown about 10.3% per year on average. After the 2005 summer count, the population was estimated at about 4,900 bison. During the winter, staff also do ground surveys in the west and north boundary management zones to assess how many bison are close to the boundary and determine when and where hazing may be required.

Long-term monitoring of bison demographics and population dynamics provides park managers with data that enables them to make more informed decisions and address the uncertainties of how brucellosis affects the bison population. Monitoring 29 bison cows during 2004 and 2005 revealed that 83% of the cows who were more than two years old became pregnant during the summer rut, and 75% of the pregnant cows gave birth to calves that lived for more than two days. While some two-year-old cows become pregnant in Yellowstone, very few are rearing calves the following summer.

Boundary Control

Under the IBMP, the National Park Service has primary responsibility for boundary control operations on the north side of the park near Gardiner, while decisions about bison that cross the west boundary near West Yellowstone are made by the Montana Department of Livestock. Hazing events were common at the west boundary starting in late fall of 2004, and began on the north boundary in early winter. Until February, hazing in both management zones involved only adult bulls, except for one adult cow that was shot after repeated attempts to haze her back across the north boundary proved futile. However, that was the only bison removed at the north boundary during the winter of 2004–2005. Outside the west boundary, where bison movements out of the park increased in March, the state of Montana captured and tested 171 bison, sent 98 seropositive bison to slaughter, released 78 that tested seronegative, including nine young bison that were vaccinated, and sent 17 seronegative bison to an experimental quarantine program north of the park that the state of Montana has initiated with APHIS.

For the first time in 15 years, in 2005 the state of Montana authorized the hunting of bison in certain areas outside the park boundary. A total of 50 permits were issued for two periods that spanned from November 15 to February 15.

Bison Management Plan Review

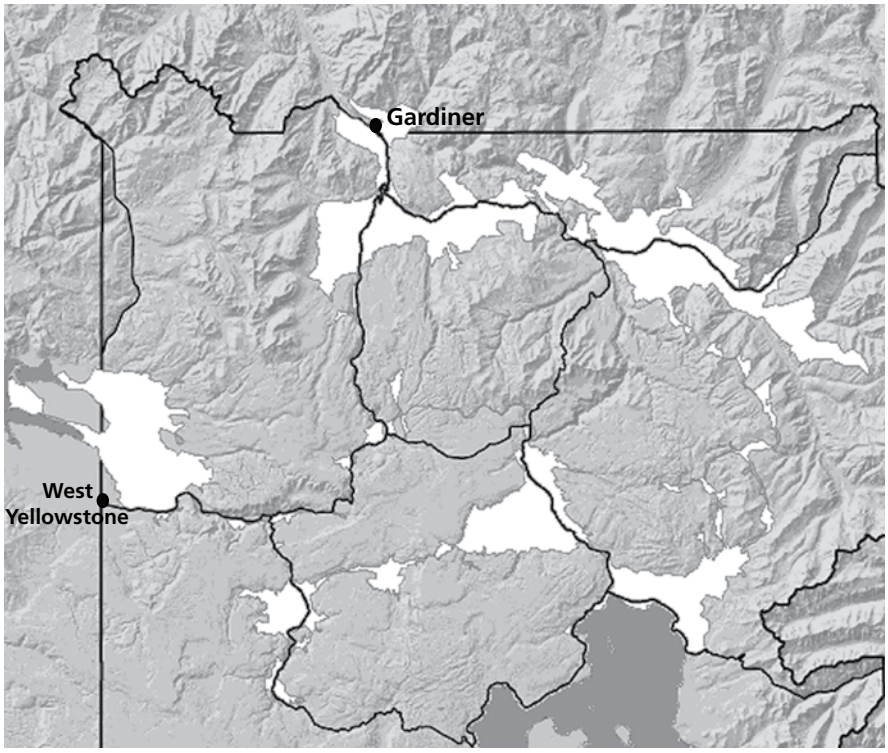
During 2005, staff participated on an interagency team that conducted a five-year status review of bison management operations since the IBMP was implemented. The resulting report, issued in September, confirmed that the agencies are working effectively together to prevent commingling of bison and cattle and noted that the state of Montana has retained its brucellosis-free status. The status review also noted that the northern boundary operations, which were expected to be focused on the northern range bison sub-population, are encountering many bison from the interior sub-population that move to the Gardiner Basin winter range.

The RB51 vaccine has met safety criteria for vaccination of eligible bison, has been determined to be reasonably effective at conveying some immunity against brucellosis, and vaccination of bison captured at the boundary has begun. However, the review determined that the agencies will not be ready to move to the next phase of the IBMP, which will permit greater tolerance for bison on low elevation winter range outside the park, until a safe and effective remote delivery mechanism is available and a bison management plan has been developed in cooperation with the Royal Teton Ranch, which owns land adjacent to the park's north boundary.

Remote Vaccination Program

Bison Vaccination EIS. By reducing the number of brucellosis-induced abortions that shed the bacteria into the environment, the vaccination of bison could, over time, further minimize any risk of brucellosis transmission to cattle. In addition to vaccination of certain seronegative bison captured at the park boundary, the IBMP committed the NPS to developing a program to vaccinate bison in the park without handling the animals. Calves and yearlings are to be the focus of the initial effort, contingent on National Environmental Policy Act evaluation of the delivery system. Subsequent research and development on remote delivery systems and vaccine safety and effectiveness now make such a program appear feasible. During 2005, staff continued work on an

Figure 1. White areas indicate habitat occupied by bison over the course of a year based on aerial surveys and radio telemetry of marked bison, 1998–2004.



environmental impact statement that evaluates the feasibility of implementing a program to remotely deliver brucellosis vaccine to free-roaming bison throughout the park. The final EIS is expected to be released around the end of 2006.

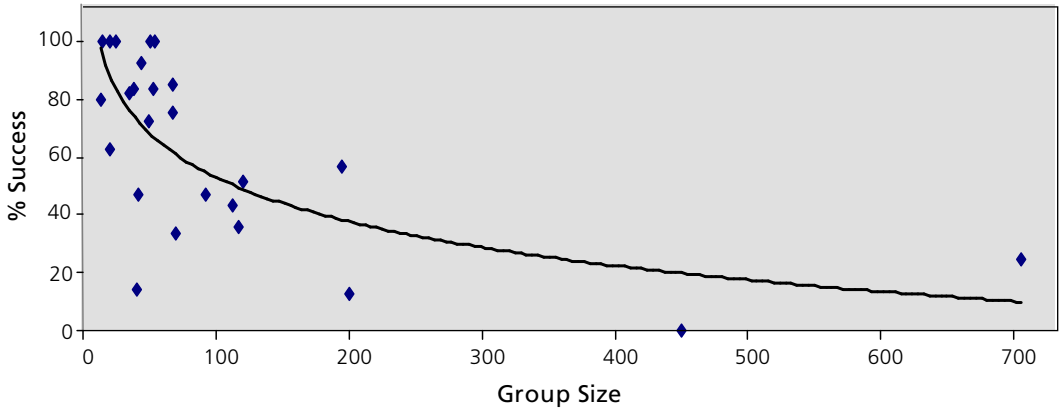
Vaccine Delivery. While vaccines for use in protecting wildlife against brucellosis are limited in number and the currently feasible methods for delivering vaccines are limited to syringes and ballistic powered remote delivery equipment, understanding group dynamics and movement patterns helps staff develop potential methods for implementing a park-wide vaccination program. A project staff have initiated to randomly mark some bison and periodically relocate them is providing insight into the ecological parameters that may make such a program successful.

Based on relocation of marked bison and information about distribution collected during aerial population counts, staff have estimated that over the course of a year the park's bison range across 220,000 acres of habitat (including about 10% of the park) located in six distinct ranges (Fig. 1) that are connected by travel corridors. Marked bison that have been located in Hayden Valley during the summer rut use winter ranges in Hayden Valley as well as Pelican Valley, Firehole Geyser Basin, the west boundary, the Gardiner Basin and the upper northern range. Group composition changes throughout the course of the annual cycle. Bison are the most concentrated when they coalesce into very large groups in the summer. By September they begin to redistribute on the landscape and spread out over a much larger area. Group size continues to decrease during the winter, from an average of 62 in December to 24 in April.

Our field studies have shown that trained crew members on foot, horseback, or vehicle could safely and successfully approach a bison group in order to deliver a vaccine biobullet to target animals (calves and yearlings). For purposes of field testing, a "successful" approach is one in which staff can stand within 30 meters of a stationary or traveling bison and make a popping noise to simulate a shot from an air-powered rifle without having the group move to an extent that would thwart the next shot. However, the ability to work around a group of bison and approach each calf and yearling depends on the size of the group; the larger the group, the smaller the percentage of target animals in the group that can be successfully approached (Fig. 2). The lower success rate in large groups is partly because they occur most often during the breeding season, which is an inopportune time to try to work closely around bison for any reason.

The uncertainties of vaccination go beyond the feasibility and logistics of delivering vaccine to individual bison throughout the park. Staff have partnered with the University of Kentucky to develop a model that can quantitatively assess the environmental consequences of three alternatives for implementing an in-park vaccination program. The modeling process has identified that the number of additional brucellosis naïve bison that are exposed to any bacteria shed by infected animals is a primary driver that allows the disease to persist in the

Figure 2. Relationship between bison group size and percent of successful approaches to within 30 meters of all calves and yearlings in the group.



population. One unknown is the probability of latent infected bison (those that developed an immunity after a previous infection) exhibiting a stress mediated re-infection response years later. These knowledge gaps point to the need for better understanding of the pregnancy cycle and the probability of shedding bacteria, regardless of whether individuals are newly infected or carry a latent infection.

Bison Movements and Distribution Study

In June 2004, the NPS arranged for Dr. Cormack Gates of the Faculty of Environmental Design at the University of Calgary to lead an independent study that would advance understanding of how groomed roads may influence winter bison movements. To prepare the resulting report that was delivered to Yellowstone managers a year later, "The Ecology of Bison Movements and Distribution in and beyond Yellowstone National Park," Gates and his colleagues met with more than 30 scientists, biologists, and current and retired park staff, as well as interested non-government organizations. The study confirmed that bison are fulfilling their functional role within the ecosystem and that their movements are explained by density of bison on suitable habitats within their range. When a threshold of about four bison per square kilometer is exceeded, the population response is to occupy a larger area. The study also concluded that road grooming is not the major factor influencing bison distribution and range expansion, and that the available evidence strongly suggests that groomed roads aligned with natural movement corridors have not changed bison population growth rates relative to what would have happened in the absence of road grooming. The study did identify a road segment through Gibbon Canyon that may facilitate bison movement from the park interior to the northern range; the possibility of conducting an experimental road closure there will be considered in winter use planning.

Brucellosis Symposium

Staff worked with other members of the Greater Yellowstone Interagency Brucellosis Committee and the United States Animal Health Association to organize a Brucellosis Vaccine and Diagnosis Workshop facilitated by the Ruckelshaus Institute of Environment and Natural Resources at the University of Wyoming in Laramie, August 16–18. With funding provided by the U.S. Departments of the Interior and Agriculture, experts from government, academic, and private institutions around the world were invited to discuss strategies for improving diagnostic capabilities, brucellosis vaccines, and delivery methods for wild bison and elk.

Public Outreach

In addition to presenting programs about bison ecology and management to a variety of audiences, staff replied to requests for information from congressmen, congressional staffers, other agency staff members, and organizations such as the American Prairie Foundation, Grasslands and Waterton national parks in Canada, and staff responded to FOIA requests from The Fund for Animals and the Buffalo Field Campaign. Staff held a workshop for Lake district staff responsible for managing visitor interactions with bison during road construction work in the Hayden Valley. Staff also provided technical assistance and logistical support for a collaboration with University of California hydrology staff who were collecting snow dynamics data (depth and water content) to validate a management and interpretive model, and helped capture relevant information for their use in preparing two films for the Division of Interpretation.

Elk and Other Ungulates

Yellowstone National Park supports one of the most diverse complexes of migratory ungulates in North America, including bighorn sheep (*Ovis canadensis)*, bison (*Bison bison*), elk (*Cervus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and white-tailed deer (*Odocoileus virginianus*). The park has also been colonized by descendents of mountain goats (*Oreamnos americanus*) that were introduced in Montana in the 1940s and 1950s.

Elk

Elk Calf Mortality Study. Staff completed a three-year study to: 1) estimate the relative causes and timing of deaths in northern Yellowstone elk calves; 2) estimate calf survival rates; and 3) evaluate factors that may predispose calves to death. Calves <6 days old were captured and fit with ear tag transmitters during May and June, 2003–2005. The calves' radio signals were monitored each day at dawn from mid-May through mid-July, when the risk of mortality to calves is relatively high, and less frequently thereafter. Ground crews investigated mortality sites and conducted necropsies to evaluate causes of death.

Of the 151 calves in the study, approximately 67% died within the first year of life. More than 90% of these deaths were the result of predation. More than 70% of this predation occurred within the first 15 days of life. During the first 30 days of life, approximately 55–60% of all mortality was the result of predation by bears; coyotes and wolves each accounted for approximately 10–15%. The causes of death did not vary significantly among the summers during the study period. Some form of compensatory mortality is likely occurring because overall summer predation has increased, while winter malnutrition may have decreased since wolf restoration. A similar study conducted in the park by Frank Singer for the period 1987–1990 found that 53% of 127 calves died during the first year of life (32% during the summer and 21% during the winter), and although nearly all summer mortality was the result of predation, winter mortality was primarily related to malnutrition. The current study was a collaborative effort of YNP, the USGS-Biological Resources Discipline, the University of Minnesota, the Yellowstone Park Foundation, Annie and Bob Graham, and Montana Fish, Wildlife and Parks.

Winter Count of Northern Yellowstone Elk. On January 5, 2005, the Northern Yellowstone Cooperative Wildlife Working Group conducted its annual winter survey of the northern Yellowstone elk population, which winters between the park's Northeast Entrance and Dome Mountain/Dailey Lake in Montana's Paradise Valley. Biologists used four fixed-wing aircraft to count elk on the entire northern range that day.

Compared to survey days in the last several mild winters, a significant snowstorm on December 31 created good survey conditions by covering the landscape, which caused elk to concentrate in relatively open areas at lower elevations where they were more likely to be detected. Approximately two-thirds of the elk observed during the 2005 survey were located within Yellowstone National Park; the rest were north of the park. The fact that this year's count of 9,545 elk was 15% higher than the 8,335 counted the previous winter, and slightly higher than the 9,215 counted two years before is considered to be more likely a result of better survey conditions than an actual increase in elk numbers. The overall trend still suggests that elk numbers have decreased substantially over the past decade as a result of predation by wolves and other large carnivores and human harvests during the Gardiner late elk hunt. Other factors that have contributed to decreased elk numbers include a substantial winterkill caused by severe snow pack during 1997.

Elk After Wolf Restoration. To evaluate predictions that ungulate numbers would move to a lower equilibrium point with corresponding density-related changes, staff have analyzed elk counts, vital rates, and limiting factors for ungulates wintering

on the northern portion of the park before and after wolf (*Canis lupus*) reintroduction in 1995–96. Elk counts decreased from approximately 17,000 in 1995 to 9,545 in 2005. From 2000–2005, pregnancy rates for prime-age females (3–15 years) during 2000–2005 were high (0.90) and similar to those during 1950–1967 when elk density was 30% lower (5–9 elk/km^2), yet indices of recruitment were among the lowest (12–14 calves/100 cows) recorded during the past several decades. The survival rate for prime-age females was 0.83 (95% CI = 0.77–0.89) compared to 0.99 when harvests were low and wolves absent.

Elk migration to lower elevation areas outside the park, and consequently, vulnerability to hunting, is strongly correlated with snow pack. The Gardiner late elk hunt was designed to limit elk numbers outside the park so that the elk do not decrease the quality of their winter range or cause long-term changes in forage productivity or diversity. During 1990–2002, a relatively constant proportion (27 $\pm$ 5%) of the elk that migrated out of the park were removed each year, primarily prime-age females with high reproductive value. As the size of the elk herd declined, a large number continued to migrate out of the park and the percentage of the herd that was harvested each year increased.

By 2003, annual wolf off-take (more than 1,000 elk even by conservative estimates) was exceeding hunter harvests, with wolves primarily selecting calves and older elk with lower reproductive value. As the ratio of wolves to elk increased, elk recruitment decreased and wolves maintained high kill rates and rapid population growth despite a 50% decrease in elk counts. In response, the state of Montana adjusted antlerless permit quotas to population size in a density-dependent manner so that harvests do not accelerate the decrease in elk numbers, and a much lower proportion of females were harvested during 2003–2005.

Other Ungulate Monitoring

Analyses suggest that the demography of bighorn sheep, mule deer, and pronghorn in northern Yellowstone has not been substantially influenced by wolf reintroduction. Pronghorn counts have remained between 204–252. With relatively high recruitment in recent years, the growth rate of the mule deer population appears to be increasing; the 2005 count was 2,366 compared to an average count of 2,032 during 1986–2005 (range = 1,616–2,544).

Bighorn sheep counts in northern Yellowstone have been relatively stable to slightly increasing since 1995, with an average count of 189 (range = 134–244). These counts remain well below the record high count of 487 sheep prior to the outbreak of infectious keratoconjunctivitis (i.e., "pinkeye") during the winter 1981–1982, which led directly or indirectly to the death of at least 60% of the population.

The current abundance of moose in and near the park is unknown because of the difficulty of conducting surveys and obtaining rigorous population estimates for this species at low densities. The abundance of moose decreased after the fires of 1988 burned important winter habitat (i.e., mature spruce/fir forests) in the north portion of the park.

Non-native mountain goats have clearly established a breeding population in the park and are at relatively high abundance in the northeastern and northwestern portions, raising concerns about adverse effects to native bighorn sheep, rare plants, and alpine habitats.

Pronghorn Migration and Seasonal Distribution. Yellowstone pronghorn retain one of only two pronghorn migrations left in the GYA. Staff used 5,750 telemetry locations of 44 adult female pronghorn obtained from June 1999 to August 2005 to determine migration patterns and seasonal distributions. Seventy percent of the pronghorn population migrated 15–50 km to four contiguous summering areas, while the remainder stayed year-round on the winter range. Migrations occurred during April 19 $\pm$ 9 (SD) days and October 18 $\pm$ 7 days, with individual migrations typically lasting 3–5 days. Most radio-collared pronghorn showed fidelity across years to their migration strategy and summer use area, but approximately 20% migrated in some years but not others. To travel the 10 km over Mount Everts, a topographic bottleneck separating the winter and summer ranges, the migrating pronghorn used three to four grassland and sagebrush pathways that are less than 300 m wide in places. Mt. Everts also served as a migration corridor for thousands of bison, elk, and mule deer, and as a destination wintering area for migratory bighorn sheep. Preserving this corridor is critical for the persistence of Yellowstone pronghorn and would aid in conserving one of the most diverse complexes of migratory ungulates in

North America.

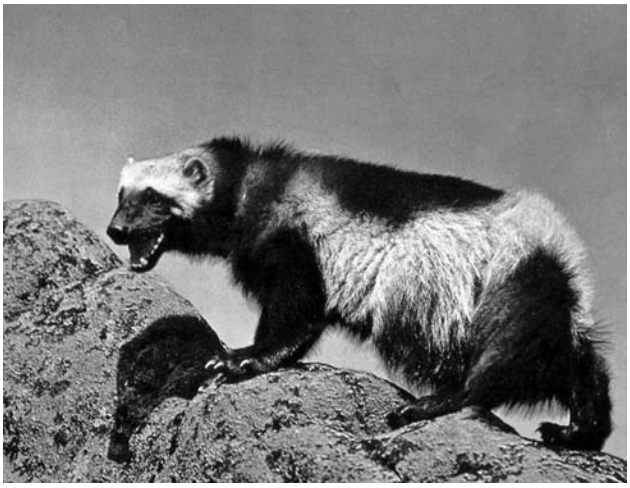
Conservation of the Pronghorn Population. Staff initiated a three-year study to 1) establish a monitoring program of abundance and key vital rates for pronghorn; 2) conduct a study of the ecological interactions among wolves, coyotes (*Canis latrans)*, and pronghorn to determine if there is differential recruitment among pronghorn fawning areas in relation to wolf and coyote densities and use areas; 3) determine the migration patterns and summer use areas of pronghorn to ensure they are not adversely affected by future infrastructure projects; 4) map habitat characteristics among fawning areas and migration routes of pronghorn; and 5) produce an electronic field trip focused on the conservation of Yellowstone pronghorn. In 2005 the electronic field trip premiered on the Windows into Wonderland website, and staff also helped convene experts to develop restoration recommendations for sites on pronghorn winter range that were once tilled for agriculture and now support invasive alien species. The study is a collaborative effort among YNP, the Yellowstone Ecological Research Center, the University of Idaho, the Bernice Barbour Foundation, and the Yellowstone Park Foundation.

Wildlife Responses to Motorized Winter Recreation. In an analysis of more than 6,500 interactions between bison and elk groups and oversnow vehicles that occurred during five winters (1999–2000, 2002–2004), staff found that elk responded with increased vigilance in 44% of the interactions and bison in 10% of the interactions. However, the frequency of higher-intensity movement responses was similar for elk and bison: 6–7% travel, 1–2% flight, less than 1% defense. These rates of movement response were relatively low compared to that found in other studies of ungulates and snowmobile disturbance. Active responses by bison were less likely during the winters that had the largest visitation, suggesting some habituation to oversnow vehicles may have occurred. There was no evidence that snowmobile or coach use during the past 35 years has affected the demography of bison or elk.

From December 2004 through March 2005, staff again monitored the behavioral responses of bison, elk, and trumpeter swans (*Olor buccinator*) to snowmobiles and coaches by surveying groomed road segments. Staff sampled more than 2,100 interactions between vehicles and wildlife groups and used multinomial logits models to identify conditions leading to behavioral responses. In 90% of the interactions, these wildlife species reacted to oversnow vehicles and associated human activities with no apparent movement or response beyond increased vigilance, in 7% they moved away from the vehicles, and in 3% they showed a flight or defense response. As in previous years, the likelihood of active responses increased significantly when the animals were on or near roads, groups of animals were smaller, or humans approached the animals. The survey results suggest that wildlife responses can be diminished by 1) restricting travel to predictable routes and times, 2) reducing the number of vehicles in groups, 3) reducing the number and length of stops to observe wildlife, 4) stopping vehicles at distances >100 m, and 5) deterring humans from engaging in disturbing activities when not in vehicles.

Public Outreach and Assistance to Other Divisions and Agencies

The Ungulate Program assisted several divisions in Yellowstone as well as other parks and refuges in complying with the Endangered Species Act and National Environmental Policy Act. Staff also assisted the Superintendent's Office with winter use planning analyses pertaining to wildlife and provided vital signs evaluations for the Greater Yellowstone Inventory and Monitoring Network. In addition, staff responded to requests from park staff for assistance in dealing with aggressive, habituated, or injured ungulates. Staff shared program results with other agencies in the Greater Yellowstone Area, including Montana Fish, Wildlife and Parks; USFWS; USGS; USFS; and Wyoming Game and Fish Department. Also, staff provided dozens of informational talks to visitors, natural resource managers, educational specialists, and students, both at the park and elsewhere. Staff participated on the graduate committees of several students and collected information or samples requested by non-governmental researchers. In addition, staff conducted a symposium on "Integrated Science in Central Yellowstone" at The Wildlife Society conference in Madison, Wisconsin.



A large-scale wolverine study was initiated in 2005.

Mid-sized Carnivores

Yellowstone supports its original diversity of mid-sized carnivores such as Canada lynx, bobcat, wolverine (*Gulo gulo*), American marten, river otter, badger, and red fox. Although little is known about the presence of these species in the park, they play an important ecological role as predators of small and mid-sized mammals and as scavengers. Due to their rareness and affinity for boreal forests or alpine habitats, the Canada lynx and wolverine are rarely seen, but they carry strong aesthetic and existence values. The Canada lynx is federally protected as a threatened species. The red fox, American marten, and long-tailed weasel are common in the park.

The mission for the mid-sized carnivore program is to improve the information available for resource management, planning, and interpretation staff in the park, as well as agency partners, such as the USFWS, that have joint conservation responsibilities for listed species under the Endangered Species Act. Inventories, monitoring, and basic research are vital to identifying and managing human effects, conservation planning, and efforts at public education.

2005 Highlights

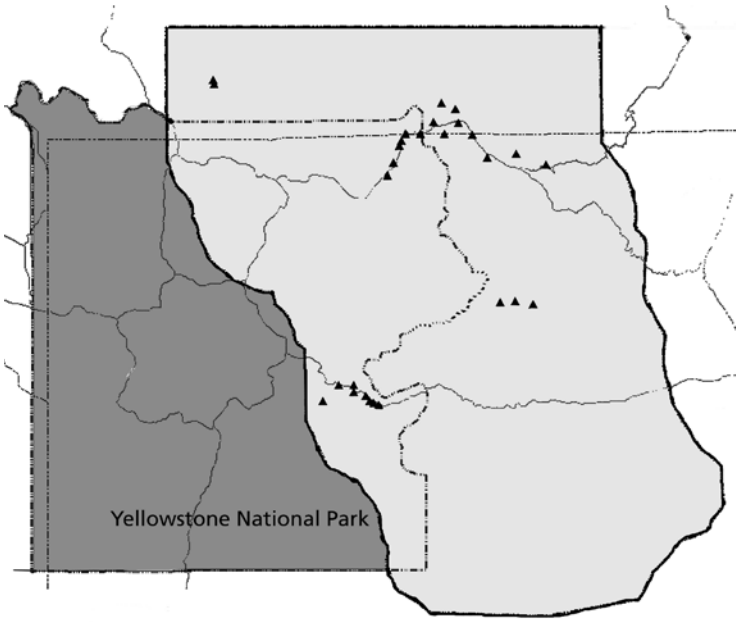
The primary focus of the mid-sized carnivore program during 2005 was on initiating a large-scale wolverine study and preparing publications related to the Canada lynx survey in Yellowstone that was completed in 2004. A summary of the survey appeared in *Yellowstone Science,* and a manuscript intended for *Northwest Science* was submitted for publication. Staff also provided field assistance to outside researchers studying river otters on Yellowstone Lake and red fox on the northern range, and administrative assistance to Wildlife Conservation Society biologists conducting wolverine research along the west and south boundaries of the park.

Absaroka-Beartooth Wolverine Ecology

The wolverine, which is the largest terrestrial member of the weasel family, recently emerged as a concern in the northern Rockies because the species may be particularly vulnerable to extirpation due to low numbers, a low reproductive rate, and large spatial requirements. Anthropogenic influences, such as winter recreation and road development, may compound unfavorable life history attributes by causing disturbance during postnatal periods and creating barriers to movement within the wolverine's native habitat and among different populations. Two petitions to list the wolverine under the Endangered Species Act have been rejected by the U.S. Fish and Wildlife Service. Conservation of this species may depend on having more information about its ecology and threats to its survival.

Lacking even basic knowledge of this elusive animal, park and national forest managers have identified the need for field studies that provide life history information and gauge the effects of humans on wolverine at a landscape scale. Such studies are essential in developing long-range strategies that help ensure wolverine persistence and the biological integrity of high-elevation environments. During 2005, YNP and the USFS Rocky Mountain Research Station began a five-year study to evaluate wolverine status, ecology, and interactions with humans in the eastern portion of the park and the Shoshone and Gallatin national forests. Other cooperators include the Wyoming Game and Fish Department, the Rocky Mountains Cooperative Ecosystem Studies Unit, the USFS Region 1 Carnivore Program, and the Yellowstone Park Foundation.

The study is specifically designed to remedy the information shortfalls that currently impede wolverine conservation planning and management in this region. The goal is to improve existing data on wolverines and their environmental requirements, particularly in regard to the anthropogenic effects of park and national forest management. A second goal



Map of wolverine study area indicating trap locations.

is to foster appreciation and support for wolverine conservation through public education. The objectives are to collect basic data on the residency and breeding status of wolverines; document aspects of their population, including sources of death, genetic characteristics, and extent of connectivity with other wolverine populations in the northern Rockies; document habitat requirements related to birthing dens and potential human disturbance; and describe interactions with other carnivores, such as wolves and grizzly bears.

During summer and fall 2005, staff constructed 28 wolverine live traps at sites distributed in four geographic areas across the 3,500-mi^2 study area. In Yellowstone, the traps were constructed using logs cut from lodgepole pine trees cleared at Canyon Village during construction of the new contractor camp. The logs were hand-carried to trap sites along the East and Northeast Entrance roads. On the national forests, logs for traps were obtained from dead trees found at the trap site.

Beginning in January 2006, the traps will be baited, set, and remotely monitored. When a trap has been entered, the nearest available of the four crews will go to the site. The captured wolverines will be radio-marked with GPS technology that provides location and movement information at a broad range of temporal and spatial scales. For the safety of both the crews and bears, the trapping season will end when bears begin to emerge from hibernation each spring.

Staff have obtained the necessary research permits from YNP, Montana Department of Fish, Wildlife and Parks; the Wyoming Game and Fish Department; and the University of Montana Institutional Animal Use and Care Committee. Staff completed a peer-reviewed study plan and aviation safety plan, and assisted the Yellowstone Park Foundation in preparing several funding proposals. Yellowstone and Grand Teton interpretation staff and project biologists made seven presentations to lay and professional audiences concerning the study, wolverine life history, and conservation needs.

Wolverines enter through the gap under the lid and, when they pull on a food bait connected to a trigger, the lid falls. Photo by Kerry Murphy.

Wolves

As part of the effort to restore a viable wolf population to the Greater Yellowstone Area that began in 1995, YCR Wolf Project staff monitor population dispersal, distribution, reproduction, mortality, and predation on ungulates within YNP.

Population Monitoring

Population Status. At least 118 wolves occupied ranges located primarily in the park at the end of 2005. That was 53 (31%) fewer wolves than were known to be present at the end of 2004 (Fig. 1), the largest annual population decline since wolf restoration began. It was largely attributable to poor pup survival, for which disease is suspected as the major cause. The decline was offset by the continued growth in the wolf population outside the park, bringing the total Greater Yellowstone population to 325 in 2005.

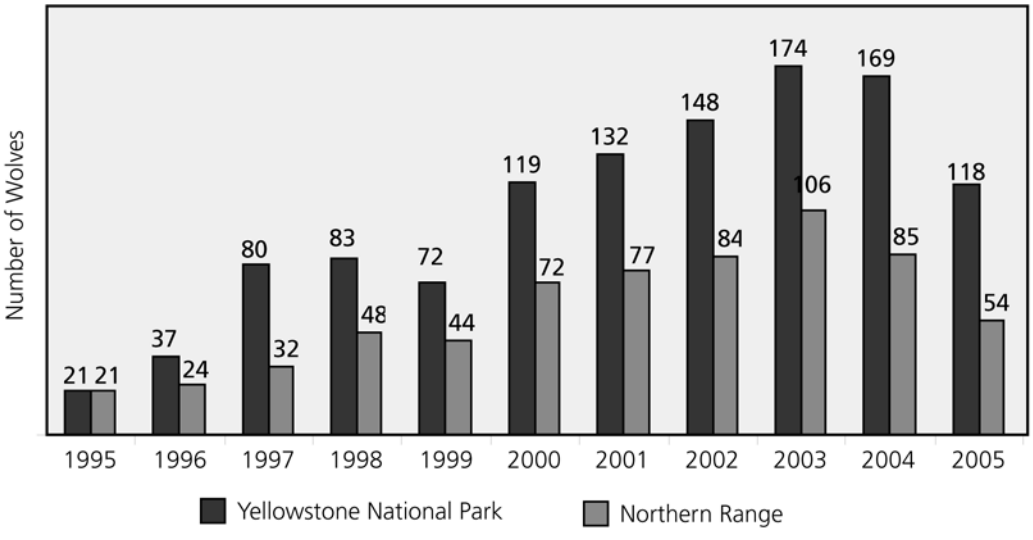
The number of packs residing primarily in the park declined from 15 to 13 during 2005. One new pack formed (Hellroaring Creek) when part of the Leopold pack split off, but three packs that were in the park at the end of 2004 are gone: the Biscuit Basin pack moved to Idaho, and the Specimen Ridge and Geode Creek packs dissolved. Two other packs, Nez Perce and Swan Lake, declined substantially and are likely to disband in 2006 if they have not already. In late December the alpha female of the Nez Perce pack was killed by the Gibbon Meadows pack and the surviving Nez Perce members dispersed.

Despite the significant population decline, wolf distribution remained largely the same in the park. Wolf territories continue to include the northern range, Pelican Valley, Hayden Valley, the Madison-Firehole, north of the Madison River, Thorofare, and Bechler. The six packs that occupied the northern range had a total of 54 members at the end of 2005, 30 (36%) less than a year earlier. The count for the other seven packs was 64 (down 26%). Pack size ranged from 4 (Druid Peak) to 17 (Yellowstone Delta) and averaged nine wolves. Seven packs had breeding pairs.

Reproduction. Eleven of the packs exhibited denning activity, and seven used a previous den (Swan Lake, Leopold, Delta, Bechler, Gibbon Meadows, Cougar Creek, and Nez Perce). Wolf Project staff visited den sites and collected scats to analyze the wolves' summer diets.

Ten of the packs produced at least 13 litters and a total of 69 pups, but only 22 pups (32%) were still alive at year end. Pup survival was especially poor on the northern range, where only 8 (16%) of 49 pups survived. None of the pups born to the Druid Peak, Swan Lake, and Nez Perce packs survived. Mollie's pack had no pups, probably because the alpha female died shortly before the breeding season

Figure 1. Number of wolves in Yellowstone National Park, 1995–2005, comparing the northern range to the total park population.



began and had not been replaced. Two packs had multiple litters: the Slough Creek pack produced four litters with a total of 15 pups, of which three survived; the Leopold pack had at least three and possibly four breeding females who gave birth to a total of 19 pups, of which two survived.

Mortalities. Twenty-five radio-collared wolves died in 2005. Intraspecific killing was the leading cause of death, but mange was a factor for the first time, resulting in three deaths. However, the 2005 mortality rate (not including pup mortality prior to September) was 15%, less than the 10-year average of 20%.

Wolf–Prey Relationships

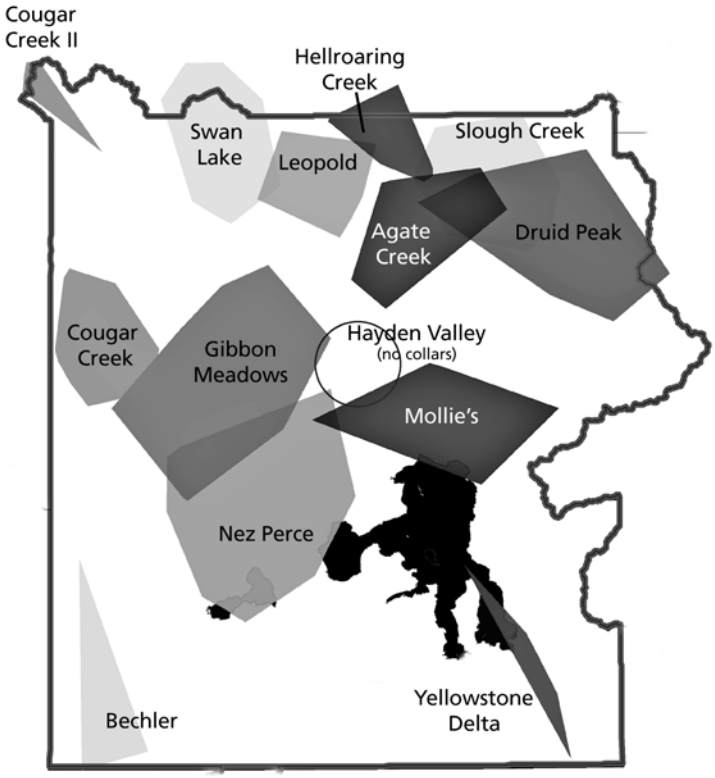
Wolf–prey relationships were documented by observing wolf predation directly and by recording the characteristics of prey at kill sites. Staff added to the database of information about behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, percent consumption of kills by wolves and scavengers, and characteristics of wolf prey (e.g., sex, species, nutritional condition), and kill sites. Similar data were also collected opportunistically throughout the year during weekly monitoring flights and ground observations.

Composition of Wolf Kills. Including definite, probable, and possible kills, staff detected a total of 316 wolf kills during 2005: 244 elk (77%), 29 bison (9%), 9 wolves (3%), 6 deer (2%), 4 moose (1%), 4 coyotes (1%), 2 skunk (1%), 2 ravens (1%), 1 pronghorn (<1%), 1 badger (<1%), and 14 unknown prey (4%). The composition of elk kills was 18% calves (0–12 months), 11% cows (1–9 years), 12% older cows (>10 years), 43% bulls, and 16% elk of unknown sex and/or age. Bison kills included 9 calves (unknown sex), 10 cows, 6 bulls, and 4 bison of unknown sex and age.

Winter Studies. During two 30-day periods in March and November–December, the wolves were intensively radio-tracked. Two-person teams on the ground monitored the Leopold, Geode Creek, and Slough Creek packs during the March study period, and the Slough Creek and Hellroaring packs during the November–December period. Aerial monitoring during both study periods was done of all four of these packs as well as the Swan Lake, Agate Creek, Mollie's, Gibbon Meadows, Nez Perce, and Cougar Creek packs. The Yellowstone Delta, Bechler, and Biscuit Basin packs were rarely located, largely because of poor conditions for aerial monitoring in the southern part of the park or because they were outside the park.

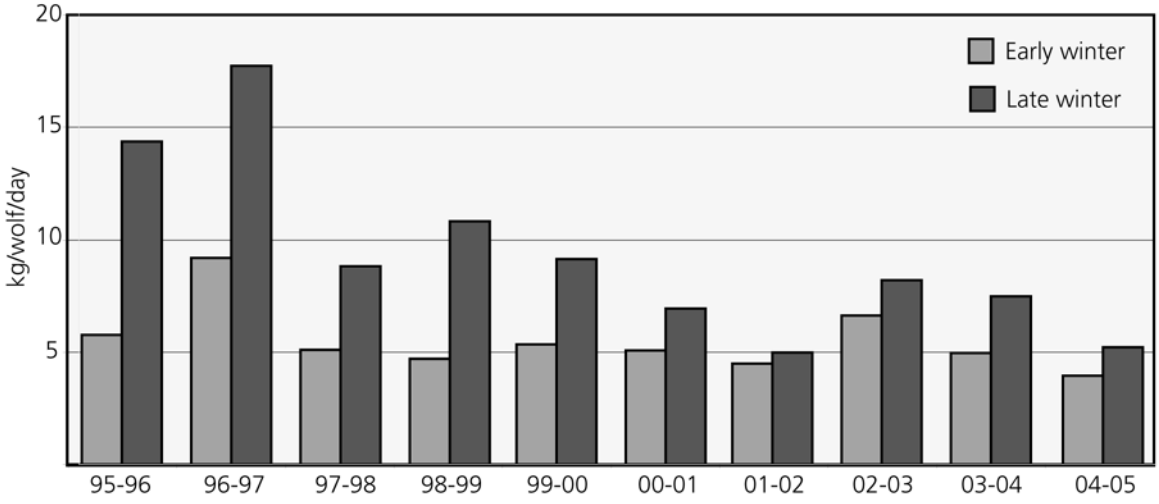
During the March study period, staff detected 69 definite or probable kills. Wolves were also observed scavenging on nine bison and seven elk that had died from other natural causes (e.g., winterkill, cougar kill, stuck in mud). During the November–December period, staff detected 55 definite or probable wolf kills.

On the northern range, winter predation rates for 1995–2000, which were calculated using the double count method, showed an average of 1.8 elk/wolf/30-day study period. In the last two winters, a slightly different method (minimum kill rate) showed an average of 0.9 ungulates/wolf/30-day study period. Although the two methods of calculation are not directly comparable, this decrease suggests changing



Territories occupied by the 13 wolf packs residing primarily in YNP, plus that of the Nez Perce pack, whose status was unknown at the end of 2005.

Figure 2. Food consumption by wolves during early and late winter study periods from the winter of 1995-1996 to the winter of 2004-2005.



ecological conditions on the northern range. Food consumption by wolves in early winter compared to late winter has varied less in recent years than it did during the first years after wolf reintroduction, which suggests that wolves are now killing at a rate that more closely approximates their daily food requirement throughout the winter (Fig. 2). Recent findings also indicate that compared to the first eight years after restoration, the use of calves has declined while the use of bulls has increased.

Summer Predation. Documenting the predatory habits of wolves is more difficult in summer because nighttime activity increases, pack cohesion decreases, the prey tends to be smaller and more quickly consumed with less evidence left, and tracking the wolves is harder without snow. The best data concerning wolf summer food habits have come from analysis of scat collected at den and rendezvous sites. In 2005, staff also deployed GPS collars on some wolves to enhance understanding of 1) seasonal predation patterns; 2) spatial and temporal interactions with other wolf packs and other carnivores; 3) movements with respect to dens during pup rearing season; and 4) territory size, use, and overlap. Using GPS radio collars with downloadable data acquisition technology, weekly data gathering on collars was attempted. Collars programmed to collect location data every 30 minutes provided high resolution data on wolf movements and enabled researchers to find more wolf kills, even newborn elk calves.

However, malfunctioning collars and wolf mortality in 2005 made summer predation patterns difficult to document. The collared alpha male in the Geode pack was killed by the Leopold pack in March. A Geode wolf pup also had a GPS collar, but he became a lone wolf after the death of the alpha male and strife with the Leopold pack led to the disbanding of the Geode pack. The GPS data showed that he survived for more than three months by scavenging more than 10 carcasses of animals ranging from two weeks to four months old, most of which consisted of only bone and hide. He died of starvation in late summer. After the GPS collar on a Leopold pack female began malfunctioning in early summer, data could not be downloaded. Summer predation studies will continue with newer collars in 2006.

Summer Scavenging. Research on wolf and scavenger interactions, mostly done in the winter, has been conducted since 1998 with support from Canon U.S.A. and YCR. This research has monitored how wolves influence the abundance and distribution of carrion, spatially and temporally, and how they facilitate food acquisition by other carnivores. Although staff have learned a great deal about the magnitude and relative importance of wolf-killed carcasses to the winter scavenger communities, little is known about the impact on summer scavengers. In the summer of 2005, Dr. Chris Wilmers of the

University of California–Davis began collaborating with project staff to document invertebrate diversity and abundance at summer carcasses. This effort will continue in 2006 with increased monitoring efforts.

Population Genetics

A collaborative effort with the University of California–Los Angeles was initiated in 2005 to use genetics techniques to construct a pedigree for all handled Yellowstone wolves and understand gene flow between the three Rocky Mountain wolf recovery areas. Blood samples from more than 500 wolves from Idaho, Montana, and Wyoming were sent to Robert Wayne at UCLA for genotyping and determination of heterozygosity (a measure of genetic diversity). Eventually a pedigree of all handled Yellowstone wolves will be constructed to help explain pack dynamics and social behavior.

The high level of heterozygosity (0.64) found in Yellowstone wolves indicates a genetically robust population. The three recovery areas can be distinguished from each other genetically and migration assessed. Movement of Yellowstone wolves to Idaho appears to be frequent, but there is no genetic evidence that any have moved to the northwest Montana recovery area. Immigration from Idaho and northwest Montana into Yellowstone appears to be rare, indicating some isolation of the wolves in the Yellowstone recovery area.

Wolf Management

Wolf Capture. Staff captured and handled a total of 36 wolves from 12 packs in 2005 (15 pups, 5 yearlings, and 16 adults). In addition to collaring the wolves, Wolf Project staff measured each captured wolf and took a blood sample for genetic and disease analysis. No wolves were ear tagged. Although the objective is to have at least one collared wolf in each pack, the Hayden Valley pack could not be located for aerial capture. At year end, 39 (33%) of the 118 known wolves were collared.

Area Closures. To prevent human disturbance of young pups, an area of about one square mile centered on the Slough Creek pack's den (southwest of the Slough Creek Campground) was closed to visitors until July 1. Shorter closures of one to two weeks were enforced around the Agate Creek and Hayden Valley dens until those packs moved to more remote dens or rendezvous sites. Den sites for the Leopold, Mollie's, and Nez Perce packs were protected through Bear Management Area closures for Blacktail (March 15 to June 30), Pelican Valley (April 1 to July 3), and Firehole (March 15 to through Memorial Day Weekend). The areas around the other packs' den sites were not closed because of historically low visitor use in these areas.

Druid Road Management Project. YCR, Resource and Visitor Protection, and the Division of Interpretation launched the Druid Road Management Project in 2000 with private funds to manage wolf viewing in Lamar Valley. The project objectives are: 1) human safety—control parking and traffic along the road to protect motorists and those viewing wolves; 2) wolf safety—protect wolves from vehicle strikes, permit wolves to cross the road without human interference, and protect the den area from visitor intrusion; 3) visitor enjoyment—provide opportunities for people to view and learn about wolves and other wildlife ecology; and 4) wolf monitoring and research—maintain opportunities for scientists to study the denning behavior, predation activity, and interactions of wolves with other wildlife.

Previously, the Druid Peak pack, which has denned in Lamar Valley since 1997, has been the most easily observed by park visitors. However, in 2005 the Druid Peak pack did not return to their traditional den site near the road. Because vehicular traffic control in that area was not needed, staff focused on the Slough Creek pack denning area, which was visible from the Northeast Entrance Road and the Slough Creek Campground road. Two staff members from the Division of Interpretation who were assigned to the northern range to help educate the public about wolves spent most of their time in the Slough Creek area working with wolf project staff. Two accidents were reported at Slough Creek but no one was injured. Traffic overall was less of an issue, especially after the Slough Creek road reopened July 1, but before that parking space was insufficient. Hundreds of visitors were able to observe the wolves from a safe distance from early April through late July. This was the second largest number of visitors to see wolves in a single year (2002 was highest).