# YELLOWSTONE WOLF PROJECT

# ANNUAL REPORT
2009

# Yellowstone Wolf Project

## Annual Report
## 2009

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National Park Service
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*Wolf logo on cover and title page: Original illustration of wolf pup #47, born to #27, of the Nez Perce pack in 1996, by Melissa Saunders. Treatment and design by Renée Evanoff.*

*All photos not otherwise marked are NPS photos.*

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# Background

Although wolf packs once roamed from the Arctic tundra to Mexico, they were regarded as dangerous predators, and gradual loss of habitat and deliberate extermination programs led to their demise throughout most of the United States. By 1926, when the National Park Service (NPS) ended its predator control efforts, there were no gray wolf (*Canis lupus*) packs left in Yellowstone National Park (YNP).

In the decades that followed, the importance of the wolf as part of a naturally functioning ecosystem came to be better understood, and the gray wolf was eventually listed as an endangered species in all of its traditional range except Alaska. NPS policy calls for restoring, where possible, native species that have been eliminated as a result of human activity. Because of its large size and the abundant prey, the Greater Yellowstone Area (GYA) was identified in the recovery plan as one of three areas where the recovery of wolf populations had a good chance of succeeding.

The U.S. Fish and Wildlife Service (USFWS) has the primary responsibility for ensuring compliance with the Endangered Species Act (ESA) and oversees the multi-state wolf recovery program. The USFWS had proposed that 30 breeding wolf pairs with an equitable and uniform distribution throughout the three Rocky Mountain recovery areas (greater Yellowstone, central Idaho, and northwest Montana) for three successive years would constitute a viable and recovered wolf population. Recovery goals were met in 2002, and gray wolves were removed from the endangered species list in Idaho and Montana in 2009; the USFWS has not yet accepted the wolf management plan proposed by the state of Wyoming.

Following an extended period of public planning and input, wolf restoration to the GYA began in 1995, when 14 wolves were brought to the park from Alberta, Canada, held in acclimation pens for 10 weeks, and then released. Initial founder wolves, named for the geographic locales at which they were acclimated, were the Crystal Creek, Rose Creek, and Soda Butte packs on Yellowstone's northern range. In 1996, an additional 17 wolves were transplanted from British Columbia and released in more widespread locations throughout the park. In 1995–96, a companion effort to restore wolves to central Idaho occurred, using a simpler technique without acclimation. Although the original plan, outlined in *The Reintroduction of Gray Wolves to Yellowstone and Central Idaho, Final Environmental Impact Statement* (1994), called for annual translocations from Canada for up to five years, additional transplants were deemed unnecessary by 1997 because the founder wolves had higher reproduction, lower mortality, and less movement from the GYA than was originally expected.

Three full-time employees worked for the Yellowstone Wolf Project in 2009: Project Leader Douglas Smith and biological science technicians Erin Albers and Rick McIntyre. Daniel Stahler split time between graduate work at the University of California in Los Angeles and working in the park as a project biologist. Other paid and volunteer staff were Colby Anton, Nate Bowersock, Nick Bromen, Cheyenne Burnett, Carrie Byron, Brenna Cassidy, Kira Cassidy, Grace Hammond, Sarah Hardee, Joshua Irving, Ky Koitzsch, Lisa Koitzsch, Bonnie McDonald, Meghan O'Reilly, Mike Peterson, Rebecca Raymond, Aaron Snyder, Dave Unger, Trina Wade, and Hilary Zaranek. Some of these staff members were paid technicians with funding provided by the Yellowstone Park Foundation.

Wolves reintroduced into Yellowstone were classified by the USFWS as "nonessential experimental" under section 10(j) of the Endangered Species Act and are managed outside the park under special rules that permit flexibility in addressing wolf conflicts with livestock and other wildlife management goals. It was anticipated that as the wolf packs established their territories, some would hunt and/or reside outside the park on other public or private land, and that some of the 412,000 livestock in the GYA would be preyed upon. The special rules contained provisions for addressing the possibility of conflicts with livestock.

To facilitate monitoring and research, all of the wolves brought from Canada were radio-collared before release, and YNP maintains radio collars in all wolf packs within the park. Wolf Project staff monitor population dispersal, distribution, reproduction, mortality, and predation on ungulates. Monitoring and management activities for the first two years of the project are documented in *The Yellowstone Wolf Project, Biennial Report 1995–96*. Subsequent project activities are presented in annual reports.

# 2009 Summary

At the end of 2009, at least 96 wolves in 14 packs, 1 non-pack group, and 2 loners occupied Yellowstone National Park (YNP). This represents a 23% decline from 124 wolves in 2008 but the number of breeding pairs (6) did not change. Intraspecific strife, food stress, and mange were the likely causes of the decline. No evidence of distemper as a cause of mortality has been found, unlike previous population declines in 1999, 2005, and 2008. Pack size ranged from 3 (Lava Creek and Canyon) to 17 (Gibbon Meadows) and averaged 7.1, down from the long-term average of 9.8 wolves per pack. The average number of pups per pack in early winter was 1.8 for all packs, but 3.8 for packs that had at least one pup, compared to the long-term average of 4.0 for packs with at least one pup.

Wolf Project staff detected 365 wolf kills in 2009, including 302 elk (83%), 19 bison (5%), 17 deer (2%), 6 wolves (2%), 4 pronghorn (<1%), 3 coyotes (<1%), 2 red foxes (<1%), 1 moose (<1%), 1 bighorn sheep (<1%), 1 Canada goose (<1%), 1 bald eagle (<1%), and 8 unknown prey (2%). The composition of elk kills was 36% cows, 29% bulls, 24% calves, and 10% unknown sex and/or age. Bison kills included 7 calves, 4 cows, 3 bulls, and 5 unknown sex adults. Intensive winter and summer studies of wolf predation continued.

Other research included population genetics, disease, hunting behavior, spatial analyses of territory use, wolf pack leadership, multi-carnivore–scavenger interactions, breeding behavior, dispersal, and observations of wolf, grizzly bear, and bison interactions in Pelican Valley.

Twenty-two wolves from 11 packs were captured and collared. At year end, 32 of the 96 (35%) known wolves in the park were collared.

Wolf management activities included den site closures and hazing of habituated wolves. For the first time a wolf was intentionally killed in the park because it had become food conditioned and threatened human safety. The Canyon pack denned within one mile of Mammoth Hot Springs and was hazed from the developed area causing them to relocate their den. Wolf Project staff made 15,285 visitor contacts and counted 31,000 people observing wolves in Lamar Valley and other places where wolves were frequently sighted. Wolf Project public outreach included 183 talks and 90 interviews to all types of groups and media including scientific conferences.

Additional information on wolves in Yellowstone National Park is available at www.nps.gov/yell/naturescience/wolves.htm, www.greateryellowstonescience.org, and www.westerngraywolf.fws.gov.

# Yellowstone Wolf Pack Territories, 2009

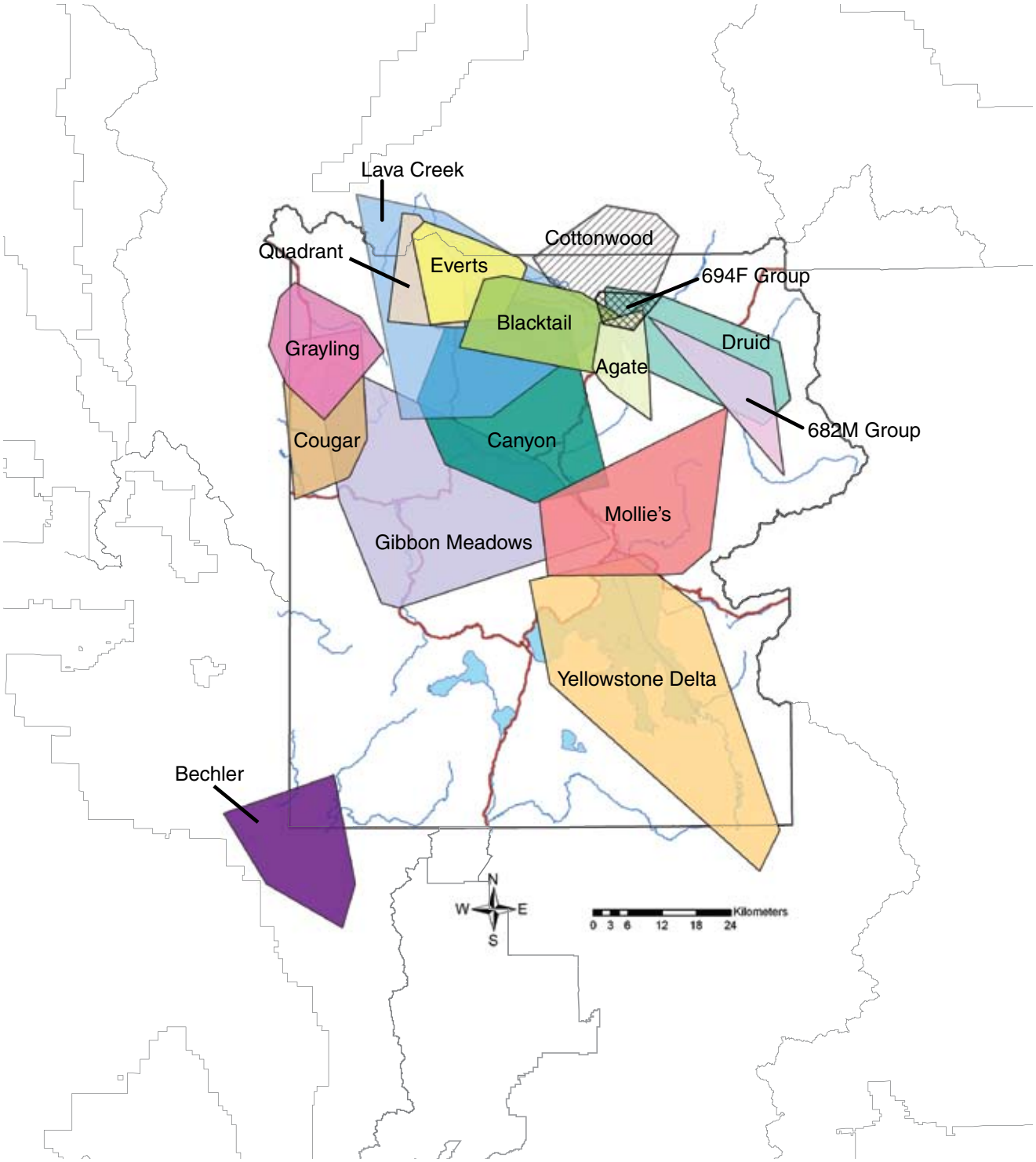


*Figure 1. Wolf packs that had some or all of their territory within Yellowstone National Park in 2009.*

*Blacktail wolves pursue elk on Blacktail Deer Plateau in late March.*

## The Yellowstone Wolf Population

### *Population and Territory Status*

At the end of 2009, at least 96 wolves in 14 packs, 1 non-pack grouping, and 2 loners occupied Yellowstone National Park (YNP; Fig. 1, Table 1). This represents a 23% decline from 124 wolves in 2008 (Fig. 2) but the number of breeding pairs (6) did not change. The decline was greater for the northern range (–29%) than for the interior (–18%). For the second consecutive year, the wolf population in the park interior was larger than on the northern range. Intraspecific strife, food stress, and mange were likely causes of the population decline. This was the first population decline not apparently caused by the disease distemper (other population declines occurred in 1999, 2005, and 2008), and the first time that the population declined for two consecutive years since wolf reintroduction began in 1995.

Each of the packs present at the end of 2008 was smaller by the end of 2009, but two new packs formed: Lava Creek on the northern range and Grayling Creek in the interior. Lava Creek was comprised of three wolves at year end, two of which (#471F and SW#147M) had been together for more than a year without successfully reproducing. The Grayling Creek pack formed when dispersers from the Cougar Creek and Gibbon Meadows packs joined with an uncollared adult. The female from Cougar Creek (#632) had at least two pups that survived, but she died late in the year, probably killed by other wolves.

Pack size ranged from 3 (Lava Creek and Canyon) to 17 (Gibbon Meadows) and averaged 7.1, down from the long-term average of 9.8 wolves. The average number of pups per pack in early winter was 1.8 for all packs and 3.8 for packs that had at least one pup (5 of 13 packs had either no pups or no surviving pups; Cottonwood Creek pack not included), compared to the long-term average of 4.0 pups per pack (this includes packs that had pups but none survived).

*Table 1. Yellowstone National Park wolf population, December 2009.*

| Pack | Adults | Pups | Total |
|---|---|---|---|
| **Northern Range:** | | | |
| 682M Group (Hoodoo dispersers) | 2 | 0 | 2 |
| Agate | 3 | 0 | 3 |
| Blacktail | 5 | 4 | 9 |
| Cottonwood | unk | unk | unk |
| Druid | 11 | 0 | 11 |
| Everts | 4 | 0 | 4 |
| Lava Creek (formerly 471F group) | 3 | 0 | 3 |
| Quadrant Mountain | 4 | 3 | 7 |
| Loners/Non-pack (Jasper Male) | 1 | 0 | 1 |
| **Northern Range Totals** | **33** | **7** | **40** |
| **Non-northern Range:** | | | |
| Bechler (no radio collars) | unk | unk | 6 |
| Canyon | 3 | 0 | 3 |
| Cougar Creek | 3 | 3 | 6 |
| Gibbon Meadows | 11 | 6 | 17 |
| Grayling Creek | 2 | 2 | 4 |
| Mollie's | 10 | 5 | 15 |
| Yellowstone Delta (no radio collars) | unk | unk | 4 |
| Loners/Non-Pack Wolves (578F) | 1 | 0 | 1 |
| **Non-northern Range Totals** | **30** | **16** | **56** |
| **Total** | **63** | **23** | **96** |

Underline denotes breeding pair.

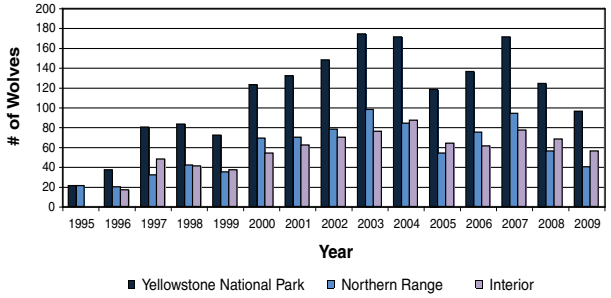


*Figure 2. Yellowstone National Park early winter wolf population, 1995–2009.*

Two wolves that had reached the advanced age of 12 years died or were presumed dead in 2009: #126F of the Delta pack disappeared and was eventually presumed dead, and #192M of the Bechler pack died during summer. Nine-year-old #302M was killed by other wolves (probably the Quadrant Mountain pack). Old wolves that survived the year were #472F of Agate Creek (8–9 years), #586M of Mollie's (7–8 years), and #482M of Gibbon Meadows (8–9 years). Wolf #480M, the longtime alpha male from Druid Peak, at 7–8 years and with a bad case of mange, disappeared and will likely not survive.

***Northern range.*** After an almost complete reorganization of the packs on the northern range (NR) in 2008, there was little overturn in pack territories in 2009. Despite stable packs, the northern range population declined 57% from 94 wolves at the end of 2007 to 40 at the end of 2009. Disease (distemper and mange), intraspecific strife, and food stress all contributed to the two-year decline. Distemper was not documented in 2009; however, mange was prevalent, especially in the Druid Peak pack, and was likely a contributing factor for some wolf mortalities. It is likely that fewer vulnerable elk were present in 2009 than in 2008, leading to less food consumption and the death of at least one wolf from malnutrition, a rare cause of death for YNP wolves. Fewer vulnerable elk may also have been an underlying cause of intraspecific strife.

No packs on the northern range disbanded during 2009 and one new pack formed (Lava Creek). The Mount Everts pack was much reduced by year end with no surviving pups, as were the Druid Peak and Agate Creek packs. Blacktail and Quadrant Mountain packs each had surviving pups. Cottonwood Creek pack, formed in late 2008 and occupying territory extending beyond the park boundary, also had pups; however, 4 of the 10 wolves in the pack, including both alphas and two radio-collared wolves, were killed during Montana's first wolf-hunting season. The pack could no longer be tracked and was not counted as a breeding pair. Other than one sighting of #383M, the Slough Creek pack was not present in the park in 2009. Wolf Project staff concluded that one of a few possibilities must have occurred: the pack broke apart, some wolves died and the rest dispersed, or the group stayed together and moved north of the park. Mange was extensive in the Druid Peak pack and likely contributed to mortality in pups as well as adults. Less severe cases of mange were observed in other packs on the NR.

***Interior.*** Wolf numbers in the park interior declined only slightly. Lower density, possibly leading to less exposure to disease including mange, and greater reliance on bison likely reducing food stress, kept the interior population from declining as much as on the NR. No pack disbanded and one pack formed (Grayling Creek). The Canyon pack produced pups but none of them survived; the pack spent time both in the interior and on the NR. Mollie's, Gibbon Meadows, and Cougar Creek packs were stable. The status of the Bechler and Yellowstone Delta packs at year end was less clear than in previous years. The Bechler pack's only radio-collared wolf (#192M) died in 2009, making tracking and counts difficult. The Delta pack was equally hard to track and no radio-collared wolf in it was consistently tracked. On a backcountry trip into the Thorofare region, multiple areas of wolf sign were recorded, indicating the presence of individuals or small groups of wolves but no pack activity.

## Reproduction

Of the 44 known pups produced in 2009, 23 (one more than in 2008) survived the summer (Fig. 3). As in 2008, this was one of the lowest years for pup production since wolf reintroduction began. Although the

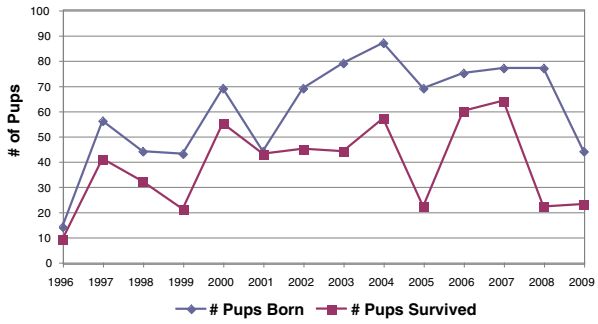


*Figure 3. Yellowstone National Park pups born and survived, 1995–2009.*

*Magpies are among the most common scavengers to visit wolf kills, occasionally arriving even before ravens.*

*Intra-pack interactions by the Quadrant Mountain pack. At right the gray wolf on its back is the "alpha" female being pinned by a subordinate or "beta" female.*

survival rate (52%) was not as low as in previous years when distemper was documented, some pups likely died before they were observed. Unlike other years when pup production was poor, distemper does not appear to be the cause of the poor recruitment. Lack of food during summer was a probable cause, although other causes cannot be ruled out. None of the Druid Peak pups survived, and their severe cases of mange were likely a contributing factor to their mortality. At year end, pups comprised more than 24% of the wolf population in the park, representing a slight increase from 17% in 2008. Eleven of 13 packs produced pups (85%; Delta and Bechler packs were excluded as pup production was unknown), but by year end only six packs were known to have pups. Although Lava Creek or Agate Creek packs denned, there was no evidence to indicate that pups survived. Pups were born but none survived in the Mt. Everts, Druid Peak, and Canyon packs. Gibbon Meadows pack had the most surviving pups (6) for the second consecutive year. Two packs (Druid Peak and Blacktail) each had two litters of pups.

## Mortalities

Ten collared wolves died in 2009 (Table 2). These included 3 old adults (>5 years), 6 adults (2–5 years), and 1 yearling. Three males and seven females died. Two of the four wolves that were legally killed during the Montana hunting season were collared, and another collared wolf from the park was killed because of mange in a control action that originated in the park but occurred outside the park. Four wolves died from intraspecific strife, one from malnutrition, and two from unknown natural causes (probable causes were old age and intraspecific strife). One uncollared, food-conditioned wolf from the Gibbon pack was killed in the park.

*Table 2. Confirmed mortalities of collared Yellowstone National Park wolves, 2009.*

| # of Deaths | Wolf #/Sex | Age Class | Pack | Date of Death | Cause of Death |
|---|---|---|---|---|---|
| 1 | 625F | Yearling | Leopold | 3/12/09 | Control Action |
| 2 | 694F | Adult | 694F Group | 4/14/09 | Intraspecific |
| 3 | 192M | Old adult | Bechler | 6/3/09 | Natural Unknown |
| 4 | 716F | Adult | Cottonwood | 9/24/09 | Harvest |
| 5 | 527F | Old adult | Cottonwood | 10/3/09 | Harvest |
| 6 | 302M | Old adult | Blacktail | 10/7/09 | Intraspecific |
| 7 | 569F | Adult | Druid | 10/15/09 | Intraspecific |
| 8 | 536F | Adult | Oxbow (was alone) | 11/5/09 | Malnutrition |
| 9 | 632F | Adult | Grayling | 11/5/09 | Natural Unknown |
| 10 | 697M | Adult | 682M Group | 12/29/09 | Intraspecific |

*Quadrant Mountain pack doing what wolves do most days: sleep.*

## Pack Summaries

### *Quadrant Mountain Pack* *(7 wolves: 4 adults, 3 pups)*

After localizing at a new den site near Reese Creek, this pack, which formed in 2008, produced three pups that survived to year end. Collared wolves included the alpha pair (#469F and #695M), but field observations revealed that an uncollared black adult female, possibly #469's sister, was vying for the alpha position. Numbering seven wolves, the pack's territory expanded slightly out of their core territory at Gardners Hole, which is dominated by bull elk, to make use of Willow Park, Elk Plaza, and the Bunsen Peak/Osprey Falls region, giving them greater access to cow/calf elk groups. The pack had a slight overlap in territory at their eastern boundary with the Blacktail Deer Plateau pack and the roving Canyon pack. It is likely that Quadrant Mountain wolves were responsible for the death of the Blacktail pack alpha male (#302) in October. Despite more frequent interaction with other packs than in 2008, no members of the Quadrant Mountain pack have shown signs of mange.

### *Mount Everts Pack* *(4 adult wolves)*

The Everts pack continued to occupy territory atop their namesake mountain near the park's north entrance. Despite spending most of its time in a relatively small area of rolling hills and plateau terrain bordered by the Yellowstone River, Gardiner, and Mammoth Hot Springs, this pack appeared to thrive in the first half of the year in a territory rich in elk, mule deer, bison, bighorn sheep, and pronghorn. In early 2009, downloadable GPS-collars were deployed on wolves #684M (black yearling) and #685M (gray alpha), allowing for detailed study of predation patterns, especially in the summer. Although numbering seven adults and five pups at mid-summer, the pack had declined to four adults by year end with a seemingly fragmented pack structure. At least two adults died during the summer, including the uncollared alpha female and an old adult female, as well as the entire litter of pups, putting the fate of this pack in question. All wolves in this pack showed moderate signs of mange, which may have contributed to pup mortality. With the alpha female gone, it was suspected that #470F (a former Leopold wolf) would take the lead alongside alpha #685M; however, for the most part, she continued to stay within the confines of her natal territory.

### *Lava Creek Pack* *(3 adult wolves)*

The Lava Creek pack formed in late February when former Agate wolf #471F and Agate/Blacktail wolf #692F joined with a black male disperser from the Eight Mile pack in Montana's Paradise Valley designated by Montana Department of Fish, Wildlife and Parks as SW#147M. Wolf #692F soon left and traveled with the Agate pack before rejoining the Blacktail pack. A two-year-old gray Agate female joined the pack in March. The pack localized around Lava Creek as if denning but no pups were observed. Suspected alpha #471F was seen temporarily with the Blacktail pack during denning season, but she rejoined the other two Lava Creek wolves in May. The frequently peaceful intermingling of these Lava, Blacktail, and Agate females is presumably due to their close kinship and shared origin in the Agate Creek pack. The pack spent most of the summer ranging from Lava Creek to

*The number of wolves in the Mount Everts pack declined significantly in 2009 and they had no surviving pups.*

Grizzly Lake. Despite wolf SW#147M's severe mange in early 2009, and #471F's mild mange, all three wolves appeared to be mange-free at year end.

### *Blacktail Deer Plateau Pack*
*(9 wolves: 5 adults, 4 pups)*

The Blacktail Deer Plateau pack remained a force on the northern range in 2009. Led by nine-year-old #302M and three-year-old #693F, the Blacktail wolves traveled widely from Little America to Swan Lake, filling in much of the territory traditionally used by the Leopold pack. Two GPS collars were deployed (#693F and #692F) and used to study summer and winter predation patterns of wolves on the northern range. Wolf #692F dispersed in February for a short time, traveling briefly with Lava Creek and her natal Agate pack before rejoining Blacktail in late April. Both #693F and subordinate #642F denned on Blacktail Plateau in former Leopold den areas, producing a total of six pups, with four surviving at the end of the year. After #302M died in October from injuries inflicted by other wolves, likely the Quadrant Mountain pack (see inset, page 6), a two-year-old uncollared gray male relative of his became the alpha male. An uncollared black male was hit by a car and killed in November. Two of the Blacktail wolves that showed signs of mange earlier in 2009 appeared to have completely recovered from the infection by year end.

*The Blacktail pack occupies old Leopold territory plus some other areas, possibly because the founding alpha male (#302 who died in late 2009; see inset) was born to this territory.*

*Much reduced in number compared to a few years ago, the Agate Creek pack still hangs on, probably because of the long-time alpha female (right) #472.*

### *Cottonwood Creek Pack (Unknown)*

Formerly classified as a group (an unstable association of wolves in which membership is fluid), this pack formed in late 2008 and was named in early 2009 when five wolves settled in the Cottonwood Creek to Hellroaring Creek region. This area had previously been occupied by three other packs (Rose Creek, Geode Creek, and Hellroaring Creek), indicating high turnover for this territory. The Cottonwood Creek pack denned and produced six pups. During the denning season the pack attacked an unnamed trio of wolves denning near Slough Creek and killed the alpha female (collared #694, formerly of Druid Peak pack), at least two pups, and possibly another uncollared wolf. The rest of the pups perished and the one surviving uncollared wolf became a loner whose movements could not be tracked. During the Montana hunting season in late September and early October, four Cottonwood Creek wolves were legally killed north of the park boundary, including both alphas and both radio-collared wolves. The pack was not tracked and there were no sightings of them for the remainder of 2009.

### *Agate Creek Pack (3 adult wolves)*

Early in 2009, long-time pack member and former alpha male #383 dispersed north of the park where he joined the females remaining from the Slough Creek pack, which had disbanded in 2008. Agate Creek pack's nine-year-old alpha female (#472) did not produce pups despite breeding with at least three different males and localizing around a den. However, the two former Blacktail males remained with the pack. A three-year-old subordinate female dispersed in the spring to join former Agate #471F's group. The remaining Agate Creek pack of four

DOUG DANCE

*Wolf #302M was perhaps one of the most unique wolves in Yellowstone's new wolf era.*

# The Rise and Fall of Wolf #302M

*by Kira Cassidy*

Rarely are we given the opportunity to follow a wild wolf's life from birth to death. But that is what happened with wolf #302M. The *2003 Yellowstone Wolf Project Annual Report* feature story recounted #302M's eventful year as he bred with several Druid pack females and then traveled back and forth between his natal Leopold pack and the Druid Peak pack, where his pups were born. If that single year had been the end of #302M's story, his life would still have been deemed a success. We gained an incredible amount of knowledge observing and recording #302M's behaviors. But that wasn't the end of his story; it was barely even the first chapter.

In many ways 2004 began much like the previous year; however, the end results could not have been more different. Wolf #302M once again began the year visiting the Druid females, this time accompanied by a submissive black male, possibly his younger brother. Major shifts in pack dynamics began when Druid alphas #42F and #21M died in February and June, respectively. Without the alphas, would the pack accept #302M? Some semblance of stability was held by long-time beta male #253M, who routinely and perhaps futilely chased off #302M and his brother throughout the summer. Most of the other Druid adults (including at least two genetically proven to be #302M's offspring from the previous year) and pups interacted with the interloping males in a friendly manner. Many Druid males, including #253M, dispersed that fall and either established or joined packs to the south and east. As 2004 came to an end, #302M and his brother were traveling with the remainder of the Druid Peak pack. Then, in a bizarre twist, #302M's uncollared brother emerged as the alpha male, with #302M as beta male. This new leader would be collared over the winter and given the number #480M.

Although things were looking up for #302M, the pack of six Druids was not large enough to control the prime hunting grounds of Lamar Valley against the 15-member neighboring Slough Creek pack. The Druids spent most of the next two years in the far eastern reaches of their territory. An outbreak of canine distemper virus killed all seven pups born in 2005, preventing the pack from increasing in size. The pups may have been the most vulnerable, but the adults were not invincible to the disease; alpha female #286 and beta female #255 both disappeared and probably died in the early fall. Now down to four members, the Druid Peak pack ranged widely. No doubt #302M's knowledge of the park's northern range and his finesse at traveling through rival territories unnoticed by other packs aided the Druid wolves' ability to survive. They seemed to abandon the usual wolf mentality of defending a territory and instead slipped quietly in and out of other packs' ranges, making kills or scavenging carcasses before moving on.

Somehow the group avoided the nearly unstoppable force of the much larger Slough pack. In spring 2006, the future of the Druid pack was born in a den north of

Round Prairie where two yearling females gave birth to a total of 11 pups. Wolves #302M and #480M fed the pups and both female adults throughout the summer. When the alpha female disappeared just before winter, the other female quickly took over and for the next two years the Druid pack flourished, taking back territory it had not controlled for many seasons. Wolf #302M seemed content to play the part of dutiful beta: hunting prey, defending the pack, and never challenging #480M's leadership. The only tension was during breeding season. With only one adult female in the pack, #480M guarded her obsessively. Although #480M was rarely aggressive toward #302M, it was clear #302M would have no chance to breed in his own pack.

With no Druid females available, #302M left the pack during the breeding season. Observers wondered if this was a repeat of his behavior with the Druid females years before. Was #302M destined to be a rover, never the leader of a pack? After spending the 2007 breeding season with some of the Slough females, #302M returned to Druid territory with an injured hind leg. He spent nearly a month slowly shadowing the pack, staying at kill sites for a week or more, indicating his reluctance to travel. Perhaps his wandering ways had finally gotten the best of him. However, he had strong ties to the Druids and when he eventually healed, he was welcomed back.

When the 2008 breeding season began, observers thought surely he would remain in the safety of the Druid pack. He may have to give up his breeding rights, but by now, the nearly eight-year-old wolf was beginning to show his age. Many young Druid females were now of breeding age and being courted by two gray males of unknown origin. Although #302M showed no interest in breeding the females himself, he was vehemently opposed to the non-Druid males being in his pack's territory. Wolf Project staff and visitors alike watched with fond reminiscence as #302M repeatedly chased the males day after day; nearly a mirror image of years before when #302M was the intruder being chased by Druid alpha #21M. Surprisingly, at the end of the breeding season, #302M took an abbreviated trip outside Druid territory and was observed with multiple Agate Creek pack females. It wasn't clear at the time that it was a small glimpse into the future. Soon after, #302M returned to the Druid Peak pack, welcomed by all 15 adults.

By fall, a number of younger Druids were beginning to exhibit signs of dispersing. They would break off from the main Druid pack for days at a time and explore nearby territories. Between the breeding season and the dispersal movements, #302M and several young Druid males encountered the Agate Creek pack regularly. Finally, on the night of November 16, 2008, they joined up with four dispersing Agate Creek females. The group remained together, centering their territory on the Blacktail Plateau area, and they were subsequently named the Blacktail Deer Plateau pack. He may have been eight and a half years old (the equivalent of 75 in human years), double the average lifespan of a Yellowstone wolf, but #302M was finally the alpha male in a pack.

The newly formed Blacktail pack traveled widely from Tower to Mammoth. In a full circle chronicle rarely seen in wildlife research, one of the pack's females used the old Leopold den where #302M was born during the 2000 denning season. Summer 2009 saw the Blacktail pack emerge as one of the powerhouse packs of the northern range and they continued to dominate an expansive area. So much traveling could not have been easy on #302M's nine-and-a-half-year-old body. He was often left behind on long chases and traveled in the back of the pack with his six pups.

On the morning of October 8, #302M's collar switched to mortality mode. His body was found a few miles south of Swan Lake, at the very edge of Blacktail pack territory. Outward signs of injury were minimal but hemorrhaging was extensive beneath his hide, with many wolf-sized bite wounds. It is unknown what wolves were responsible; however, the area borders on Quadrant Mountain pack territory. The Quadrant pack had a carcass nearby and it is possible #302M visited the carcass either alone or with only a few pack mates. With two very large males, the Quadrants may have found #302M and a fight ensued. Wolf #302M was able to get away but his injuries were too extensive and he died sometime in the early morning hours. Small wolf tracks around his body suggested that at least a few of his six-month old pups stayed with him for some time. By the end of 2009, the Blacktail pack numbered five adults and four pups. The position of alpha male was assumed by #302M's nephew, a large gray called "Big Brown." No doubt the wisdom, sagacity, and judgment taught by #302M will enable the Blacktail pack to continue their success.

Wolf #302M's extraordinary life provided us with a magnitude of insight into the lives of Yellowstone wolves. Every time #302M was observed hunting prey, howling to other wolves, chasing coyotes, or feeding his pups, it was documented and filed in the Wolf Project office. In so many ways, his life has spoken volumes.

*Druid Peak pack had no surviving pups and most members had mange, leading to the pack's decline in 2009.*

traveled widely, and was located as far as Lamar Valley, south of Canyon, and south of Amethyst Mountain. The uncollared gray beta male either died or dispersed in October. At year end, the pack consisted of #472F, a black alpha male, and subordinate #715F.

### ***694F Group*** *(0 wolves)*

Started by two dispersing Druid females and an unknown black male, the #694F group used former Slough and Oxbow pack territories. By April, one of the females returned to her natal Druid Peak pack and had pups at its traditional densite. Alpha wolf #694F and the black male remained together and denned near Slough Creek. On April 14, the five-member Cottonwood Creek pack, led by alpha #527F, killed #694F in her den. Two of the days-old pups were observed being carried out and consumed by the Cottonwood females. Upon inspection, it was noted that #694F's den was under boulders and had two entrances, enabling the Cottonwood wolves to attack and overwhelm #694F from both sides. The black alpha male was occasionally observed either alone or with various Druid females throughout the early summer but no sightings were made after June.

*When not in hibernation, grizzly bears are common scavengers on wolf kills, especially in Pelican Valley, and usually win in contests over kills made by wolves.*

### ***Druid Peak Pack*** *(11 adult wolves)*

This year brought drastic changes to the Druid Peak pack. Two litters were produced at the pack's traditional den near Soda Butte Creek, one by alpha #569F and the other by a three-year-old black wolf who returned to the pack in April after dispersing to #694F's group over the winter. At least nine pups were observed in early summer, but members of the pack started to show signs of mange and only four pups survived until fall. Numerous pack adults could not be located during the fall (a three-year-old black female, a gray yearling male, and #645F); it is unknown if they dispersed or died. After leading the pack for three years, #569F was killed by other wolves (suspected to be from the Hoodoo pack outside YNP in Wyoming) in the Lamar River backcountry. The remaining pups had severe cases of mange and were not seen alive after October. In early December, after an unknown black male joined the pack, long-term alpha male #480M ventured out on his own, presumably because the only remaining females in the pack were his daughters and were unlikely to breed with him.

*When wolves outnumber a grizzly bear, they may win control of the carcass, or at least get bites from the carcass as the bear is held at bay by other wolves.*

*Mollie's wolf #495M, weighing 143 lb (including an unmeasured amount of bison meat in his stomach) is the largest wolf captured in Yellowstone since reintroduction.*

### ***682M Group*** *(2 adult wolves)*

Three large black males (#682, #697, and an uncollared wolf) dispersed into the park in June from the Hoodoo Creek pack, which lives east of the Lamar Valley in Wyoming's Absaroka Wilderness. The Hoodoo Creek pack is related to YNP wolves through its alpha female, #525, who was born in the Agate Creek pack. In early October, the group began frequenting the Lamar Valley and drainages flowing into the upper Lamar. The 682M group interacted with the Druid pack throughout the fall, and GPS-collar data implicated them in the killing of Druid alpha #569F. They were also observed attacking Druid #571F and an uncollared Druid male, and seemed poised to take over territory in the Lamar Valley through their repeated challenges of the Druid pack. On the last day of the year, #697M was killed by Mollie's pack near the Cache Creek/Lamar River confluence. The remaining two males will be followed in 2010 to see whether they become genetically effective migrants into the park by finding mates and reproducing.

### ***Mollie's Pack*** *(15 wolves: 10 adults, 5 pups)*

The second largest pack in the park, Mollie's pack size and traditional territory use were stable in 2009. With the grizzly- and bison-rich Pelican Valley as its core territory, Mollie's pack continued to make occasional forays into Hayden Valley and the northern range. Weighing 143 lbs, #495M was re-collared and confirmed to be the pack's alpha male along with his mate #486. The pair produced a litter of five pups in the heart of Pelican Valley. Although many of the pack members had mange in 2008, they appeared to have recovered in 2009, providing valuable data on the ability of wolves to recover from mange. Wolf–bison–grizzly bear interaction studies in Pelican Valley continued for the twelfth year.

### ***Canyon Pack*** *(3 adult wolves)*

The Canyon pack, comprised of dispersers from the Hayden and Mollie's packs, continued to roam between its core area of Hayden Valley up to Mammoth Hot Springs in search of a stable territory. Denning just outside park headquarters in Mammoth Hot Springs, this pack regularly hunted elk in the developed area. Because of the pack's tendency to travel in road corridors, park staff sought to minimize its development of habituated behaviors. Following several hazing events (see Habituated Wolves), the pack responded by moving its one surviving pup to Hayden Valley and remaining there during summer and fall. At year end, the pup and #587M had disappeared, leaving just three adults.

### ***Yellowstone Delta Pack*** *(Estimated 4 wolves)*

Despite the presence of four collared wolves, including three collared in early 2009, tracking the Yellowstone Delta pack proved difficult. With few sightings, pack size was estimated at four wolves. Because the pack's two traditional den sites were not used and no pups were documented, the pack was assumed to not have a breeding pair. The 12-year-old alpha female (#126), one of the oldest wolves in the YNP population, disappeared. It is unlikely her collar, replaced in 2008, malfunctioned, so she probably left the pack's traditional territory. She was eventually presumed dead. Wolf #633F was occasionally

*Making its way through an early winter snow, the Gibbon Meadows pack was the largest pack in Yellowstone at the end of 2009.*

located during tracking flights, often outside the park, with a few other wolves (well below previous Delta pack numbers of more than 10 and sometimes 15 wolves). Wolf Project staff traveling by horseback into the Delta and Thorofare areas in late August discovered wolf sign in several places (Trail Creek and Mountain Creek), but there was no evidence that more than a few wolves had been present.

### ***Bechler Pack*** *(6 wolves: unknown age)*

One of the oldest known wolves in the park, 12-year-old #192M, died during the summer. Because he was the last radio-collared animal in the Bechler pack, tracking was difficult, few observations were made, and it is not known whether this pack had a breeding pair. Early season radio tracking and sightings indicated that the pack continued to use its traditional territory, making future tracking, and possibly collaring, feasible. Year-end pack size was estimated at six wolves.

### ***Gibbon Meadows Pack***
### *(17 wolves: 11 adults, 6 pups)*

For the second consecutive year, the Gibbon pack was the largest in the park. Preying on bison and elk, this pack has flourished in the Madison–Firehole and western Hayden Valley areas. The pack's long-time alpha female (#537) produced six pups that survived to year end, but her radio collar was transmitting in mortality mode in Hayden Valley in the fall. Efforts to locate her failed, likely due to a dead collar battery. With her distinct white pelage, this seven-year-old was not seen with the pack for the remainder of the year, and is believed to have died of natural causes. The Gibbon lineage continued outside the pack as several Gibbon males dispersed during a territorial foray the entire pack made into Cougar Creek pack territory in February. At least three males (#689, #687, and #647) stayed behind, forming two new breeding pairs with Cougar Creek pack females (see Cougar and Grayling pack summaries). An uncollared black yearling male, believed to be a Gibbon disperser, began displaying habituated behaviors near Old Faithful in the spring, prompting focused monitoring and management action that resulted in the first lethal removal of a wolf occurring within the park boundary since wolf reintroduction began (see Wolf Habituation).

### ***Cougar Creek Pack*** *(6 wolves: 3 adults, 3 pups)*

Since its formation in 2001, the Cougar Creek pack has maintained a solid presence in the northwest section of the park, inhabiting a territory where bull elk are the most abundant prey throughout the year. With the 2008 loss of long-time alpha wolves #151F and #303M, the pack continued when their daughter (#478) bred with Gibbon disperser #689M (a large, black, three-year-old that showed up just prior to the breeding season). This new alpha pair produced three black pups at a traditional den. A previously dispersed Cougar Creek male, #636, returned to his natal territory in May and settled into a role of aiding his sister and the alpha male in raising the pups. The only other known surviving Cougar Creek wolf, #632F, dispersed and carved out a territory to the north with the newly formed Grayling Creek pack.

### ***Grayling Creek Pack*** *(4 wolves: 2 adults, 2 pups)*

The only new pack in the park interior in 2009, the Grayling Creek pack was formed when Cougar Creek female #632 joined two Gibbon males, #687 and #647, and some uncollared Gibbon wolves. Nicknamed "Tripod" because she had lost the lower part of a hind leg from an unknown injury years ago, #632 became the alpha female and presumably bred with one of the Gibbon males, producing two pups that survived through the year. She died of natural causes in December. At the end of the year, alpha male #647 continued to lead two pups of unknown paternity and an uncollared adult female in their new territory.

## Wolf Capture and Collaring

In 2009, twenty-two wolves were captured and collared in 11 packs (Table 3). One old adult, 12 adults, 5 yearlings, and 4 pups were caught, of which 8 were male and 14 were female. At year end, 34 (35%) of the 96 known wolves were collared. Two types of radio collars were deployed: VHF and downloadable GPS. Which collars were placed on which wolves depended on monitoring objectives, but VHF radio collars were still the most commonly used.

*Taking notes, helicopter pilot Bob Hawkins makes sure everyone gets the right data while processing wolves from the Delta pack.*

*Table 3. Yellowstone Wolf Project collaring operations, 2009 calendar year.*

| Capture Date | Wolf #/ Sex | Age | Color | Pack |
|---|---|---|---|---|
| 1/15/09 | 470F | Adult | Black | Everts |
| | 495M | Adult | Black | Mollie's |
| | 684M | Pup | Black | Everts |
| | 685M | Adult | Gray | Everts |
| | 686F | Yearling | Gray | Mollie's |
| 1/16/09 | 687M | Pup | Black | Gibbon Meadows |
| | 688M | Pup | Gray | Gibbon Meadows |
| | 689M | Adult | Black | Gibbon Meadows |
| | 690F | Pup | Black | Druid Peak |
| | 691F | Adult | Gray | Druid Peak |
| 1/17/09 | 692F | Adult | Black | Blacktail |
| | 693F | Adult | Gray | Blacktail |
| 1/18/09 | 469F | Adult | Gray | Quadrant |
| | 694F | Adult | Gray | 694F Group |
| | 695M | Adult | Black | Quadrant |
| 2/21/09 | 472F | Old adult | Black | Agate Creek |
| | 633F | Yearling | Black | Yellowstone Delta |
| | 712M | Adult | Black | Canyon |
| | 713F | Yearling | Black | Yellowstone Delta |
| | 714F | Yearling | Black | Yellowstone Delta |
| | 715F | Yearling | Gray | Agate Creek |
| 2/22/09 | 716F | Adult | Black | Cottonwood |

## Wolf Predation

### *Wolf–Prey Relationships*

Wolf–prey relationships were documented by observing wolf predation directly and by recording the characteristics of wolf prey at kill sites. Wolf packs were monitored for two winter-study sessions in 2009 during which wolves were intensively radio-tracked and observed for 30-day periods in March and from mid-November to mid-December. The Blacktail (March and November–December), Everts (March), and Quadrant Mountain (November–December) packs were the main packs monitored by three-person ground teams. All packs in the park were monitored from aircraft. In addition, ground crews opportunistically monitored the Agate Creek, Canyon, Cottonwood Creek, Lava Creek, and Mollie's packs, along with several newly formed groups of wolves, and collected prey selection and kill rate data. The Cougar Creek, Grayling, and Gibbon Meadows packs were monitored from aircraft only. The Yellowstone Delta and Bechler packs were rarely located by ground or air due in part to their absence from the park or poor conditions for aerial monitoring in southern YNP, and lack of radio collars (Bechler).

The summer study used data from downloadable GPS collars on wolves from the Everts and Blacktail packs (see below) to understand summer predation patterns. During these established predation studies as well as opportunistically throughout the year, project staff recorded behavioral interactions between wolves and prey, predation rates, total time wolves fed on carcasses, percent consumption of kills by scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites.

### *Composition of Wolf Kills*

Project staff detected 365 kills (definite, probable, and possible combined) made by wolves in 2009, including 302 elk (83%), 19 bison (5%), 17 deer (2%), 6

wolves (2%), 4 pronghorn (<1%), 3 coyotes (<1%), 2 red foxes (<1%), 1 moose (<1%), 1 bighorn sheep (<1%), 1 Canada goose (<1%), 1 bald eagle (<1%), and 8 unknown prey (2%). The composition of elk kills was 36% cows, 29% bulls, 24% calves, and 10% elk of unknown sex and/or age. Bison kills included seven calves, four cows, three bulls, and five unknown sex adults.

Winter predation rates in 2009 continued the recent pattern of lower kill rates than in prior years. Changes in prey selection (shift to bull elk), an increase in scavenging on winter-killed ungulates, and a suspected decrease in the number of vulnerable prey available to wolves are factors in these lower kill rates. When examined, however, not as number of elk killed per wolf but as biomass consumed (kg/wolf/day), kill rates have remained stable since 1995. The wolf–elk interaction continues to be a primary focus of predation studies in the park. Since wolf reintroduction, the elk population has declined approximately 60% (Fig. 4). In addition to wolves, factors include other predators, management of elk outside the park, and possibly long-term drought leading to reduced forage and, ultimately, poorer elk condition (especially bulls).

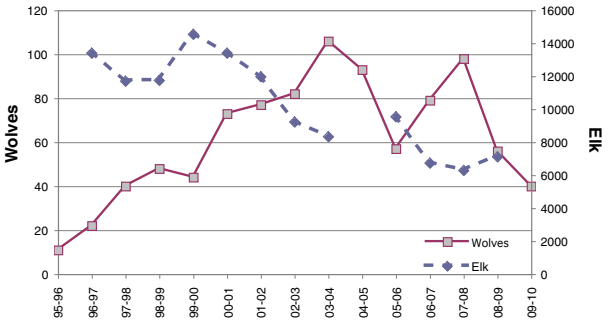


*Figure 4. Yellowstone National Park northern range elk–wolf population, 1995–2009.*

## *Winter Studies*

***March.*** During the 30-day March study, wolves were observed for 283 hours from the ground. The number of days wolf packs were located from the air ranged from 9 (Canyon) to 13 (Everts, Blacktail, and 471F's group). Air and ground teams located a total of 80 carcasses that wolves had fed on (62 elk, 13 bison, 3 mule deer, and 2 unknown species). Among the elk, 32 (52%) were bulls, 20 (32%) were cows, 9 (15%) were calves, and 1 (<1 %) was of unknown sex and age. In addition, 10 bison and 2 mule deer were killed by wolves. Most of the carcasses were wolf kills; five were winter-killed ungulates (3 bison, 1 elk, and 1 deer). Documenting the consumption of biomass from ungulates not killed by wolves is important in explaining variation in kill rates through time. Lower than expected kill rates, particularly for larger wolf packs, can sometimes be explained by increased scavenging of winter-killed ungulates in the spring.

*Josh Irving processing an elk carcass.*

***November–December.*** During the 30-day November–December study, wolves were observed for 234 hours from the ground. The number of days wolf packs were located from the air ranged from 9 (Grayling) to 11 (Agate, Canyon, Druid Peak, Gibbon, Mollie's, and Quadrant). Aerial monitoring was affected by poor weather conditions and cold temperatures, resulting in the lowest number of flights for any November–December predation study. A total of 45 ungulate carcasses utilized by wolves was discovered by air and ground teams. These carcasses were made up mostly of wolf kills, with some other natural and human-caused mortalities that wolves scavenged on. All wolf-killed prey were elk, comprised of 17 cows (43%), 15 bulls (38%), 6 calves (15%), and 2 (<1%) of unknown sex and age. Wolves also scavenged five ungulates (3 elk, 1 bison, and 1 mule deer) that died from either non-predation natural causes or from human hunters along the park boundary. The Druid Peak pack had very low kill rates this study period and mostly scavenged other packs' kills. With severe mange affecting a majority of them, the Druid wolves showed prolonged periods of inactivity and appeared less fit to hunt. This has implications for predator health and disease impacts on predator–prey dynamics.

In addition to the customary monitoring of prey composition and kill rates, the Wolf Project began to incorporate GPS clustering methodology during the

*Winter study training often includes working up a wolf-kill in the field and discussing proper procedures.*

*Canyon wolves on a kill near Mammoth. The Canyon pack is one of the few packs that roam from the park interior to the northern range.*

November–December 2009 winter study to determine whether ungulates killed by wolves are missed via traditional monitoring methods (aerial and ground). If so, Wolf Project staff seek to understand what factors (e.g., prey size, time of day kill is made) are most likely to lead to not detecting a kill. Further, clusters may not always indicate a kill, so staff seek to refine and understand error in kill detection. During this pilot study, Wolf Project staff hiked to GPS clusters created by Blacktail Deer Plateau wolves #692F and #693F. The few kills that were missed by aerial and ground monitoring tended to be elk calf kills made during the night. Additionally, some carcasses visited by Blacktail wolves were not detected by GPS clusters. Initial results proved this to be a valuable component to wolf predation study methodology and the Yellowstone Wolf Project plans to incorporate GPS clustering methodology during the winter study in 2010.

## *Summer Predation*

During summer 2009, Wolf Project staff collaborated with Michigan Technological University to continue documentation of summer wolf predation. Documenting summer predation is problematic due to the lack of snow for tracking, lack of pack cohesiveness, grizzly bear kleptoparasitism (usurpation) of carcasses, and smaller prey items leading to quick consumption and loss of evidence. The best data concerning wolf summer food habits has come from analysis of scats collected at den and rendezvous sites, but this technique is limited by a lack of information regarding whether the wolves were feeding on freshly killed prey or scavenging older carcasses. Although scats were collected in 2009, GPS collar technology was again used to facilitate a greater understanding of summer predation patterns. Additionally, in collaboration with Humboldt State University, scats were collected at GPS clusters for comparison (see Graduate Students).

During the 2009 capture season, Wolf Project staff deployed five downloadable GPS collars on the northern range 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. The goal was to download data weekly from May 1 to July 31 on four collars programmed to collect location data every 30 minutes. This approach has proven successful in prior years by yielding high-resolution wolf movement data that revealed composition of prey killed by wolves, including neonate elk calves.

*Intent on gathering data no matter what the weather, Rebecca Raymond, Dave Unger, and Hilary Zaranek take a hard look at the Blacktail pack.*

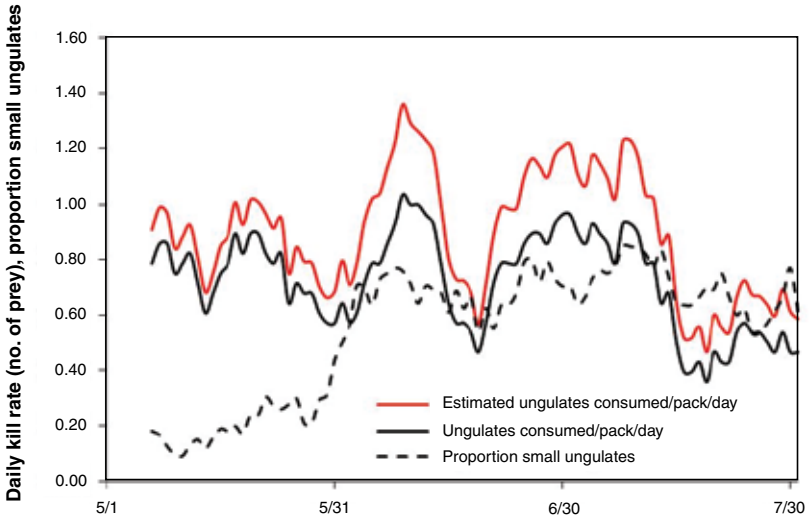


*Figure 5. Temporal trends of kill rate estimates and proportion of small ungulates in 2008 and 2009. Minimum and estimated kill rates are determined by calculating the average number of ungulate kills per day for the previous seven days. Proportion of small ungulates is the proportion of total kills that were small ungulates (deer, bighorn sheep, or any neonate ungulate) and has a maximum value of 1.*

In the 2009 summer predation study, two GPS collars were placed on wolves in both the Mount Everts and Blacktail packs. The collars all obtained more than 95% of possible locations (Fig. 5), except when Blacktail wolf #693F was in the den after giving birth. Summer predation staff worked intensively to search clusters, hiking more than 1,100 miles during the more than three-month field season to record the presence of wolf sign, wolf-killed prey, and carcasses scavenged by wolves (classified as either fresh or old to indicate whether they provided significant biomass). During this effort, 108 suspected kills or fresh carcasses were found at identified clusters. Staff also found one bighorn sheep ram at a cluster of the Everts pack. Both packs preyed upon mostly elk, but the Everts pack also often preyed on deer, as their territory contains more deer and fewer elk in comparison to other packs. The Blacktail pack preyed upon cow elk more than the previous wolves that resided on the Blacktail Deer Plateau (the Leopold pack). The estimated number of ungulates consumed by wolves utilizes methodology that accounts for the foraging behavior of wolves in summer. The number of ungulates consumed by wolves declines in late May as prey condition improves. However, kill rates increase shortly thereafter as neonate elk calves appear on the northern range. Much of the variability in summer kill rates is explained by the proportion of kills that are small ungulates, such as deer and neonate ungulates.

## Population Genetics

Collaborative efforts between the Yellowstone Wolf Project and the University of California, Los Angeles (UCLA), continued in 2009. Dan Stahler attended UCLA for the spring quarter and continued collecting data in the YNP population throughout 2009 for his dissertation. Stahler and Smith were co-authors on a large collaborative study published in *Science* that incorporated data on Yellowstone pedigrees, coat color, and molecular markers to describe the evolutionary history of melanism (black fur) in North American wolves. This study revealed that black wolves get their coat color from a genetic mutation that first occurred in dogs and was likely introduced and selected in wild wolf populations as a result of their mating with dogs that came into North America with humans thousands of years ago. Research is underway to investigate the selective advantage that genes associated with black coat color may have for wolves.

An analysis of genetic diversity and gene flow in the Northern Rocky Mountain (NRM) recovery areas was completed in 2009 and submitted for publication by Stahler and Smith in collaboration with USFWS colleagues and UCLA researchers. The degrees to which subpopulations are genetically structured and connected, along with the preservation of genetic variation, are important conservation concerns. This study analyzed genetic samples of 555 NRM wolves from the three recovery areas (Greater Yellowstone, Northwest Montana, and Central Idaho), including the 66 introduced population founders, during the initial recovery period (1995–2004). The NRM population maintained high levels of variation with low levels of inbreeding. Population assignment and migrant detection was difficult because related founders were released in different recovery areas, which required a novel approach to determine genetically effective migration and admixture. By combining migrant assignment

tests, kinship reconstruction, and field observations, gene flow among all recovery areas inferred by the presence of migrant and admixed (offspring of migrants) individuals. Continued success in the conservation genetics of NRM wolves will rely on management decisions that promote natural dispersal dynamics and minimize anthropogenic factors that reduce genetic connectivity.

## *Disease*

Research on disease in the Yellowstone wolf population is ongoing. In 2009, Emily Almberg finished her M.S. at the University of Minnesota on the diseases affecting Yellowstone wolves and published some of her results (see Appendix II). Despite a population decline in 2009, disease did not appear to play the same role as was documented in 1999, 2005, and 2008. Most significantly, sarcoptic mange showed increased prevalence in the population, particularly on the northern range.

Sarcoptic mange (or "scabies") is an infectious skin disease caused by a mite (*Sarcoptes scabei).* Since its intentional introduction in the western United States in the early 1900s as a biological control of wolf and coyote populations, mange has been present in Greater Yellowstone coyotes. It appeared in wolves outside of YNP in the early 2000s and its incidence has increased since it was first suspected in the park in early 2007, when the alpha male of Mollie's pack was observed with significant hair loss along his neck and shoulders. Sarcoptic mange is host-specific and typically spreads through direct contact from host to host. Mange mites crawl on and burrow in the skin of its host to reproduce and lay eggs, causing severe itching and an allergic response. The infected animal scratches and chews its skin for relief, causing hair loss, crusted skin, and open sores, which can lead to systemic infection and risk of hypothermia due to exposure. The severity and persistence of mange is often correlated with an individual's health and age, with individuals that are immuno-compromised or malnourished experiencing greater infection.

Perhaps spread through contact with wolves outside the park, an immigrant joining the pack, or contact with an infected coyote, Mollie's pack seemed to be the first to be severely afflicted. During the winter of 2008–2009, at least 7 of the 13 Mollie's pack members had mange and at least three were more than 50% hairless. However, evidence for recovery does exist; only four months later the same wolves were observed with full, normal-looking coats. Similarly, two adults in the Blacktail pack who experienced moderate hair loss during spring 2009 appeared completely furred only three months later. The most severe cases of mange in 2009 occurred in the Druid Peak pack, with nearly all pack members showing severe stages of mange.

From a biological standpoint, it is invaluable to gain insight into the spread of a disease from its beginning and through its persistence in the population. In other wolf systems where mange has been documented, it does not appear to have had significant demographic impacts and often shows epizootic or cyclic patterns. Treating mange in the wild, which would require multiple recaptures and veterinary care of infected wolves, would be logistically infeasible. The Wolf Project is closely monitoring patterns and severity of mange to learn about its ecology and address questions such as: Do environmental and ecological conditions, such as climate change and vulnerable prey availability, influence mange severity? Do other diseases, such as canine distemper, increase susceptibility to mange? Do certain individuals show resistance or more successful recovery from mange, and if so, does this response have a genetic basis?

*Mange afflicted the Druid Peak pack early winter 2009.*

*Wolf #625F, formerly of the Leopold pack, was frequently seen in the Mammoth/Gardiner areas with a bad case of mange which led to her removal outside the park.*

*Wolf watchers at Slough Creek, possibly the best place in the world to observe wild wolves.*

# Wolf Management

## *Area Closures*

To prevent human disturbance of denning wolves during the sensitive period of pup rearing, visitor access to some areas of the park is temporarily closed. Land surrounding the Druid Peak pack's den area was closed until July 1 in the eastern end of Lamar Valley. Thousands of visitors were still able to observe adults and pups from a safe distance, providing both protection to the pack and enjoyment to visitors. The den and rendezvous sites used by the Canyon pack were closed at different periods in the summer. With the Canyon pack wolves exhibiting habituated behaviors through their frequent travel on roadways and through developed areas, NPS staff sought to minimize human encounters with these wolves through temporary closure of trails and areas near den and rendezvous sites throughout the summer. Den sites for the Mollie's and Agate Creek packs were protected from disturbance coincidental to area closures for bear management in the park. The areas around the remaining packs' den sites were not closed because of historically low visitor use.

## *Wolf Road Management Project*

Since wolf reintroduction began in Yellowstone, the Lamar Valley has become the premier location worldwide to observe free-ranging wolves. The main pack of interest has usually been the Druid Peak pack, which has denned in or near the Lamar Valley since 1997, but several other packs on the northern range have also been regularly watched by visitors over the years. The NPS established the Wolf Road Management Project to better deal with the opportunities and problems that accompany increasing visitor numbers. The objectives for this program are: 1) human safety, 2) wolf safety, 3) visitor enjoyment; and 4) wolf monitoring and research. A record number of visitor contacts were made by staff in the 2009 season (15,285 people) and the summer season was characterized by high wolf viewing opportunities (Table 4).

The 2009 road management season was staffed primarily by two Wolf Project employees, Rick McIntyre and Kira Cassidy-Quimby, for 124 days (May 12 to September 12). The Druid Peak pack, which denned in a site used between 1997 and 2004 in a forested area one-half mile north of the main road in Lamar Valley, was again the most visible. In 2009 there were two litters: one by alpha female #569 and the other by an uncollared three-year-old female. Most sightings of the 14 adult wolves occurred when they crossed the road as they traveled to and from the main den. Pups were first observed on June

*The Canyon alpha male, #712, crosses the road near the pack's den outside Mammoth.*

15 with a high count of nine. The pack brought the pups across the road and river at night on July 8 or 9. The entire pack then traveled southeast to a rendezvous site up Cache Creek. Sightings decreased until August 28, when the adults and pups traveled back to the Lamar Valley and rendezvoused at Chalcedony Creek, an area highly visible to visitors. The four pups that returned with the adults were extremely small and had a great deal of hair loss due to mange. The adults varied from minimal hair-loss to about 50% hairless. The adults and pups remained in this area through the end of the road management season.

The Blacktail pack, formed during winter 2008–2009, denned in the old Leopold pack territory. Many visitors wanted to see this pack and its leader, nine-year-old #302M, a well-known wolf popularized by televised nature programs. The first den this pack used was well out of view, but in late May the pups were moved to an area visible from an observation point one mile from the road. With the exception of a few weeks, the pups and adults stayed in this area and were highly visible for the rest of the summer season.

## *Habituated Wolves*

***Canyon Wolves Den in Mammoth.*** In late April, the Canyon pack denned ~1 km east of Mammoth Hot Springs (park headquarters). The four wolves showed no interest in humans and were not food conditioned, but after they killed several elk in the residential district they were hazed whenever they appeared in the developed area or nearby road corridor, and their den area and nearby trails were closed to human access. They were never a threat to human safety, but they did walk near people on several occasions. Wolf Project, Bear Management, and ranger staff patrolled the area daily, especially when the wolves were most active, to haze them from the developed area. On May 9, staff successfully hazed three of the four wolves in the pack with non-lethal beanbag rounds and cracker shells. Shortly afterward, the wolves left the Mammoth area and moved to their summer range in Hayden Valley where they spent the rest of the summer. One pup was with them despite never being observed at the Mammoth den and having been carried the long distance to Hayden Valley, but it did not survive the summer. Its mortality was unrelated to the long-distance den

*Table 4. Visitor contacts while working on the road management project during summer.*

| Year | Visitor Contacts | Informal Talks | # of People at Informal Talks | Total Contacts | # of People Seeing Wolves | Time Wolves Visible | Days Wolves Visible |
|---|---|---|---|---|---|---|---|
| 2000 | 6,760 | 83 | 1,833 | 8,593 | 8,145 | 283.2 hrs | 77/82 (94%) |
| 2001 | 9,375 | 288 | 1,552 | 10,927 | 11,210 | 368 hrs | 125/125 (100%) |
| 2002 | 9,450 | 244 | 1,952 | 11,402 | 12,414 | 460 hrs | 126/126 (100%) |
| 2003 | 9,375 | 258 | 2,064 | 11,439 | 9,827 | 415 hrs | 124/124 (100%) |
| 2004 | 9,450 | 226 | 2,260 | 11,710 | 8,721 | 395 hrs | 126/126 (100%) |
| 2005 | 6,200 | 125 | 1,250 | 7,450 | 11,695 | 790 hrs | 124/124 (100%) |
| 2006 | 6,500 | 200 | 2,000 | 8,500 | 13,640 | 620 hrs | 124/124 (100%) |
| 2007 | 8,775 | 230 | 2,300 | 11,075 | 32,600 | 750 hrs | 117/117 (100%) |
| 2008 | 8.660 | 358 | 3,925 | 12,585 | 35,000 | 830 hrs | 124/124 (100%) |
| 2009 | 10,040 | 602 | 5,245 | 15,285 | 31,000 | 750 hrs | 124/124 (100%) |

relocation. After frequently traveling the road in Hayden Valley and approaching vehicles during summer 2008, the pack was never observed on the road or near people during summer 2009, suggesting that the hazing caused a behavior change. Considering experiences with this pack and other hazing events in the park, hazing is an effective strategy for habituated wolves and has caused cessation of unwanted behaviors.

***Gibbon Meadows Wolf Removed.*** In early May, a yearling male from the Gibbon Meadows pack chased a woman riding a bicycle near Old Faithful. The chase lasted long enough that the bicyclist waved down a passer-by in a pick-up truck for help. This caused the wolf to move away but not leave the area. When the gate to the pick-up was opened to load the bicycle, an empty oil can fell out and rolled across the pavement, and the wolf quickly grabbed the can and ran away with it. This behavior suggested food conditioning and habituation to people. A wolf fitting this description had been observed in the Old Faithful area approaching people since March, and likely had been fed. The same wolf later chased two motorcycles and was seen approaching vehicles on the road. Its interest in people, different from the Canyon wolves, and the indications of food-conditioned behavior made this wolf a human safety threat and the decision was made to remove him. Using photographs and other identifying marks, Wolf Project personnel and park rangers searched for the animal. On May 19, he was shot in a location away from the road and out of visitor view. After this event no wolves exhibiting similar behavior were observed, an indication that the habituated wolf had been removed.

### *Wolf Management Outside Yellowstone*

Information on wolf management and recovery status in the greater Yellowstone recovery area in 2009 is available at www.westerngraywolf.fws.gov.

## Collaborative Research

The Wolf Project and the Yellowstone Park Foundation provided financial and in-kind support for collaborative research with scientists at other institutions, including universities, interagency divisions, and non-government research organizations. These investigations required Wolf Project staff to assist graduate students and outside researchers in their efforts to better understand wolf ecology, ecosystem function, and conservation, much of which is pioneering research.

*Supercub pilot Roger Stradley doing what he does best.*

### *Wolf Project Students: Direct Assistance*

Five students worked in collaboration with the Wolf Project in 2009: Daniel Stahler, Emily Almberg, Matt Metz, Bonnie Trejo, and Alessia Uboni. Three are long-time employees on the project that have moved on to work in a new capacity and are partially supported by project funding. Stahler's project focuses on combining behavioral data gathered in the field with genetic data from DNA samples to better understand wolf social behavior and life history. Almberg's project focused on wolf diseases from both a current and historical perspective. With severe morality caused by disease in 1999, 2005, and 2008, Almberg's work helped elucidate the role of diseases for wolf population ecology in the Northern Rockies. Metz's project focuses on summer predation patterns in wolves by incorporating downloadable GPS collar technology and modeling techniques. Trejo's project analyzes the summer diet of wolves in the Greater Yellowstone Area using a traditional scat analysis technique in comparison with more technologically advanced methods such as GPS-collar cluster analysis. Uboni's project will use radio locations acquired from VHF and GPS collars since 1995 to map wolf territories and address questions about wolf habitat use.

*Title:* Behavioral, ecological, and genetic influences on life-history strategies and social dynamics of gray wolves
*Graduate Student:* Daniel Stahler, PhD candidate
*Committee Chair:* Dr. Robert Wayne, University of California, Los Angeles
*Project Summary:* The evolution of complex societies, such as seen in wolves, is greatly influenced by how

*Erin Albers and Dan Stahler draw blood for genetic and disease sampling.*

ecological and social constraints impact population structure and mating systems. In combination with the underlying genetic structure of wolf packs, aspects of wolf ecology such as reproduction, dispersal, pack formation, and territoriality are predicted to vary with the abundance and distribution of resources. This research investigates the link between socioecological conditions and these aspects of wolf ecology in Yellowstone. This project takes advantage of long-term datasets available following the 1995 reintroduction: 1) a complete population pedigree of marked individuals resulting from the integration of molecular and field-based behavioral data; and 2) predator–prey and wolf population dynamics. By combining field and laboratory-based data, this study will address questions concerning life history patterns, territoriality, and pack interactions and how they are associated with kinship and ecological condition. By combining long-term ecological, behavioral, and molecular datasets, this study will enhance our understanding of the evolution of complex, kin-structured societies, as well as provide a better understanding of how social and ecological conditions are related to wolf population dynamics and conservation.

*Project Activity in 2009:* Fulfilled teaching requirements at UCLA, field data collection and management, analyzed genetic samples, began data analysis, co-authored several YNP wolf genetics-related papers.

*Anticipated Completion Date:* 2011

*Title:* Infectious disease in Yellowstone National Park's canid community

*Graduate Student:* Emily Almberg, Master of Science

*Committee Chair:* Dr. L. David Mech, University of Minnesota, St. Paul

*Project Summary:* Gray wolves were reintroduced into Yellowstone National Park (YNP) after a >70-year absence and, as part of recovery efforts, the population has been closely monitored. This study analyzed sympatric wolf, coyote (*Canis latrans*), and red fox (*Vulpes vulpes*) serologic data from YNP, spanning 1991–2007, to identify long-term patterns of pathogen exposure and to examine evidence for disease-induced mortality. The study found that canine parvovirus, canine adenovirus-1, canine herpesvirus, and *Neospora caninum* were enzootic in YNP wolves and coyotes. Wolf, coyote, and fox exposure to canine distemper virus (CDV) was temporally variable, with evidence for distinct multi-host outbreaks in 1999 and 2005. The years of high wolf-pup mortality in 1999 and 2005 in the northern region of the park were correlated with peaks in CDV seroprevalence, suggesting that CDV contributed to the observed mortality. Although CDV appears capable of causing short-term population declines, none of the pathogens examined appear to jeopardize the long-term population of canids in YNP. CDV causes acute, highly immunizing infections among its wide range of carnivore hosts. Repeated outbreaks of CDV among YNP's wolves, coyotes, and cougars (*Puma concolor*) prompted questions as to how, where, and at what scale CDV might be persisting in the regional carnivore community. Using several stochastic, spatially-explicit, susceptible-exposed-infectious-recovered (SEIR) simulation models, results from the study indicated that 1) current wolf populations in the Greater Yellowstone Ecosystem are too small to support endemic CDV, 2) under the assumption that coyotes are the primary reservoir host, CDV requires an unrealistically large number of individual hosts (50,000–100,000) for long-term persistence, and 3) the inclusion of a second host species capable of inter-species transmission can greatly increase the probability of long-term CDV persistence, particularly at relatively small spatial scales. Given the small group sizes of carnivores and their annual reproductive pulses, CDV probably requires multi-host transmission for long-term persistence.

*Project Activity in 2009:* Successfully defended thesis and published two peer-reviewed papers.

*Completion Date:* May 2009

*Title:* Seasonal predation patterns of gray wolves in Yellowstone

*Graduate Student:* Matt Metz, Master of Science candidate

*Committee Chair:* Dr. John Vucetich, Michigan Technological University

*Project Summary:* The summer predation patterns of wolves are mostly unknown, which creates an important knowledge gap regarding annual predation patterns. As a result of methodological difficulties in detecting kills outside of winter months due to changes in both ecological conditions and wolf behavior, wolf kill rates from winter have often been projected throughout the year to estimate a wolf's impact on the prey population for the entire year. This likely overestimates kill rates (at least in kg/wolf/day, not necessarily in ungulates/wolf/day) because the data is gathered only in winter, when adult prey become increasingly vulnerable. Additionally, the need to provide for pups and the utilization of small prey items likely changes the foraging strategy of wolves in the summer. Finally, the presence of both grizzly and black bears in Yellowstone may cause wolves to spend only a short time period at a kill. Due to these challenges, GPS collars deployed on individual wolves will identify location clusters in an attempt to find summer kills and then examine their characteristics (species, sex, age). Results of wolf summer predation patterns will be compared to data collected in winter from Yellowstone to compare seasonal patterns of predation.

*Project Activity in 2009*: Summer fieldwork searching GPS clusters, coursework, and thesis preparation.

*Anticipated Completion Date*: May 2010

*Matt Metz, and John and Leah Vucetich, visiting scholars and collaborators, check bone fragments from a calf elk at a wolf GPS cluster (>1 wolf location) in summer.*

*Title:* A comparison of two methods to assess the summer food habits of wolves

*Graduate Student*: Bonnie Trejo, Master of Science candidate

*Committee Chair*: Dr. Richard Golightly, Humboldt State University

*Project Summary*: Scat analysis is commonly used to document the summer diet of wolves. The method is non-invasive and cost efficient; however, biases as well as technical and interpretational difficulties can limit its value. Recent technological advances in the use of GPS-telemetry and location cluster analysis have been utilized in Yellowstone National Park (YNP) and Grand Teton National Park (GTNP) to improve our knowledge of the summer food habits of wolves. To date, information collected using GPS techniques has not been compared with that gained from the longstanding method of scat analysis. Scat analysis may be particularly useful for detecting small prey items that may be missed by tracking techniques. The objectives of this study are to: 1) analyze wolf scat collected in YNP and GTNP to determine percent frequency of occurrence of prey items and calculate the relative number of prey consumed; 2) compare the results of scat analysis to those of GPS cluster analysis to evaluate the differential assessment of prey composition and biomass of the two approaches; and 3) compare the summer diet of wolves among years, between packs, seasons (summer and winter), and geographical regions within the greater Yellowstone ecosystem. This project is a collaborative effort among the NPS, USFWS, and Humboldt State University.

*Project Activity in 2009:* Collection of approximately 500 scats from YNP. Development of lab techniques and beginning analysis of scats collected from GTNP.

*Anticipated Completion Date:* May 2011

*Title:* Effects of wolf age structure and life history on wolf–elk interactions

*Post-doctoral Researcher:* Dr. Dan MacNulty

*Post-doctoral Advisor:* Dr. John Vucetich, Michigan Technological University

*Project Summary:* Most wild animal populations are composed of individuals that differ with respect to traits such as age, sex, and body size. Such heterogeneities in predator populations are thought to have

profound effects on predator–prey dynamics. In particular, variation in traits that determine a predator's capture ability may promote dynamic stability. Yet most predation research has treated predators as abstract, homogeneous sources of risk to which prey respond. The overall goal of this research project is to determine the extent to which heterogeneities in the Yellowstone wolf population influence the outcome of wolf–elk interactions at the individual- and population-level. Results are expected to clarify the effects of wolves on ungulate populations.

*Project Activity in 2009:* Published research findings detailing how wolf body size and age influence wolf–elk interactions. Results indicate that large body size sometimes limits predatory performance and that individual-level aging impairs hunting ability and reduces prey offtake via fluctuations in population age structure. Because age structure varies independently of population size, results suggest that predatory senescence may cause wolf populations of equal size but different age structure to have different impacts on elk populations. Knowledge of wolf age structure may therefore improve predictions of wolf-dynamics.

*Anticipated Completion Date:* September 2010

*Title:* Wolf spatial analysis: habitat use and territorial patterns

*Graduate Student*: Alessia Uboni, PhD candidate

*Committee Chair*: Dr. John Vucetich, Michigan Technological University

*Project Summary*: This project focuses primarily on spatial analysis of wolf movements using radio telemetry. Territory mapping and determining wolf habitat use via Resource Selection Function (RSF) will be a major part of this project. Relating habitat use to variables like elk distribution and abundance, pack size, kill rate, intraspecific strife, winter versus summer, and day versus night will be the major emphasis of this project, which will use data from 1995 to the present. Data derived from both GPS and VHF collars will be used.

*Project Activity in 2009:* Attended school at MTU taking classes and working on data analyses.

*Anticipated Completion Date:* May 2013

*Wolf Project staff cover many miles on foot throughout the year and especially in summer during predation studies.*

## *The Yellowstone–Abruzzo Wolf Research Exchange Program*

In September 2009, Yellowstone Wolf Project members Matt Metz and Rebecca Raymond visited Abruzzo National Park in Italy to observe and participate in an Abruzzo Large Carnivore Research Program led by renowned wolf biologist Luigi Boitani from the University of Rome. The trip was made possible through a new donor-sponsored program designed to exchange professional and cultural ideas about the science and conservation of carnivores through the experiences of young biologists. The Abruzzo Research Program investigates the ecology of two large carnivores: the Marsican brown bear (*Ursus arctos marsicanus*) and the Italian wolf (*Canis lupus italicus*). Primary research objectives for each species include population estimation and diet analysis, as little has been historically known about these carnivores. An important goal is to estimate annual reproduction. For bears, this is achieved by observing females in open country foraging on the berries of *Rhamnus alpinus*, an

*Matt Metz (far left) and Rebecca Raymond (far right) process a captured wolf in Italy as part of an exchange program through the University of Rome.*

important food source. Wolf reproduction is documented during the summer by conducting howling surveys near homesites. The investigation of these carnivores' diets is primarily accomplished via GPS cluster-searches and scat analysis. Prey species available to and utilized by wolves varies among pack territories, with red deer, roe deer, wild boar, and domestic livestock as the primary prey.

During the trip to Abruzzo, Metz, and Raymond had a culturally and professionally unique experience with the opportunity to learn from another wolf research program. They assisted with the monitoring of both bears and wolves while in Italy, using methodologies that were both similar and different. As part of the objectives of this program, researchers exchanged information on research techniques to strengthen both teams' programs. Additionally, Metz and Raymond gave presentations on the ecological lessons learned from 15 years of Yellowstone research following wolf restoration. This exchange of ideas and experiences will continue in 2010 when two members of the Abruzzo Large Carnivore Research Program will visit the Yellowstone Wolf Project during the March winter study.

*Winter study in Pelican Valley from the observation point.*

## *Yellowstone Wolf Project Research*

***Predator–Prey.*** A major objective for Yellowstone wolf research is wolf–prey relationships. Biannual 30-day winter studies (November 15–December 14 and March 1–30), ongoing for 15 years, are designed to record early and late winter predation patterns. More recently, summer predation patterns are studied using downloadable GPS-collar data (May through July), along with scat collection for diet analysis. During these established predation studies and opportunistically throughout the year, project staff record behavioral interactions between wolves and prey, predation rates, total time wolves feed on carcasses, percent consumption of kills by scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites. Graduate students Matt Metz and Bonnie Trejo and post-doctoral student Dan MacNulty conducted research associated with this topic.

***Hunting Behavior.*** This aspect of wolf–prey relationships has been a research focus in Yellowstone largely through the efforts of long-term graduate and post-doctoral researcher Dan MacNulty. With the availability of longitudinal data from repeated observations of individually known wolves hunting prey, behavioral, ecological and evolutionary dynamics of predation have been uniquely studied. Published research in 2009 focused on the predatory performance of wolves with respect to age and body size, and their ecological and evolutionary dynamics.

***Pelican Valley Wolf, Grizzly Bear, and Bison.*** Starting in 1999, the Yellowstone Wolf Project has monitored wolves, bison, and grizzly bears from a hilltop observation point in Yellowstone's Pelican Valley for two to four weeks during March. The primary goal is to document the behavioral interactions between wolves, bison, and grizzly bears in order to: 1) identify patterns of wolf predation on bison; 2) determine how the risk of wolf predation influences bison foraging behavior, movement, and habitat use; and 3) assess the importance of wolf-killed ungulates for grizzly bears emerging in early spring.

***Population Dynamics.*** Using data from a radio-marked population, year-round research focuses on understanding the major components of wolf population dynamics (births, deaths, immigration, and emigration). Monitoring efforts through ground and aerial tracking and observations provide annual census size, territory size and use, reproductive success, cause-specific mortality, survival, and other life history patterns. Data on social behavior and pack structure are collected to investigate patterns of dispersal, social stability, and age structure. Necropsies of all recovered radio-collared individuals and uncollared wolves provide cause-specific mortality data.

***Dispersal.*** The ecological, demographic, and genetic implications of dispersal are an important research focus for Yellowstone wolf biologists. Using radiocollar tracking information and genetic techniques under the umbrella of other project objectives, current research aims to understand basic demographic patterns of dispersal (age, sex, distance, season) along with the influence of wolf

*The Wolf Project visits L.A. Josh Irving gives a talk at an elementary school in Inglewood, California.*

density, pack structure and size, kinship, and breeder loss in a naturally regulated system. Additionally, migrant detection analysis using molecular techniques will assess gene flow and genetic connectivity to other regional wolf populations. Graduate work by Dan Stahler at UCLA and Kira Cassidy-Quimby at the University of Minnesota is associated with the topic.

***Breeding Behavior.*** During January and February each year, project staff monitor Yellowstone packs for courtship and breeding behaviors. The opportunity to study breeding behavior in wild wolves is unprecedented, and this study is designed to investigate the role of interacting social and ecological factors influencing individuals' attempts to breed and their relative fitness consequences. Aspects of breeding behavior are included in Dan Stahler's graduate research.

***Wolf Pack Leadership.*** The purpose of this study is to determine the nature of leadership in wild wolf packs. Ultimately, this project will define when leadership is asserted and by which wolves in the hierarchy. Due to the difficulty of observing wild wolves in a natural environment, leadership has been an unexplored aspect of wolf behavior. By observing packs with recognizable individuals, leadership behavior can be distinguished between identified dominant (alpha) and non-dominant (non-alpha) wolves. This study gathers data to determine under what circumstances leadership behavior is demonstrated and how it is correlated to breeding status, social status, environmental conditions, and season.

***Wolf Capture and Handling.*** Each year, approximately 25–30 wolves are helicopter darted and radio-collared. Handling of individuals provides data on morphometrics, disease, genetic sampling, age, sex, breeding status, and condition. Both VHF and GPS collars are deployed, and provide the basis for nearly all other aspects of Yellowstone's wolf research program.

***Disease.*** Research on the disease ecology of Yellowstone wolves is ongoing. The majority of disease monitoring comes from extracting and analyzing blood samples. Serum and blood profile analyses record disease exposure and prevalence. Nasal, rectal, and ocular swabs collected on both live and dead wolves aid in documenting disease and cause of death. Disease screening includes parvovirus, distemper, and infectious canine hepatitis. Additionally, a population-wide sarcoptic mange monitoring effort has begun using an individual-based monthly documentation of mange occurrence, severity, and recovery in all packs through the use of direct observations, handling, and aerial photographs. Graduate work was completed by Emily Almberg in 2009 in association with this research topic.

***Population Genetics.*** Annual genetic sampling (blood, tissue, and scats) from live and dead wolves is used to study genetic diversity, population structure, parentage and kinship, gene flow, and selection of fitness related traits. In combination with ecological and behavioral datasets, genetic data supports research on both evolutionary and ecological dynamics in the Yellowstone population. Examples of current research include evolutionary history and selection for coat color, evolution of life history traits (e.g., reproduction, senescence), and effect of kinship on breeding strategies, territoriality, and strife. Graduate work was ongoing by Dan Stahler and Bridgett vonHoldt through UCLA in 2009 in association with this research topic.

***Multi-carnivore and Scavenger Interactions.*** Research is ongoing to understand the degree to which exploitative and interference competition is occurring among Yellowstone's carnivores. Data is collected on all observed wolf–bear, wolf–cougar, and wolf–coyote interactions. Additionally, data on scavenger species diversity, abundance, and carcass utilization at wolf kills are collected to understand how these interactions influence structure and function of the ecosystem.

***Wolf Spatial Dynamics.*** Thousands of wolf radiolocations, both VHF and GPS, have been gathered since wolves were reintroduced in Yellowstone in 1995. Rigorous analyses using these locations have begun examining many questions concerning habitat use and territoriality. Year-to-year changes in territory use are being related to variables such as elk density and distribution, intraspecific strife, pack size, and reproduction. Other analyses under-

way are habitat use (using Resource Selection Functions), travel and territory size, summer versus winter, and night versus day, as well as comparisons between GPS and VHF collars. Alessia Uboni at Michigan Technological University is working on this project as a graduate student.

*The 2009 winter study crew (back row, left to right): Trina Wade, Josh Irving, Dan Stahler, Doug Smith, Matt Metz, Nate Bowersock, Hilary Zaranek, Colby Anton, Nick Bromen; (front row, left to right): Rebecca Raymond, Kira Cassidy, Erin Albers, Cheyenne Burnett.*

## Staff and Public Involvement

### *Staff and Volunteers*

Three full-time employees worked for the Yellowstone Wolf Project in 2009: Project Leader Douglas Smith and biological science technicians Erin Albers and Rick McIntyre. Daniel Stahler split time between graduate work at the University of California in Los Angeles and working in the park as a project biologist. Other paid and volunteer staff were Colby Anton, Nate Bowersock, Nick Bromen, Cheyenne Burnett, Carrie Byron, Brenna Cassidy, Kira Cassidy, Grace Hammond, Sarah Hardee, Joshua Irving, Ky Koitzsch, Lisa Koitzsch, Bonnie McDonald, Meghan O'Reilly, Mike Peterson, Rebecca Raymond, Aaron Snyder, Dave Unger, Trina Wade, and Hilary Zaranek. Some of these staff members were paid technicians with funding provided by the Yellowstone Park Foundation.

### *Outreach*

Yellowstone Wolf Project staff gave 183 talks and 90 interviews (see Appendices III and IV). Talks were presented at both scientific conferences and to general audiences. Interviews were to all forms of media.

## Acknowledgements

We thank all of the Wolf Project field technician volunteers, especially winter study volunteers, without whom we could not carry on the vital research and management of YNP wolves. We also thank the many generous individuals, foundations, and organizations that have provided a total of $4 million in grants through the Yellowstone Park Foundation to the Wolf Project since 1996. In particular, we would like to thank Canon U.S.A., Inc., an anonymous donor, The Tapeats Fund, the Turner Foundation, the Twin Spruce Foundation, the Perkins-Prothro Foundation, the participants in the Yellowstone Park Foundation's Wolf Collar Sponsorship Program, and the National Science Foundation grant DEB-0613730.

Generous contributions to the Yellowstone Park Foundation provide more than 60% of the Wolf Project's annual budget and enable important studies on disease transmission, genetics, predation habits, the social dynamics of Yellowstone's wolf packs and their role in the ecosystem. This valuable support also ensures that programs to educate visitors and help them see wolves in Yellowstone continue to meet the demands of the park's growing number of visitors. Learn more at www.ypf.org/wolf.

Finally, we also thank pilots Roger Stradley, Steve Ard, Neil Cadwell, and Bob Hawkins for safe and successful piloting during wolf tracking and helicopter darting. We know that a successful program needs a strong base of support and to all of the above we are deeply indebted.

# Appendices

## *Appendix I. Wolf Project Volunteer Roster, 2009*

| Name | Period of Involvement | Hours Worked |
|---|---|---|
| Colby Anton | 5/26–12/31/09 | 1,288 |
| Nate Bowersock | 5/11–8/18/09 & 11/12–12/18/09 | 816 |
| Nick Bromen | 2/25–4/4/09 & 11/12–12/31/09 | 616 |
| Cheyenne Burnett | 11/12–12/18/09 | 240 |
| Carrie Byron | 2/25–4/4/09 | 256 |
| Brenna Cassidy | 6/22–8/24/09 | 368 |
| Grace Hammond | 7/20–8/10/09 | 144 |
| Sarah Hardee | 2/4–4/4/09 | 376 |
| Ky Koitzsch | 2/25–4/4/09 | 256 |
| Lisa Koitzsch | 2/25–4/4/09 | 256 |
| Bonnie Mcdonald | 2/25–4/4/09 | 256 |
| Meghan O'Reilly | 5/11–7/6/09 | 328 |
| Mike Peterson | 2/4–7/14/09 | 952 |
| Rebecca Raymond | 1/1–2/28/09 | 336 |
| Aaron Snyder | 5/19–8/30/09 | 592 |
| Dave Unger | 7/8–8/15/09 | 224 |
| Trina Wade | 11/12–12/18/09 | 240 |
| Hilary Zaranek | 2/25–4/4/09 | 256 |
| **Total Volunteer Hours*** | | **2,424** |

* Volunteer hours = approx. 4 full-time field technician positions

## *Appendix II. Publications in 2009*


Almberg, E.S., L.D. Mech, D.W. Smith, J.W. Sheldon, and R.L. Crabtree. 2009. A serological survey of infectious disease in Yellowstone National Park's canid community. *PLoS ONE* 4(9):e7042.

Anderson, T.M., B.M. vonHoldt, S.I. Candille, M. Musiani, C. Greco, D.R. Stahler, D.W. Smith, B. Padhukasahasram, E. Randi, J.A. Leonard, C.D. Bustamante, E.A. Ostrander, H. Tang, R.K. Wayne, and G.S. Barsh. 2009. Molecular and evolutionary history of melanisn in North American gray wolves. *Science* 323:1339–1343.

Smith, D.W., E.E. Bangs, J.K. Oakleaf, C. Mack, J. Fontaine, D. Boyd, M. Jimenez, D.H. Pletscher, C.C. Niemeyer, T.J. Meier, D.R. Stahler, J. Holyan, V.J. Asher, and D. Murray. In press. Survival of colonizing wolves in the northern Rocky Mountains of the United States, 1982–2004. *Journal of Wildlife Management*.

MacNulty, D.R, D.W. Smith, L.D. Mech, and L.E. Eberly. 2009. Body size and predatory performance in wolves: is bigger better? *Journal of Animal Ecology* 78(3):532–539.

MacNulty, D.R., D.W. Smith, J.A. Vucetich, L.D. Mech, D.R. Stahler, and C. Packer. 2009. Predatory senescence in ageing wolves. 2009. *Ecology Letters* 12:1–10.

Merkle, J.A., D.R. Stahler, D.W. Smith. 2009. Interference competition between gray wolves and coyotes in Yellowstone National Park. *Canadian Journal of Zoology* 87:56–63.


## *Appendix III. Interviews Given by Wolf Project Staff, 2009*

| Date | Interviewer |
|---|---|
| ***Doug Smith:*** | |
| January | National Geographic Television |
| February | Oregon State University wildlife policy class |
| | Brent French, *Billings Gazette* |
| | Kelly Bascone, *Backpacker Magazine* |
| | Jeff Corwin, book project |
| | Al Stahler, KVMR Radio, Nevada City |
| | Peter Davies, Cornell University, CA |
| | Eric Barker, *Lewiston Tribune* |
| | Ted Kerasote, author |
| | Brett French, *Billings Gazette* |
| | Todd Wilkerson, journalist |
| | Matt Joyce, Associated Press |
| | Gardiner School, 7th grade class |
| | Jeff Corwin, Doug Wagner |
| March | Allan Wright, writer |
| | Lily Huang, *Newsweek* |
| | *West Yellowstone News* |
| | Allan Wright, writer |
| | Gib Mathers, *Powell Tribune* |

| Date | Interviewer |
|---|---|
| ***Doug Smith (cont.):*** | |
| | Sharon Levy, freelance writer |
| | Greg McNutt, Defiance College |
| April | Jan Fennell, dog trainer |
| | Echo Renner, *Wyoming Livestock Roundup* |
| | Neil Rodgers |
| | Scott Williams, *National Geographic* |
| | Lena Naslumd, Swedish Radio |
| | John Shearer, BBC |
| | Karen Silverstein, PBS |
| | Breann Hunt, Idaho 5th grade class |
| May | Brett French, *Billings Gazette* |
| | Michael Behor, *Backpacker Magazine* |
| | Karen Silverstein, PBS |
| | Ruth Harries, Animal Planet |
| | Jennifer McCarthy, National Geographic |
| | Cory Hatch, *Jackson Hole News & Guide* |
| | Andy Newcomer, KFBB, Great Falls, MT |
| | Karen Snyder, KTWO Radio, Casper, WY |
| | John Sherer, KBZK News, Bozeman, MT |
| | Rich Landers, *The Spokesman Review* |
| June | PBS, *Fetch!* (1st Interview) |
| | PBS, *Fetch!* (2nd Interview) |
| July | Sara Sandolfi, *Corriere Della Sera Magazine*, Italy |
| | Brett French, *Billings Gazette* |
| August | Martha Stewart Show |
| | Alexandra Fuller, *National Geographic Magazine* (1st Interview) |
| | Alexandra Fuller, *National Geographic Magazine* (2nd Interview) |
| September | Ali Guio, Stanford University |
| | Gib Mathers, *Powell Tribune* |
| | Amanda Hobbs, *National Geographic Magazine* |
| October | Richard Reeder, *Cody Enterprise* |
| | Brett French, *Billings Gazette* |
| | Virginia Morell, *Science Magazine* |
| | Kim Murphy, *LA Times* |
| | Virginia Morell, *Science Magazine* |
| | Holly Jaycox, Wolf Park |
| | Amanda Hobbs, *National Geographic Magazine* |
| | Tara Bannow, *The Minnesota Daily* |
| | Brett French, *Billings Gazette* |
| | Doug Chadwick, *National Geographic Magazine* |

| Date | Interviewer |
|---|---|
| ***Doug Smith (cont.):*** | |
| | Todd Wilkinson, *Christian Science Magazine* |
| | Phillip Taylor, *Land Letter Magazine* |
| November | Jeffrey Masson, Auckland, NZ |
| | North Carolina school teachers |
| December | Janice Lloyd, *USA Today* |
| | Emily Krieger, *National Geographic Magazine* |
| | Bill McNulty, *National Geographic Magazine* |
| | David Brancaccio, NOW on PBS |
| | Jordan Fisher Smith, *Discover Magazine* |
| | Jean Plackol, Andrea Stephens, Ecology Project International |
| | Addie Goss, Wyoming Public Radio |
| | Brett French, *Billings Gazette* |
| | Sharon Levy, freelance journalist |
| | Eve Byron, *Helena Independent Record* |
| | Amy Quick, *Cody and Beyond* |
| ***Dan Stahler:*** | |
| October | Matt Moyer, *National Geographic Magazine* photographer |
| ***Rick McIntyre:*** | |
| January | Emily Benzie (San Diego, CA), student phone interview |
| April | Lena Naslund, Sweden (day 1) |
| | Lena Naslund, Sweden (day 2) |
| May | Kim Freeman, Xanterra Corporation |
| | Kim Freeman, Xanterra Corporation |
| | Andy Newcomer, Channel 5 News, Great Falls, MT |
| | David Keptner (Midland, MI), student phone interview |
| July | Sara Gandolfi, Italian newspaper reporter |
| October | Kim Murphy, *LA Times* |
| | Joe Roman, Harvard Press |
| | Matt Moyer, *National Geographic Magazine* photographer |
| December | Todd Wilkerson, *On Earth Magazine* |
| ***Kira Cassidy:*** | |
| October | Matt Moyer, *National Geographic Magazine* photographer |
| ***Josh Irving:*** | |
| May | Brett French/David Grubbs, *Billings Gazette* |
| ***Rebecca Raymond:*** | |
| October | Matt Moyer, *National Geographic Magazine* photographer |

## *Appendix IV. Talks Given by Wolf Project Staff, 2009*

| Date | Group | Location |
|---|---|---|
| ***Doug Smith:*** | | |
| January | NPS Second Century field trip | YNP |
| February | University of Montana–Western workshop | Dillon, MT |
| | YNP Resource Management workshop | YNP |
| | Winter study training | YNP |
| | Yellowstone Association Institute Winter Rendezvous | YNP |
| | Wild Side Tours | YNP |
| March | Tory and Meredith Taylor group | YNP |
| | Yale University, wildlife policy class | YNP |
| | United World College class | |
| | The Wildlife Society Keynote Idaho State Conference | Moscow, ID |
| | University of Minnesota conservation biology class | YNP |
| | University of Washington ecology class | YNP |
| April | Wilson Auditorium | Bozeman, MT |
| | University of Montana–Western | Dillon, MT |
| | College of Southern Idaho | Gardiner, MT |
| | Yellowstone Association Members | Minneapolis, MN |
| May | Mammoth Communication Center | YNP |
| | Greater Yellowstone Coalition group | YNP |
| | NPS Interpretive staff training | YNP |
| | Environmental Lawyers Foundation field trip | YNP |
| June | Yellowstone Wolf Tracker | Gardiner, MT |
| | Outfitter training | Lake, YNP |
| | Emerson Cultural Center | Bozeman, MT |
| August | Elk/wolf meeting | Missoula, MT |
| September | Roosevelt Lodge | YNP |
| | Judson Park | Cleveland, OH |
| | Nathaniel Reid field trip | YNP |
| October | Draper Museum | Cody, WY |
| | North Dakota State University wildlife class | YNP |
| | Michigan Technical University | Houghton, MI |
| | Tavern Club | Cleveland, OH |
| November | Yellowstone Association Institute class | YNP |
| | Greater Yellowstone Coalition, Yellowstone Association | YNP |
| December | Montana State University Department of Ecology | Bozeman, MT |
| | Xanterra snow coach drivers | YNP |
| | Interpretive staff training | YNP |
| | Guides and outfitters training | YNP |
| ***Dan Stahler:*** | | |
| February | The Wild Side, LLC | Gardiner, MT |
| March | Canon U.S.A., Inc. Annual Photo Trade Show | LasVegas, NV |
| April | California Wolf Center | Julian, CA |
| August | American Associations State Colleges | YNP |
| | Wildlands Institute | YNP |
| | Canon U.S.A., Inc. | YNP |
| September | Yellowstone Association Institute class | YNP |
| | U.S. assistant secretary of interior and NPS director field trip | YNP |
| | U.S. Courts, District of Wyoming, U.S. Magistrates Conference | YNP |

| Date | Group | Location |
|---|---|---|
| | The Wild Side, LLC | Gardiner, MT |
| October | YPF Board of Directors field trip | YNP |
| November | Winter study training | YNP |
| December | Food for the Masses group, Yellowstone Institute | YNP |
| | Food for the Masses group, Yellowstone Institute | YNP |
| ***Rick McIntyre:*** | | |
| January | University of Wisconsin at Whitewater field trip | YNP |
| | Yellowstone Association/Xanterra press tour (Day 1) | YNP |
| | Yellowstone Association/Xanterra press tour (Day 2) | YNP |
| | Bozeman (MT) High School wildlife ecology and management field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Darby (MT) High School field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Yellowstone Association wildlife tour | YNP |
| | North Carolina Museum of Natural Sciences field trip | YNP |
| | Friends of Arizona Highways field trip | YNP |
| | Star Light Center High School (Casper, WY) field trip | YNP |
| | Ken Burns (PBS) press tour | YNP |
| | Yellowstone Association/Xanterra press tour | YNP |
| February | Wolf tour, Jim Halfpenny | YNP |
| | Iowa Department of Natural Resources field trip | YNP |
| | Jackson Hole Conservation Alliance field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Environmental Adventures wolf tour | YNP |
| | Greater Yellowstone Coalition | YNP |
| March | United World College (New Mexico) field trip | YNP |
| | Yale Forestry School field trip | YNP |
| | Mike Nelson's wolf field trip | YNP |
| | University of Minnesota Spring Break field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Trevor School (New York City) *Expedition: Yellowstone!* class | YNP |
| | University of Washington Wildlife Conservation field trip | YNP |
| | Rocky Mountain College Yellowstone ecology field trip | YNP |
| | International Wolf Center field trip | YNP |
| April | Roundup (MT) Elementary School *Expedition: Yellowstone!* class | YNP |
| | Thermopolis (WY) Elementary School *Expedition: Yellowstone!* class | YNP |
| | Twin Falls (ID) Elementary School *Expedition: Yellowstone!* class | YNP |
| | Bozeman (MT) High School wildlife ecology and management field trip | YNP |
| | Big Sky (MT) High School field trip | YNP |
| | Thermopolis (WY) Elementary School *Expedition: Yellowstone!* class | YNP |
| | Billings (MT) Central High School field trip | YNP |
| | College of Southern Idaho field trip | YNP |
| May | Fort Casper (WY) Academy *Expedition: Yellowstone!* class | YNP |
| | Summit (UT) Middle School field trip | YNP |
| | Cody (WY) High School environmental studies field trip | YNP |
| | Bozeman (MT) High School wildlife ecology and management field trip | YNP |
| | Fort Casper (WY) Academy *Expedition: Yellowstone!* class | YNP |
| | Winston (OR) Middle School field trip | YNP |
| | Burley (ID) High School field trip | YNP |

| Date | Group | Location |
|---|---|---|
| | Hellgate (Missoula, MT) High School field trip | YNP |
| | Teton Science School Graduate School field trip | YNP |
| | Greater Yellowstone Coalition field trip | YNP |
| | Yellowstone Association wildlife tour | YNP |
| | Yellowstone Association Institute class | YNP |
| | China Protected Areas Leadership Alliance field trip | YNP |
| | Kicking Horse Job Corps Center (Ronan, MT) field trip | YNP |
| June | Xanterra Tour Guides training field trip | YNP |
| | Casper College (WY) field trip | YNP |
| | Whitman College (Walla Walla, WA) field trip | YNP |
| | Xanterra Lamar Valley wildlife tour | YNP |
| | Ecology Project International (students from Los Angeles) field trip | YNP |
| | Gannon University (Erie, PA) field trip | YNP |
| | Statesville (NC) High School Project field trip | YNP |
| | Montana State University field trip for master's-level students | YNP |
| | Defenders of Wildlife field trip | YNP |
| | DePaul University (Chicago, IL) environmental policy field trip | YNP |
| | Ecology Project International (students from Oakland, CA) field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Wild Rockies Field Institute of University of Montana field trip | YNP |
| | Roosevelt Lodge Xanterra employees | YNP |
| July | Westminster (Atlanta, GA) High School field trip | YNP |
| | Ecology Project International (students from Oakland, CA) field trip | YNP |
| | Girl Scout Troop 2301 (Lake Jackson, TX) | YNP |
| | Yellowstone Association Institute class | YNP |
| | Ecology Project International (students from Missoula, MT) field trip | YNP |
| August | Erie (PA) Playhouse field trip | YNP |
| | California State University at Monterey wildlife studies field trip | YNP |
| | American Association of Colleges and Universities | YNP |
| | Defenders of Wildlife field trip | YNP |
| | Ecology Project International (students from Costa Rica) field trip | YNP |
| | Yellowstone Association Institute class | YNP |
| | Beartooth Alliance, annual meeting | Silver Gate, MT |
| | Yellowstone Association Institute class | YNP |
| | South Dakota School of Mines field trip | YNP |
| September | Yellowstone Association Institute class | YNP |
| | Yellowstone Association Institute class | YNP |
| October | Longfellow Elementary School (Bozeman, MT) field trip | YNP |
| | Yellowstone Park Foundation field trip | YNP |
| | Flathead High School (Kalispell, MT) environmental systems field trip | YNP |
| | University of Montana marketing and tourism class | YNP |
| | Grace Lutheran Elementary School (Pocatello, ID) *Expedition: Yellowstone!* class (Day 1) | YNP |
| | Grace Lutheran Elementary School (Pocatello, ID) *Expedition: Yellowstone!* class (Day 2) | YNP |
| | North Dakota State environmental science field trip | YNP |
| | Cody (WY) High School environmental sciences field trip | YNP |
| | Dubois (WY) Elementary School *Expedition: Yellowstone!* class | YNP |
| November | Montana State University Yellowstone science class field trip | YNP |

| Date | Group | Location |
|---|---|---|
| | Capital High School (Helena, MT) field trip | YNP |
| | Greater Yellowstone Coalition field trip | YNP |
| | Yellowstone Institute Food for the Masses class (Session One) | YNP |
| | Yellowstone Association field trip | YNP |
| | Yellowstone Institute Food for the Masses class (Session Two) | YNP |
| December | Yellowstone Institute Food for the Masses class (Session Three) | YNP |
| | Yellowstone Institute Food for the Masses class (Session Four) | YNP |
| | Yellowstone Institute tour group | YNP |
| | Bozeman (MT) High School wildlife ecology and management class | YNP |
| | National Geographic Expeditions | YNP |
| | Yellowstone Association class/field trip | YNP |
| | Yellowstone Association field trip | YNP |
| ***Kira Cassidy:*** | | |
| May | Xanterra employees | Grant, YNP |
| June | Xanterra employees | Lake, YNP |
| July | 5th and 6th grade students from Missoula, MT | YNP |
| ***Matt Metz:*** | | |
| February | Ecosystem Science Center Graduate Research Forum (Poster) | Houghton, MI |
| | Graduate Student Research Symposium (poster) | Houghton, MI |
| May | Summer predation training | YNP |
| June | YNP trail crew | YNP |
| | Xanterra summer employees | YNP |
| September | University of Wyoming | Laramie, WY |
| | Wildlife Society Conference (poster) | Monterey, CA |
| October | Large Carnivore Project, Abruzzo National Park | Villetta Barrea, Italy |
| ***Josh Irving:*** | | |
| February | British Columbia Institute of Technology | YNP |
| May | NPS employees | Mammoth, YNP |
| | NPS employees | Old Faithful, YNP |
| | Skagit Valley College | YNP |
| | NPS employees | Mammoth, YNP |
| August | National Geographic "Off the Beaten Path" | YNP |
| | Veterinary medical students, Gakuno Rakuen University, Ebetsu, Japan | YNP |
| September | Lovell Elementary School, Lovell, WY | NWC Field Station |
| | Biologists, University of Lisbon, Portugal | YNP |
| October | Graduate Students, Norwegian University of Life Sciences | YNP |
| | 1st and 2nd Grade, View Park Accelerated Charter Elementary School | Inglewood, CA |
| | Crowe Horwath, LLP | Sherman Oaks, CA |
| November | Winter study training | YNP |
| ***Rebecca Raymond:*** | | |
| May | Xanterra employees | Grant Village, YNP |
| | Park County Mental Health Center | YNP |
| July | Ackworth, GA tour group | YNP |
| | Teton Science School | YNP |
| August | Montana Conservation Corps | YNP |
| October | Large Carnivore Project, Abruzzo National Park | Villetta Barrea, Italy |