

Wolves

OVERVIEW

Wolf-like canids were among the first carnivores, and are estimated to have taken form about 40 million years ago. A wolf resembling the contemporary species first appeared during the Pleistocene, about one million years ago, and played an important role in the structuring of ecosystems. The wolf is the largest extant wild member of the *Canidae* family, which includes coyotes and domestic dogs. All wolves are considered members of the same species (*Canis lupus*), except for those native to the southeastern United States, commonly referred to as the red wolf (*Canis rufus*).

Recent research suggests that North America has five extant subspecies of *Canis lupus*. Native to Alaska and the northern Rocky Mountains of Canada and the United States, *Canis lupus occidentalis*, often called the Rocky Mountain wolf, was brought from Canada to restore populations in Idaho and Greater Yellowstone in the 1990s. *Canis lupus baileyi*, referred to as the Mexican wolf, is native to that country and the southwestern United States. However, the distinctions among the five subspecies are generally not considered significant, at least partly because of the wolves' mobility and overlapping ranges (Nowak 2005). Differences in *Canis lupus* exist in gradations across North America, creating gray areas rather than distinct boundaries between one subspecies and another. On average, the largest skulls of gray wolves are from the northwestern part of North America and the smallest are from Mexico and southeastern Canada (Paquet and Carbyn 2003).

Physical Characteristics

Although often referred to as the gray wolf, *Canis lupus* comes in various combinations and shades of white, brown, gray, and black. In Minnesota, most wolves are gray or shades of brown while in Montana, wolves are black as often as gray.

Adult males may weigh up to 130 pounds, but average 110–115 pounds and are usually 5–6½ feet long from nose to tail tip. Adult females weigh up to 115 pounds but are typically 90–95 pounds and 4½–6 feet in length. Most adult wolves stand 26–32 inches tall at the shoulder.

With long legs and a deep, narrow chest, the wolf is well-suited for far-ranging travel. Wolves have large feet that aid in moving over crusted snow and provide an advantage for preying on ungulates species whose hooves and often heavier weight can cause them to sink more deeply into snow or mud. The front feet are slightly larger than rear feet, but wolf tracks average about 4 inches wide and 5 inches long, including the claw marks (USFWS 1994).

Distribution and Population Size

Once one of the most widely distributed land mammals in the Northern Hemisphere, the gray wolf was systematically extirpated beginning in the 1630s in the eastern United States and gradually moving west, where they were completely removed from parts of southern Canada and all of the coterminous U.S. except northeastern Minnesota by the 1930s. Fifty years later, wolf distribution began expanding again, extending southward into Alberta and British Columbia, reaching northwestern Montana and northern Wisconsin and Michigan in the 1980s. As a result of restoration programs that began in the 1990s, wolf packs have also returned to Greater Yellowstone, central Idaho, and a contiguous area of Arizona and New Mexico (International Wolf Center 2005). The worldwide gray wolf population has been estimated at 150,000 in 41 countries, including about 50,000 in Canada and 12,000 in the United States, more than half of them in Alaska. As of the end of 2005, the wolf population in the Northern Rockies was reported to include an estimated 512 wolves in Idaho, 252 in Wyoming, and 256 in Montana (USFWS et al. 2006).

Wolves are territorial mammals that usually live in familial packs and defend their boundaries against other wolves. Starting with the first release of 14 wolves in Yellowstone in 1995, the wolves quickly dispersed to establish territories, but not without conflict. For example, when the Druid Peak pack was released in 1996, these wolves roamed widely, fighting with two other packs, and evicting the Crystal Creek pack from its territory in Lamar Valley on the northern range. The Crystal Creek pack fled to Pelican Valley, in the middle of the park, where their descendants still reside, renamed Mollie's pack (for late USFWS Director Mollie Beattie).

The Yellowstone wolf population grew quickly in the first years after restoration as the newly forming packs spread out to establish territories in areas with sufficient prey. However, population declines occurred in Yellowstone in 1999 and 2005, largely because of poor pup survival. The Yellowstone wolf count dropped from a high of 174 in 2003 to 118 (13 packs) in 2005 (Smith et al. 2006). This decline was offset by the continued growth in the wolf population outside the park, bringing the total Greater Yellowstone population to 325 in 2005 (USFWS et al. 2006).

Despite the significant population decrease in 2005, wolf distribution has remained largely the same in Yellowstone, with six packs occupying territories on the northern range and the others in the Pelican Valley, Madison–Firehole, north of the Madison River, Thorofare, and Bechler areas. The Bechler region was one of the last places in the park to



be reoccupied by wolves. Because typically harsh winters prevent year-round occupation by elk or moose, wolves have had difficulty living there or on Mirror Plateau, although wolves do use the latter in the summer when elk are present (Smith 2005).

Ecology

Habitat

Gray wolves have occupied nearly all habitat types in the Northern Hemisphere except tropical rainforests, true deserts, and the southeastern United States, which was inhabited by the red wolf. Rather than on landform, climate, or plant community, the presence of wolves depends on the availability of suitable prey.

In Yellowstone, wolves may be said to occupy two kinds of habitat as a result of differences in the availability of prey between the northern range and the park interior. On the northern range, which is lower in elevation and receives less snow, elk are abundant and the primary prey of wolves year-round. In the park interior however, most elk leave in the winter except for the Madison–Firehole herd. Consequently, wolf density is much higher on the northern range than in the park interior, where wolves must often kill bison and sometimes moose to survive the winter. In 2003, 41% of the area included in northern range wolf territories was in more than one pack's territory, whereas interior wolf pack territories were mostly isolated and rarely overlapped. As a result, wolf-to-wolf conflict and kills have been much higher on the northern range than in the park interior. Wolves on the northern range are smaller in average size, and their population typically declines over winter because of death and dispersal, whereas the interior population usually does not decline over winter (Smith 2005).

The size of wolf territories is highly variable and depends on pack size, food availability, and season, with territories typically larger in winter than in summer. In Yellowstone, annual average territory size ranged from 53 square miles for the Cougar Creek pack to 553 square miles for the Chief Joseph pack. Packs occupying the prey-rich northern range tend to have smaller territories, averaging 113 square miles compared to an average of 340 square miles in the rest of the park (Smith 2005).

Food Sources

Unlike bears, which eat a wide variety of food, wolves eat mostly meat. Because of their size and their ability to hunt in packs and quickly consume large amounts of meat, their most efficient food source is generally large animals (Mech 1970). Except in areas of North America with abundant beaver populations, ungulates typically account

for more than 90% of the biomass consumed by wolves (USFWS 1994). In addition to preying on animals, wolves obtain meat by scavenging the carcasses of animals that have died from other causes, sometimes displacing other scavengers.

Knowledge about wolf predation in Yellowstone depends largely on information from detected kills. Not all kills are detected; they are more likely to be noticed in certain parts of the park, and in the winter than in the summer, when elk and bison calves may disappear without a trace. However, some conclusions can be drawn based on the kills that have been detected. Of the 1,275 documented winter-kills by wolves in Yellowstone since restoration, 90% have been elk. Data collected on wolves in Greater Yellowstone has shown that a 10-member wolf pack kills an average of 180–190 elk per year (Smith and Ferguson 2005).

A wolf can be severely injured or die as result of the struggle to bring down a prey animal; hence, wolves search for vulnerable prey (Smith 2005). Bison are the most difficult ungulate prey for wolves in Yellowstone, but wolves have gradually increased their take, with 29 bison kills (9% of all documented kills) in 2005 (Smith et al. 2006). Adult bison are most likely to be taken in late winter, when they are in their weakest condition.

Although elk and bison constitute nearly all of Yellowstone wolves' winter diet, about 25% of their summer diet is mule deer. Wolves have taken few pronghorn, probably because an adult pronghorn can run 60 mph, compared to 35 mph for a wolf (Smith 2005). Wolves occasionally take moose, but like bison, moose are difficult for wolves to kill. From 1995 through 2005, documented wolf kills include 37 moose, 2 bighorn sheep, and 2 mountain goats.

Life Cycle

Reproduction. Wolves reach sexual maturity at two years, but usually only the alpha male and alpha female within a pack mate. However, when conditions permit (typically when there is abundant food), a pack may produce multiple litters. The production of multiple litters in Yellowstone may also have resulted from situations in which packs created from the relocated Canadian wolves included multiple unrelated wolves (Smith 2005). Although courtship behavior may occur throughout the year, wolves typically breed from late January through April, depending on the latitude; wolves in higher latitudes generally breed later (USFWS 1994). Wolves in Yellowstone breed in February.

Denning. Wolves who become pregnant complete digging their dens as much as three weeks before the birth of the pups. Most wolf dens are burrows in the ground, usually in sandy soil. Wolves may also den in hollow logs, rock caves, or abandoned beaver lodges (USFWS 1994).



Some packs use the same den site year after year.

With the denning area established, pack movements center around the den. However, adult pack members often travel throughout their territory for food. The gestation period for wolves is about 63 days; in Yellowstone, pups are born from late March through April in litters that have averaged 4.7 pups (Smith 2005). All pack members may play with and protect the pups, as well as help feed them and their mother. A wolf pack will usually move from the den site to the first rendezvous site when the pups are 6–10 weeks old (late May–early July). The first rendezvous site is usually within 1–6 miles (2–10 km) of the natal den and often consists of meadows and adjacent timber with surface water nearby. The maternal female is usually at the rendezvous site more than the other adults are, but she may also travel throughout the territory as pups grow and are weaned after five to six weeks. A succession of rendezvous sites is used, each for about 10–70 days, and each about 1–4 miles (2–6 km) from the previous site, until the pups are mature enough to travel with the adults, usually by September or early October (USFWS 1994). As with dens, rendezvous sites may receive repeated use by the same pack year after year.

Mortality. The average life expectancy for a wolf in the wild is about two to four years; a wolf in captivity may live up to 16 years. The average life span for a Yellowstone wolf, however, has been 3.4 years; a Yellowstone wolf that lives past five years is doing well. The leading known natural cause of death in Yellowstone has been attacks by other wolves. Wolves are fiercely territorial, and when trespasses occur, wolves may die (Smith 2005).

Parvovirus or some other disease or combination of diseases is probably responsible for Yellowstone's poor pup survival in 1999 and 2005. Mange has been reported to the north, east, and west of Yellowstone, and was detected for the first time in the park in 2004, when a wolf was observed with hair loss. Mange is caused by a mite that is spread by direct contact with an infected animal or with something that an infected animal has contaminated. The mite burrows into an animal's skin causing irritation, lesions and scabs. It can be fatal when its presence leads to a chronically weakened immune system, secondary infections, or hypothermia (USFWS et al. 2006).

Social Habits

Pack formation. Wolves are highly social, and their basic social unit is the pack. Central to the pack are the dominant (alpha) male and female. The remaining pack members are usually related to the alpha pair and express their subordinate status through postures and expressions when interacting with the dominant pair. Wolves approaching sexual maturity may challenge an alpha wolf, which can result in changes in each wolf's social position in the pack. Wolf pack composition influences how a

pack operates and defends its territory. A simple pack is made up of a breeding pair with pups; a complex pack has a breeding pair with several generations of offspring (Smith 2005). Six of the seven packs that were released in Yellowstone in 1995 and 1996 still exist, but two of these packs have recently shifted most of their territory across the park's north boundary into Montana.

As a pack travels throughout its territory, the alpha pair usually leads the way and chooses the direction and specific routes of travel. Wolves often travel on established routes including trails, roads, and frozen waterways, occasionally cutting across from one such route to another. Daily travel distances for wolf packs are typically in the range of 1–10 miles (2–15 km), while distances between successive kills vary from 8–34 miles (13–55 km) (USFWS 1994).

Pack size. Pack size depends partly on the size of the primary prey—the larger the prey, the more food there is available to eat and the larger the number of wolves needed to bring the prey down. Wolves that live on deer tend to have packs of 5–7 wolves, whereas wolves that prey on moose or bison tend to have packs of more than 15 wolves. Pack size during the first 10 years after restoration in Yellowstone has averaged 11, but it has ranged up to 37 (Smith 2005). That was the size reached by the Druid Peak pack after it produced three litters in the spring of 2000. However, in subsequent years the pack experienced numerous dispersals and deaths, including the killing of an alpha female by her pack members. With only four members left in 2005, the alpha pair mated both with each other and with the pack's other member of the opposite sex, and at least six pups resulted, but none of them survived. By year's end, they had been pushed out of their territory in the Lamar and Soda Butte valleys by the 15-member Slough Creek pack (Smith et al. 2006).

Larger pack size may confer territorial advantages for wolves on the northern range where the combination of more prey and more wolves competing for it has led to greater population instability than in the park interior. The wolves on the northern range, especially the pups, have begun to show body condition declines and increased mortality rates (Smith 2005).

Communication. Howling and scent marking are two important means of communication for wolves. Within a pack, howling helps with identification, location, and assembly of separated pack members. It may also be useful in facilitating the movements of pups and adults from one rendezvous site to the next. Howling may serve a social function when pack members rally around the alpha individuals and greet each other. It is also a means of advertising a pack's presence and its willingness to defend its territory, pups, or a kill from other wolves. This helps prevent direct conflicts between packs.

Scent-marking is the application of an animal's odor to its environment, usually by urinating or defecating. It is used



by wolves to communicate information regarding territory, position in the dominance hierarchy, location of food, and even the behavioral or physiological condition of the animal. Scent marks are commonly made at route junctions and especially along the edges of pack territories to inform wolves when they are entering another pack's territory (USFWS 1994).

Dispersal. Wolves may disperse from their natal pack after they reach about nine months of age. Yearlings often disperse in late winter (USFWS 1994). The nature and extent of dispersal in wolves appears to be related to wolf density and prey availability. In low-density populations, wolves may disperse just out of their natal pack's territory into an unoccupied area, find a lone wolf of the opposite sex, breed, and produce a litter, forming a new pack. In high-density populations, such animals may stay in the pack if permitted and wait for changes in the rank order and opportunities to mate. If forced out, these loners may trail a pack or live in the buffer zones between territories to avoid conflicts. However, mortality is often high among dispersing animals; and, the chances of finding a mate and successfully establishing a new pack are low. In some situations, wolves may disperse hundreds of miles. In 2004, a two-year-old wolf that had left Yellowstone's Swan Lake pack was found dead on Interstate 70 near Denver, Colorado (Wondrak Biel and Smith 2005).

Ecological Role

The Yellowstone area has one of the most diverse assemblages of large carnivores in North America, and these species all feed on elk—black and grizzly bears, cougars, coyotes, wolves, and humans. Wolf reintroduction has affected coyotes more than any other carnivore; reduced coyote densities have been recorded across the northern range. Some displacement of cougars by wolves seems to be occurring, but these findings are preliminary. Observations indicate that wolves are benefiting grizzly bears by providing carcasses for them to scavenge. When whitebark pine nuts, a key pre-hibernation food source for bears, were scarce in the autumn of 2002, an unusually large number of grizzly bears were observed feeding on wolf kills throughout the park. Interactions with black bears have been fewer, but wolves seem able to dominate them (Smith 2005).

Black and grizzly bears visit wolf kill sites, and grizzlies have forcefully expelled wolves from them. Although all Yellowstone wolf packs must deal with bear competition, Mollie's pack in Pelican Valley is particularly vulnerable to bear raids. When grizzly bears emerge from their dens in Pelican Valley, typically in March, they now tend to zero in on wolf kills. From March through October during the three year period ending in 2004, every observed kill made by Mollie's pack was taken over by grizzly bears. Within a few hours of wolves' killing an elk or bison, bears

tended to sniff it out and chase the wolves away. In late 2004 and early 2005, it appeared that Mollie's pack might be breaking apart. This may be largely due to the death of their alpha male and female in December 2004, but loss of food to grizzlies may also be a factor (Smith 2005).

Rarer animals may also take advantage of wolf kills. Wolverines, for example, do not typically migrate to lower elevations in winter, and they rely primarily on carrion to survive. Wolves often make kills on high windblown ridges in winter where bull elk remain, surrounded by deep snow. These kills could serve as food sources for the rare wolverine. Nothing from a wolf kill goes to waste. An average of 29 ravens attend every wolf kill (Smith and Ferguson 2005).

Although wildlife biologists disagree about the current or likely long-term effects of wolf restoration in Yellowstone, one hypothesis is that it is triggering a trophic cascade—a succession of direct and indirect impacts that may affect every part of the park. Most researchers agree that willow are growing taller in some areas. Although the elk population in Yellowstone was limited for more than 30 years by trapping to prevent what was regarded as overgrazing, anecdotal evidence suggests that that willow growth remained suppressed during that period. The current willow release is happening with roughly three times as many elk on the landscape. One theory is that it may be elk behavior, rather than elk numbers, that makes the difference. Most researchers agree that along with a decline in the elk population, elk behavior is changing. With wolves now always present on the landscape and hunting at night, elk have responded by keeping on the move. Elk reduction was done as quickly as possible, and only during the day, so it may have had less effect on elk browsing patterns (Smith 2005).

Status in the Greater Yellowstone Ecosystem

Legal Status

By 1978, all *Canis lupus* subspecies were on the federal list of endangered species for the lower 48 states except Minnesota, where it was listed as threatened. The U.S. Fish and Wildlife Service (USFWS), which is responsible for administering the Endangered Species Act, began wolf recovery programs in Idaho, Montana, Wyoming, Arizona, and New Mexico, in the 1990s. To address objections raised by surrounding communities, these populations were designated as "non-essential experimental." This provides more flexibility than is otherwise allowed in managing an endangered species. For example, a wolf or wolf pack in an experimental population may be relocated or killed if it preys on livestock (USFWS 1994).

As of 2002, the three Northern Rocky Mountain



recovery areas had met the criteria set by the USFWS: a total of at least 30 breeding pairs well distributed among Wyoming, Montana, and Idaho for three consecutive years. (A breeding pair for this purpose is defined as an adult male and female that produces a litter of pups at least two of which survive until year-end.) The USFWS has approved the plans submitted by Idaho and Montana, and those states have been granted authority for managing wolves outside Yellowstone. However, the USFWS determined that Wyoming's statutes and wolf management plan must contain adequate protections for the gray wolf before the species will be delisted. Regardless of listing status, the National Park Service will continue to be responsible for monitoring the wolves whose territories lie primarily within Yellowstone.

Threats to Wolves

As in most other wolf populations in North America, most known wolf deaths in Greater Yellowstone are the result of human actions: management removals, usually because of predation on domestic animals; vehicular accidents; and illegal killing. However, within Yellowstone National Park, where conflicts with human activity are less likely to occur, most wolves die of natural causes. For example, of the 25 Yellowstone wolf deaths that were documented in 2005, 11 were wolves that died as a result of fighting within or between packs, 3 died from mange-related problems, 12 died of other natural or unknown causes, and 2 appeared to have died from human-related causes after leaving the park. The overall mortality rate for Yellowstone wolves in 2005 (not including pup mortality prior to September) was 15%, compared to the 10-year average of 20% (Smith et al. 2006).

The role of human-caused mortality in wolf survival makes protected areas especially important to sustaining wolf populations. With an adequate prey base, an established wolf population can reproduce at a rate sufficient to offset human-caused mortality rates of 28%–35% (USFWS 1994). In Yellowstone National Park and central Idaho, wolf survival has averaged 80–85% annually since reintroduction. Outside protected areas (such as in northwest Montana and in the Greater Yellowstone Area outside Yellowstone National Park), mean annual wolf survival is 55%. These numbers are supported by the preliminary results of a survival analysis using a model that will include 30–40 independent variables and 716 wolves living in the northern Rockies between 1982 and 2004.

Management Activities in Yellowstone National Park

Historical Management

Like most other Euro-Americans of the nineteenth and early twentieth centuries, park managers regarded wolves as vicious predators that endangered the well-being of more popular animals such as elk. With congressional support, wolves and other predators were routinely killed in Yellowstone. During the 1920s, however, at the beginning of the movement toward more ecologically-based wildlife management, predator control in national parks began falling from favor. Yellowstone's elk herds grew substantially during the first three decades of the century, along with a concern that they would have to be reduced by some means to prevent habitat degradation and starvation. National Park Service (NPS) policies were revised in 1931 to prohibit predator control except "when they are actually found making serious inroads upon herds of game or other animals needing special protection" (Albright 1931). But by then, no wolf packs were left in Yellowstone to control.

As a result of the designation of *Canis lupus* as an endangered species, the USFWS's first Northern Rocky Mountain Wolf Recovery Plan was signed in 1980 and updated in 1987. In 1988, Congress directed the NPS to study the potential impacts of wolf reintroduction in Yellowstone and a four-volume report was produced (Varley and Brewster 1992). By 1994, the USFWS had, with Congressional authorization and funding, completed an environmental impact statement for the reintroduction of gray wolves into Yellowstone and central Idaho in consultation with the NPS and the U.S. Forest Service. Wolves had already returned to northwest Montana through dispersal from Canada, so the strategy was to protect that new wolf population and relocate wolves from Canada to Idaho and Yellowstone (USFWS 1994).

Despite some strong opposition, primarily from local politicians and ranching communities, the USFWS worked with Canadian wildlife biologists to capture wolves by darting them from a helicopter. Fourteen wolves were shipped to Yellowstone from Alberta in January 1995, and 17 from British Columbia in January 1996. The return of the only species known to be missing from Yellowstone for the past half-century was a milestone in ecological restoration. The Canadian source areas, located along the Rocky Mountains, were similar to Yellowstone in terrain and prey type. Another 35 wolves from the same areas were shipped to central Idaho (Smith 2005).

Although the wolves sent to Idaho in 1995 and 1996 were released immediately in the Frank Church–River of No Return Wilderness, the areas of Yellowstone selected for release of the wolves were less remote and the wolves would have less room to wander safely. Therefore, to try



to curb their homing instinct and curtail wide ranging movement, the wolves sent to Yellowstone were acclimated in pens for 10 weeks before they were released. In most cases, the wolves grouped together in a pen had been caught together in Canada. However, when a breeding pair could not be captured, park staff did the matchmaking. Although putting same-sexed adult wolves together in a pen almost always causes fights or deaths, an adult male and female in a pen will almost always get along, and adding pups of either sex rarely causes problems. In addition to being considered a reasonable precaution, the use of acclimation pens was more feasible in Yellowstone than in Idaho because of the park's road system and the availability of park staff to guard and feed the captive wolves (Smith 2005).

In 1995, the first wolves were placed in three pens on Yellowstone's northern range at Soda Butte, Rose Creek, and Crystal Creek. In 1996, two groups were placed in pens on the northern range, one at Nez Perce Creek, and one on the southeast arm of Yellowstone Lake. Rangers patrolled the pen areas from a distance but, to prevent habituation to humans, they had minimal contact with the wolves. Twice a week park staff and volunteers brought in road-killed deer, elk, moose, and bison (Smith 2005). Of the seven packs released from the pens in 1995 and 1996, only the Nez Perce pack did not fulfill the goals of acclimation—to reduce post-release movements and maintain familial ties between wolves (Smith 2005).

Although the recovery plan had provided for three to five years of wolf captures and shipment from Canada, the released wolf populations were thought to be on their way to recovery with sufficient genetic diversity after the first two years. However, a litter of ten wolf pups from northwest Montana was released in Yellowstone in late winter 1997 after an acclimation period (Smith 2005).

The USFWS has primary responsibility for overseeing implementation of the Endangered Species Act regardless of what state or federal agency has jurisdiction over the land where the species is located. However, as wolves began to establish territories that extended partly or entirely outside the park, Yellowstone staff initially continued to keep track of these wolves as well those in the park, making frequent trips to Red Lodge and Dillon, Montana; Jackson and Sunlight Basin, Wyoming; and most often, Paradise Valley, Montana. In 1999, the USFWS hired staff and partnered with the Turner Endangered Species Fund to monitor wolves outside the park, and now the states of Montana and Idaho have taken over management responsibilities within their jurisdictions outside the park.

Current Management

Current management activities in Yellowstone National Park consist primarily of research and monitoring projects and management of potential wolf–visitor conflicts as a result of the occasional proximity of wolves to roads and visitors to areas used by wolves.

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