YELLOWSTONE WOLF PROJECT

ANNUAL REPORT
2006

Yellowstone Wolf Project

Annual Report
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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 by Douglas Smith and Daniel R. Stahler.

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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, but delisting is contingent on the implementation of USFWS-approved state laws and wolf management plans. Currently Montana and Idaho manage wolves in their states, with federal funding and according to federal guidelines. Until Wyoming's regulatory framework for wolf management can be approved, wolves in northwestern Wyoming will remain protected by the ESA.

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 2006: Project Leader Douglas Smith, and Biological Science Technicians Debra Guernsey and Dan Stahler. The Wolf Project was able to hire paid seasonal staff through the Yellowstone Park Foundation and Yellowstone Association to assist in several key aspects of our annual work. Erin Albers, Emily Almberg, Matt Metz, Abby Nelson, Jesse Newby, and Katie Yale worked for the summer and fall field season. Erin, Emily, Matt, and Abby also worked during the winter months. Rick McIntyre worked for the Wolf Project for six months as a National Park Service seasonal employee and six months as a volunteer. Additional volunteers (see Acknowledgments and Appendix) staffed the early (November–December) and late (March) winter study periods.

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.

2006 Summary

At the end of 2006, at least 136 wolves in 13 packs occupied Yellowstone National Park. This represents a 15% increase over 2005, when disease caused the largest population decline since reintroduction. Ten packs counted toward the breeding pair objective for the Yellowstone Recovery Area. One pack dissolved (Nez Perce) and one new pack formed (Oxbow Creek), marking one of the more stable years in pack turnover. Wolf distribution changed little.

The population increase is probably a response to low wolf numbers in 2005 and greater pup survival (80% compared to 32% in 2005). Although blood serology is not available at the time of this report, there was no evidence of a disease outbreak in 2006. Mortality was about equal (18%) to the 10-year average (20%). Intraspecific mortality was again the leading cause of death. Average pack size was 10.5, and an average of 4.6 pups survived per pack.

Twenty-six wolves were captured and collared. At year's end, 37 of 136 (27%) wolves were collared. A new type of radio collar was deployed this year. The ARGOS collar is designed to track animals in remote locations that are hard to track via fixed-wing aircraft. These collars use satellite technology that can forward data to the wolf office via email.

Wolf predation was affected by a winter of average snow accumulation but above average temperature. Deep snow and temperatures that often rose above freezing produced a crust on the snow and made it difficult for ungulates to access forage. Significant winterkill was documented for the first time since the severe winter of 1996–1997. Elk were in poorer condition (as measured by bone marrow) and kill rates were higher than in 2005. Wolf Project staff documented 281 kills (definite, probable, and possible combined) made by wolves in 2006, including 219 elk (80%), 30 bison (14%), 6 coyotes (2%), 5 wolves (2%), 3 deer (1%), 2 bighorn sheep (<1%), 2 moose (<1%), 1 beaver (<1%), 1 golden eagle (<1%), and 12 unknown prey (4%). The composition of elk kills was 32% calves (0–12 months), 31% bulls, 16% cows (1–9 years old), 14% old cows (≥10 years old), and 7% elk of unknown sex and/or age. Bison kills included 12 calves (unknown sex), 11 cows, 3 bulls, and 2 of unknown sex and age. Bison kills increased compared to the last two years, and on the northern range an early winter (November–December) switch to calves was evident after two years of selection for bull elk.

Studies continued on vertebrate scavenger use of wolf-killed prey, and expanded to include invertebrates.

Den closures and other wolf management activities continued. Wolves were visible at several locations across the northern range and in Hayden Valley. Possibly because of the high level of human activity in close proximity to their core territory and repeated human disturbances, the Hayden Valley wolves are the most human-tolerant in the park.

Wolf Project staff published seven scientific publications. Wolf Project leader Doug Smith gave 58 talks and 60 interviews (see Appendices), the first time such a high volume of public outreach was conducted.

For the seventh consecutive year, in conjunction with the U.S. Fish and Wildlife Service and the U.S. Forest Service, Wolf Project staff rode horses into hunting camps along the park boundary to discuss wolf issues with outfitters and their clients. Three hunting camps in the Gallatin National Forest were visited. In previous years, camps in the Bridger-Teton Forest were visited.

Additional information on wolves in Yellowstone National Park is available at <www.nps.gov/yell/naturescience/wolves.htm >, <www.greateryellowstonescience.org>, and <www.r6.fws.gov/wolf/>.

Yellowstone Wolf Pack Territories, 2006

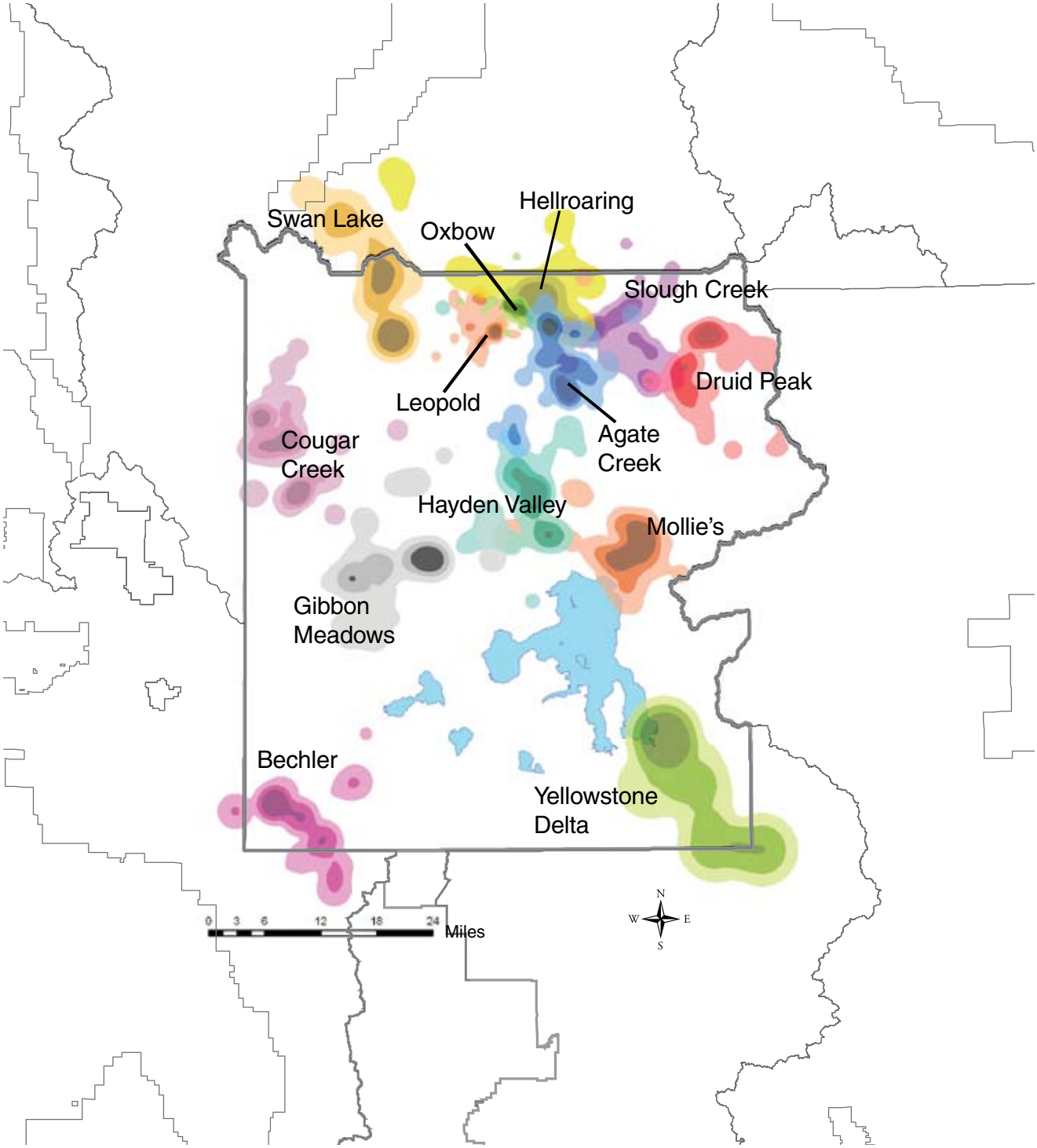

Figure 1. Wolf pack territories in Yellowstone National Park in 2006, plotted as kernel estimates. Darker colors depict higher use, or core, territories.

Agate Creek pups testing a bull elk in August near Mt. Washburn. Only the pups are interested, as the adults know this elk is not worth pursuing.

The Yellowstone Wolf Population

Population and Territory Status

At the end of 2006, at least 136 wolves in 13 packs occupied Yellowstone National Park (YNP) (Figure 1, Table 1). This represents a 15% rebound in wolf numbers after the population decline caused by disease in 2005 (Figure 2). There was no evidence of a disease outbreak in 2006; adult and pup survival was good (see below).

An examination of wolf numbers over the last 12 years revealed the annual low for the YNP wolf population occurs in late winter rather than early winter (the official reporting time to the U.S. Fish and Wildlife Service [USFWS]) (Figure 3). For example, last year the reported early winter wolf population was 118, but the late winter count was only 85 wolves (–28%). After a record low in 2005, the percentage of pups in the population bounced back in 2006 (Figure 3). Comparing mortality and dispersal over the same period, mortality has increased over the last three years (26% compared to 17% for the first eight years), whereas dispersal (when a wolf leaves its natal pack) has been stable at about 28% per year (Figure 3).

Twelve of the 13 packs (92%) present in 2006 were present in 2005. One new pack (Oxbow Creek) was

Pack	Adults	Pups	Total
Northern Range			
Swan Lake	2	3	5
Leopold	7	12	19
Hellroaring	5	1	6
Agate	7	6	13
Slough	8	0	8
Druid	3	9	12
Oxbow Creek	4	8	12
Northern Range Totals	**36**	**39**	**75**
Non-Northern Range			
Mollie's*	6	5	11
Yellowstone Delta	11	5	16
Bechler	8	5	13
Cougar Creek	4	0	4
Gibbon Meadows	8	4	12
Hayden	3	2	5
Non-Northern Range Totals	**40**	**21**	**61**
Total	**76**	**60**	**136**

Underline denotes breeding pair
*Age breakdown unconfirmed

Table 1. Yellowstone National Park wolf population, December 2006.

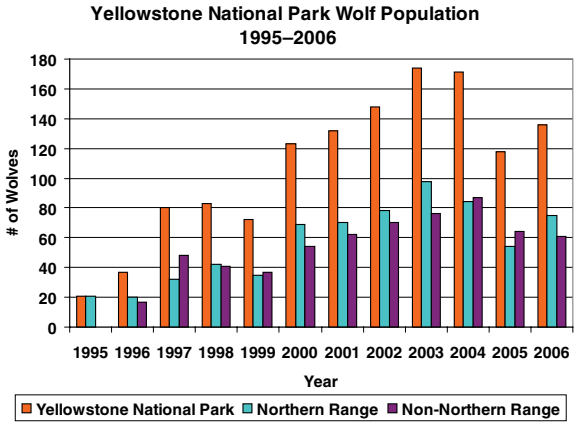

Figure 2. Yellowstone National Park early winter wolf population, 1995–2006.

formed by three Leopold females that dispersed, joined an unidentified male, and took over a portion of Leopold territory.

Seven packs (75 wolves, up 38% from 2005) used the northern range, and six packs (61 wolves, down 5% from 2005) used the rest of the park. Pack size ranged from 4 (Cougar Creek) to 19 (Leopold) wolves and averaged 10.5.

The northern range supports a majority of the park's wolves despite having a smaller area (1,000 km^2) than the rest of the park (7,991 km^2). This has consistently been the case in previous years and is attributed to a greater year-round prey density on the northern range. However, recent analyses indicate that social strife (wolf–wolf killing and territorial clashes) has limited wolf numbers and, probably, disease as well.

In 2006, there were numerous indications of an increase in social strife. Conflicts between the Agate Creek and Hellroaring packs, the Agate Creek and Slough Creek packs, the Slough Creek and Druid Peak packs, and the Leopold and Oxbow Creek packs were all indicative of social competition related to increasing wolf density and probable declining prey availability. Elk are wolves' primary winter prey and their numbers have declined by about 50% since 1995. At the same time, high wolf density has contributed to an observed increase in wolf–wolf conflict. Based on these observations, and despite the increase in wolf numbers in 2006, we expect wolf numbers to decline over the next several years.

By the end of the year, the Swan Lake pack was residing north of the park and had not returned. After a territorial clash with the Agate Creek pack, the Hellroaring Creek pack moved north temporarily. The Oxbow

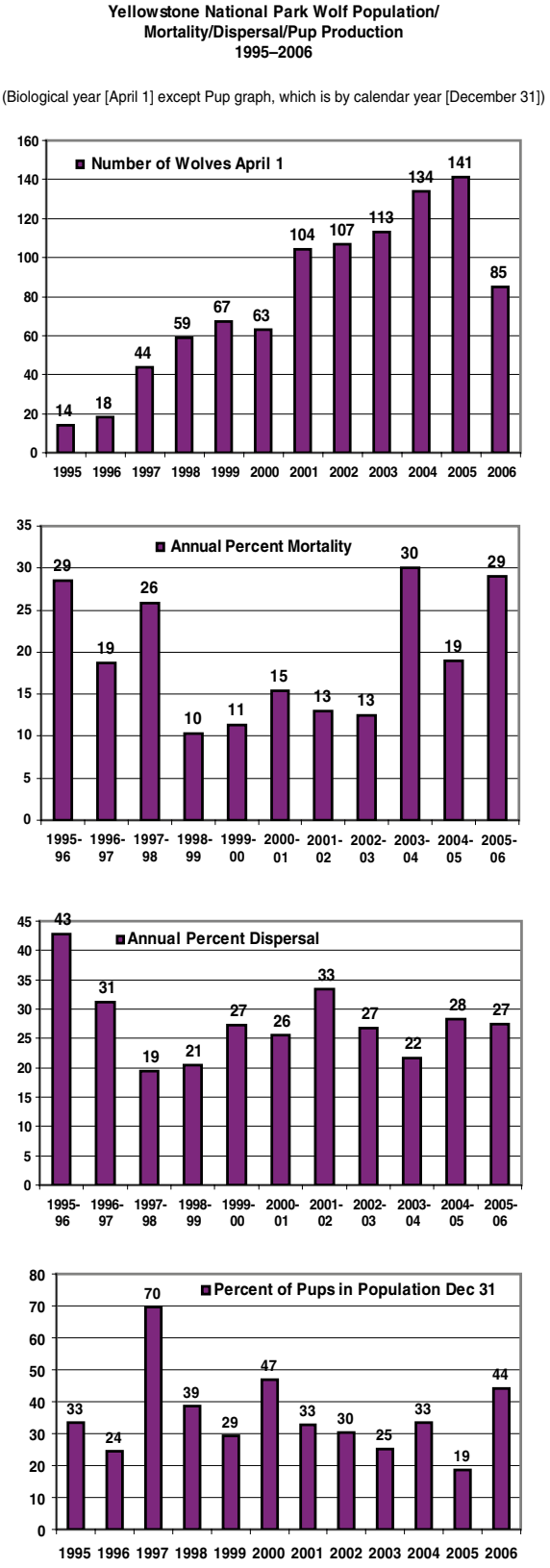

Figure 3. Yellowstone National Park wolf population vital statistics, 1995–2006.

Leopold pups in early summer.

Creek pack had claimed a portion of what was formerly Leopold territory. How long these two packs will coexist is open to question. It is clear that Leopold, Agate Creek, and probably Druid Peak are dominant packs on the northern range and the other packs are likely to be at a competitive disadvantage.

Packs in the park interior are much more stable and occur at lower density without the level of conflict observed on the northern range. Their numbers changed little (from 64 in 2005 to 61 in 2006) and one pack dissolved. Territories are large with space in between them. The Madison–Firehole range has stabilized somewhat after a previous high density that supported three packs in 2004. Two southern packs (Bechler and Yellowstone Delta), the most isolated in the park, spend significant amounts of time outside the park boundary. They both reproduced with good pup survival, and remained relatively large packs (>10 wolves each). Two interior packs, however, are in decline. Because of pressure from Mollie's pack, and possibly because of poor habitat, the Hayden Valley pack is in decline. The Cougar Creek pack has an aging alpha female (see *Pack Summaries* below).

Wolf distribution has remained largely unchanged for several years, indicating that all available wolf habitat is settled. Pack turnover, when it occurs, is always within already occupied wolf range; no new areas of settlement have been recorded.

Reproduction

Pup survival was excellent in 2006. After a poor year in 2005, there seemed to be some compensatory survival. Seventy-seven pups were born parkwide and 60 (78%) survived compared to only 32% in 2005 (Figure 4). Fifty-two pups were born on the northern range and 39 (75%) survived compared to only 16% in 2005. Pup numbers in the interior increased slightly, with 21 compared to 14 in 2005, but because interior pups are rarely seen at their dens early in the season, it is unknown how many were born and did not survive.

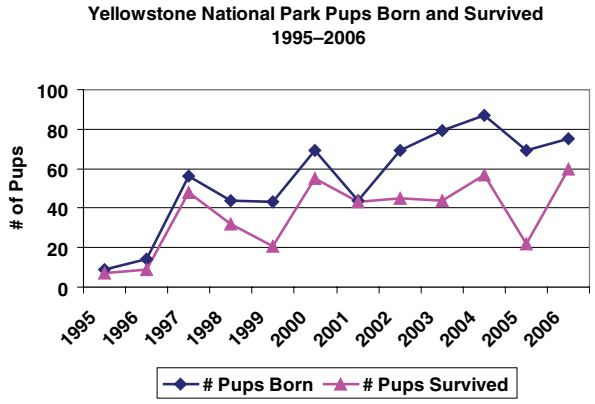

Figure 4. Yellowstone National Park pups born and survived, 1995–2006.

The 13 packs that produced litters had an average of 5.9 pups (including packs with multiple breeders), and an average of 4.6 pups per pack survived. On the northern range, an average of 5.6 pups per pack survived, compared to 3.5 pups per pack in the park interior, where no multiple litters were documented.

Two out of 13 packs had no surviving pups. The Slough Creek pack produced pups but none survived. Pup mortality was probably due to competitive interactions with other packs. In the other case of reproductive failure, the Cougar Creek pack, the cause of pup mortality is unknown but possibly related to the age of

# of Deaths	Wolf #/Sex	Age Class	Pack	Date of Death	COD
1	288F	Adult	Dispersed from Leopold	1/1/2006	Natural Unknown
2	377M	Adult	Slough Creek	4/28/2006	Intraspecific
3	453M	Adult	Dispersed from Slough	6/11/2006	Control Action
4	474M	Adult	Disperser	12/3/2006	Illegal
5	487M	Adult	Dispersed from Yell. Delta	4/21/2006	Unknown
6	489M	Adult	Slough Creek	4/4/2006	Intraspecific
7	493M	Yearling	Poss. Dispersed from Yell. Delta	2/20/2006	Unknown
8	528M	Adult	Hellroaring	2/11/2006	Intraspecific
9	542F	Adult	Yellowstone Delta	4/9/2006	Intraspecific
10	490M	Adult	Slough Creek	12/29/2006	Natural Unkown

Table 2. Yellowstone National Park wolf mortalities (collared YNP wolves), 2006.

the breeding female, who was eight years old. Field data indicated that this pack localized around a den, but only briefly, suggesting that the pups died early.

Wolf Project staff visited every den site, except Gibbon Meadows, and most rendezvous sites to collect scat samples for summer food habits studies. Staff also discovered a dead wolf inside a secondary den (see *Pack Summaries* below), and checked for dead pups (as in 2005).

Mortalities

Not counting over-summer pup mortality, 10 collared wolves died in 2006 (Table 2), including 1 yearling and 9 adults (2–5 years). Eight males and 2 females died. The leading cause of mortality was intraspecific strife (Figure 5). The mortality rate in 2006 was 18%, about equal to the 11-year average of 20%.

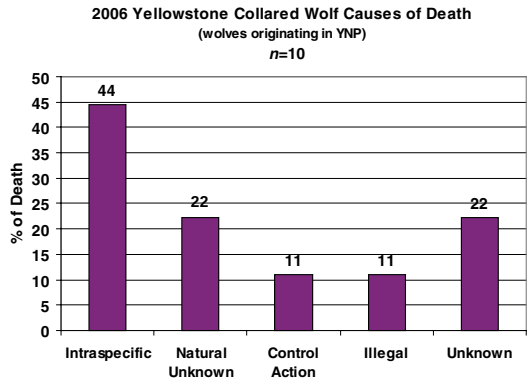

Figure 5. Causes of death for wolves in Yellowstone National Park, 2006.

Pack Summaries

Swan Lake Pack

At the end of 2005, the status of the Swan Lake pack was unknown, but in 2006, male #295 paired and bred with an unknown female. In April, the pair used a den near an old Swan Lake rendezvous site and produced six pups, three of which survived. The pack used traditional Swan Lake territory but moved north of the park boundary in October and had not returned by year's end. It is unknown why the pack left the park, and it does not appear that pressure from other packs was the reason. None of the original Swan Lake wolves are still alive.

Leopold Pack

One of the oldest and most stable packs in YNP, the Leopold pack again anchored itself on the Blacktail Deer Plateau. The pack numbered only seven wolves in early 2006, but was the largest pack in YNP at the end of the year at 19 wolves. The alpha pair of female #209 and male #534 (who was collared and numbered for the first time in January 2006) continued to lead the Leopold pack. Remarkably, there have only been two alpha males (#2 and #534) and three alpha females (#7, #259, and #209) in the pack's 11-year history. One of those alpha females (#259) was present only one year. The current breeding pair (female #209 and male #534) have bred three seasons. (Male #534 has bred four seasons, including one year with female #259). A total of 15 pups in two litters, one by #209 and another by an uncollared subordinate female, were produced. Field work suggests that this subordinate wolf moved between the Leopold pack

Wolf #295M of the Swan Lake pack tries unsuccessfully to reclaim his kill from a grizzly bear.

and the nearby Oxbow Creek pack in March before giving birth to her pups at an unknown location. She then moved her pups to the traditional den with #209F's litter in June. At the end of the year, 12 pups had survived and were traveling with the pack.

On a routine trip to a secondary Leopold den after it was abandoned for the season, Wolf Project staff discovered a dead wolf near its entrance. The wolf was female #288, who had dispersed in 2005 with a malfunctioning collar. The find was unusual because the wolf probably died before the denning season, yet the pack (including pups) still used the den for about a week in May.

The Leopold pack made fewer extraterritorial forays in 2006 than 2005, probably because of its smaller size. In 2006, they did not venture north of the Yellowstone River, where they had usurped kills and clashed with neighboring packs in previous years.

Oxbow Creek Pack

Oxbow Creek was a new pack that formed at the end of the 2006 breeding season. Three females (#536, #470, and an uncollared wolf) splintered from the Leopold pack, joined an uncollared male, and carved out a piece of what was formerly Leopold territory. Some territorial conflict was witnessed, but possibly because the pack members are familiar with the landscape, Oxbow persisted. In previous years, another Leopold splinter, the Swan Lake pack, had thrived next door to Leopold.

The new pack produced 10 pups in two litters. Eight pups survived to year's end. The mothers were believed to be #536 and #470, who had recovered but still limped after being captured in a coyote trap.

Hellroaring Creek Pack

Occupying a territory with high turnover (three packs have lived there in the last 10 years) and bordered by four other packs, the Hellroaring Creek pack appears to be under pressure and experiencing territorial incursions from other packs. At least two trespasses by the Agate Creek pack may have caused them to spend more time north of the park. Wolf Project staff observed one trespass in which conflict over a kill caused the Hellroaring wolves to flee in several directions. Unlike the Swan Lake pack, they returned to the park. The pack numbered seven wolves in early 2006 but only six at year's end. At least four pups were born, presumably to the alpha female #353 and male #287, three of which survived to November, but only one to year's end. One pup disappeared in late November after an attack by the Agate Creek pack.

NPS/MATT METZ

Two Leopold wolves traveling mid-winter.

Agate Creek Pack

In early 2006, the Agate Creek pack numbered seven wolves and occupied the pack's traditional territory, which spans the Washburn/Antelope Creek basin, Tower Junction, Specimen Ridge, and Little America. During the summer the Agate wolves were the most visible pack for visitors to watch in the Antelope Creek area. The pack produced six pups, all of which survived to year's end, increasing the pack size to 13. In the fall and early winter months, the Agates made extraterritorial forays to the north side of the Yellowstone River and were becoming a dominant pack on the northern range, intruding into both the Hellroaring and the Slough Creek pack territories and initiating aggressive interactions. One of these interactions may have introduced a male Agate yearling to a breeding vacancy in the Slough Creek pack, which had recently lost their alpha male #490. Questions remain over the fate of Agate's longtime alpha male #113, who at nine years old was showing his age.

Siege at Slough Creek

A Slough Creek female at the site where the siege took place.

In April 2006, a highly unusual event occurred at Slough Creek. It may be the first time such behavior has been documented in a wolf population.

On April 4, what seemed to be a pack of 12 wolves (six adults, one of whom wore a non-functioning collar, and six pups) was observed for the first time in Lamar Valley. Since their identity was unknown, they were called the Unknown pack. For the next few days, we saw them off and on in Lamar. These Unknown wolves howled back and forth with the resident Slough Creek wolves (nine adults and three pups) on several occasions.

On April 8, we discovered that the number three Slough Creek male (#489) was dead. It appeared he had been killed by wolves, most likely members of the Unknown pack.

The two pregnant Slough Creek wolves, #380 (the alpha female) and #527 (the beta female), went into a shared den on April 12 to have pups. That evening other Slough Creek wolves killed a bull elk about a mile south of the den. The Unknown pack was about two miles east of the Slough Creek den at the time. At dark, the Unknown pack started to move west toward Slough Creek.

The next morning the Unknown wolves were near the Slough Creek pack's den. There was no challenge from the Slough Creek wolves. A yearling from the Unknown pack had a freshly injured ear, possibly indicating a fight between the two packs the previous night. The Unknown wolves probably arrived during the night when some of the Slough Creek wolves were feeding on the elk carcass, chased them off, and followed their scent back to the den. A lack of telemetry signals indicated that the two Slough Creek mothers and #526F were in the den.

The Unknown wolves stayed at the Slough Creek den area for 13 days. They regularly went to the den and looked inside. Some even went a short way into the den tunnel. At times, Unknown wolves that went into the den suddenly jumped back out. We assumed a Slough Creek female had lunged at them. Eventually, we saw the three collared Slough Creek females (#380, #526, and #527) and at least three uncollared females slip in and out of the den.

One day the Unknown wolves spotted a Slough Creek yearling approaching the den after feeding on a nearby carcass. They charged at her, but she got safely inside. The yearling likely shared meat from the carcass with the mother wolves.

On another occasion, the two Slough Creek mothers came out of their den when 10 Unknown wolves were resting downhill. The mothers slowly moved uphill, but frequently stopped to look down at the other pack. Suddenly both females ran back down the slope while the Unknown wolves ran uphill at top speed. Both mothers reached the den and slipped inside just moments before the Unknown wolves arrived.

By that point, the two packs seemed to be at a stalemate. The Unknowns were prevented from getting to the den by the Slough females. The Slough mothers had survived, but probably were not getting enough food and water to support their litters. During a tracking flight by Wolf Project staff, six wolves were observed bedded down by the Slough Creek den hole with the signals of the Slough Creek mothers clearly audible. Unbeknownst to the air crew, it wasn't the Slough Creek wolves around the den, it was the Unknown wolves, a fact that almost went unrecorded because the air crew thought all the wolves lying by the den were Slough Creek wolves.

The Slough Creek alpha and beta males (#490 and #377) stayed in the area a few days, then retreated to Lamar Valley, where they temporarily linked up with an uncollared gray female and the three did scent marking together.

The alpha female of the Unknown pack did not look pregnant, a possible reason why her pack had wandered outside their territory during the denning season. However, one of the subordinate females was clearly pregnant. She entered a burrow only a few hundred feet from the Slough natal den and it appeared she had pups there on April 24.

The next day females #380 and #527 left the area and reunited with other Slough Creek wolves including #377 and #490. The two Slough Creek mothers likely lost their litters due to stress and inadequate food and water. They probably

could not produce enough milk to sustain the pups. After a few days, the Unknown pack's female stopped going into her den and traveled full-time with the pack. She had also endured a lot of stress from denning so close to rival wolves, which may have led to the loss of her pups.

On the evening of April 27, the Slough Creek wolves traveled west and were within a few miles of their den as it was getting dark. The next morning #377M was severely injured at Slough Creek by the Unknown pack. He died later that day of wounds inflicted by wolves. Number 490 howled almost continually at #377 that morning, but #377 never howled back and #490 eventually retreated to Lamar.

After the siege ended, eight of the 10 surviving Slough Creek wolves traveled together, including #490, the three collared females (#380, #526, and #527), a two-year-old female, and three female yearlings. Later, the other two pack members (a two-year-old male and an adult female) were seen traveling together apart from the main group.

After it was determined that neither pack was still using the denning area, Wolf Project staff inspected the dens. No pup remains were found; staff concluded that the pups may have been consumed.

The Unknown pack encountered the Druid Peak pack and were sighted occasionally afterward. It is still unclear who the Unknown wolves were, possibly the old Buffalo Fork pack, which is closest to Slough Creek, or the old Rose Creek pack, which was last known to range in Hellroaring Creek, or a combination of both packs. An old Leopold wolf, #150M, joined the Rose Creek pack in 2000, and he could have been the gray male with a non-functioning collar in the Unknown pack. But all of this is speculation; we hope genetic tests someday will clarify the identity of these wolves. Reports of wolves to the north in the Absaroka-Beartooth wilderness area fit the description of these wolves, and the trip into Yellowstone seems to have been a brief extraterritorial foray.

In late December, near the northern park boundary on Slough Creek, #490, the alpha male of the Slough Creek pack, was found dead. The state of his remains prevented determination of the cause of death, but it could have been wolf-caused, possibly by the Unknown wolves. Within a few days of his death, a male yearling from the nearby Agate Creek pack joined the Slough females and became the new alpha male, marking a new start for the Slough Creek pack after their run-in with the pack to the north.

Slough Creek Pack

The Slough Creek pack was the center of attention in April when an unknown pack of 12 wolves, likely from north of YNP, attacked while they were denning (*see inset story*). Two females (#380 and #527) from Slough Creek denned on April 12 but were mostly pinned inside the den and unable to access adequate water or food for about two weeks. Two adult male Slough wolves (#377 and #489) were killed by this trespassing pack. The females eventually abandoned the den and no pups survived. After both packs had left the denning area, Wolf Project staff examined the den and found no pups, concluding that they may have been eaten by the Slough Creek females. The lack of successful reproduction and the mortality caused by the unknown pack reduced the Slough Creek pack to seven females and one male. Smaller pack size put them at a competitive disadvantage to the adjacent Druid Peak and Agate Creek packs, which are now dominant in territorial interactions. The Slough Creek pack's territory has contracted as a result. Instead of occupying most of Lamar and Soda Butte valleys, they restrict their movements to only a portion of Lamar and spend more time in Slough Creek.

In late December, near the northern park boundary on Slough Creek, #490, the alpha male of the Slough Creek pack, was found dead. The state of his remains prevented determination of the cause of death.

Druid Peak Pack

In 2006, the Druid Peak pack recovered from the previous year's decline to only four wolves. Both females in the pack bred and produced a total of 11 pups. Eight of these pups survived. The alpha female subsequently disappeared wearing a non-functioning radio collar. At year's end, the pack numbered 11 wolves, including 3 adults and 8 pups. With more wolves, the Druid Peak pack pushed back against the Slough Creek pack and reclaimed traditional Druid Peak territory in Soda Butte and Lamar valleys (see Slough Creek update above).

This pack was not very visible in 2005, but in 2006, they denned near the road in Round Prairie and were once again in the public eye. However, as soon as the pups were able to travel, the pack moved east into the backcountry and were not seen for the rest of the summer.

Mollie's Pack

Mollie's pack continued to inhabit Pelican Valley, and has one of the oldest known wolves in Yellowstone (the other is male #113 in Agate Creek). Male wolf #193 was nine years old in 2006, which is remarkable given that the average lifespan for a wolf in the park is 4.1 years. He is black and graying, but he is still the alpha male. He seems to participate less in pack activities and was most often observed at the den or rendezvous site during summer.

Unlike last year, pup survival was good in 2006, with five of six pups surviving to year's end and increasing the pack's size from 7 to 11.

Winter observational studies of this pack, begun in 2000, continued, focusing on bison carcasses—both wolf- and winter-killed—that attract grizzlies and other scavengers. Wolf Project staff observed interactions between wolves and bison, and wolves and other wildlife. A combination of deep snow and mild temperatures in winter 2005–2006 produced a crust that hampered bison access to forage, especially in Pelican and Hayden valleys. Because of their weakened condition, bison were highly vulnerable to wolf attacks, and winter-killed carcasses were more common than in previous winters. In March and throughout the summer, grizzly bears continued to usurp wolf kills, which may have stressed the pack and could contribute to reproductive failure in the future. This wolf–bear–carcass relationship may be benefiting grizzly bears during poor whitebark pine seed years, when grizzlies usurp more wolf kills than in good pine seed years. (Whitebark pine seeds are a key fall food source for grizzly bears.)

Pelican camp.

BOB WESELMANN

Wolves are sometimes collared for management purposes. In this photo, winter visitors watch a Hayden wolf.

Hayden Valley Pack

After nearly two years as an uncollared pack because they could not be located for aerial capture, the Hayden Valley pack was finally collared. Two older wolves (5–6 years) lead this pack and the alpha female is one of two white wolves in the park. The pack appears to struggle in Hayden Valley, possibly because of human interference and/or pressure from the nearby and larger Mollie's pack. Another contributing factor may be the fact that elk migrate from the valley in winter, forcing the pack to prey on the more formidable bison.

The pack denned in the same location as in 2005, a site partially visible from the road. It is likely that hikers walked to the den despite the area being closed. The pack then moved to a rendezvous site that was even more visible from the road and several human disturbances (e.g., people walking through the rendezvous site) were witnessed despite closures and controlled access. Only two pups were observed. This pack is the most human-tolerant of any in the park. They have been reported traveling the road while cars drive by, and approaching cars, snowcoaches, and snowmobiles. Because of their proximity to the road, the prevention of habituation to vehicles and people is an issue of special concern for this pack.

At year's end the pack numbered five wolves (three adults and two pups). They were recorded traveling widely beyond Hayden Valley, in contrast to previous years when they were rarely located outside the valley.

Yellowstone Delta Pack

This pack continues to be the most difficult to monitor in the park. Their large territory is located in a remote area and extends outside the park. For the first time since their inception as the original Soda Butte pack in 1996,

NPS/MATT METZ

Bechler wolves rally around male #192, a rare white wolf.

NPS/ABBY NELSON

Two Gibbon Meadows wolves in central Yellowstone.

no pack member was wearing a working radio collar. An ARGOS GPS radio collar was placed on an adult female, #542, in early February, but she was killed by Mollie's pack when she, and possibly other pack members, made a trip to Mary Bay, at the edge of the Mollie's pack's territory. GPS data from the alpha male's collar in Mollie's pack placed that wolf precisely at the same location as #542F. This, in addition to a field necropsy, suggests that the cause of death was other wolves. The only other working collar in the Yellowstone Delta pack (#492F) stopped beaconing sometime in August, or this wolf dispersed and was lost. Despite this tracking difficulty, visual observations were made late in the year by flying the pack's traditional routes. Seven pups were counted in early summer, but only five could be accounted for at year's end, making a total pack size of 16. However, these data are questionable because of tracking difficulty. One aid to tracking without collars is that this pack is very consistent in its choice of a den site inside the park that allows Wolf Project staff many summer observations. This pack is the highest priority for the 2007 collaring season.

Bechler Pack

Like the Yellowstone Delta pack, the Bechler pack is remotely located, occupying the southwest corner of the park. They are also a boundary pack, meaning a large portion of their territory is outside of YNP in the Targhee National Forest. The locations of Bechler's male #543 are emailed by his ARGOS collar to the Wolf Project office in Mammoth. The founding alpha male, now eight years old, still appears to be the breeding male. The pack successfully recruited five pups in 2006 and, with eight adults, numbered 13 wolves at year's end.

Gibbon Meadows Pack

A relatively new pack on the Madison–Firehole range, the Gibbon Meadows pack occupies what was traditionally Nez Perce pack territory. The pack is notable in that they prey on bison in winter, though not exclusively as do the Hayden Valley and Mollie's packs. Five pups were born and four survived in 2006. With eight adults the pack numbered 12 wolves at year's end. This pack was difficult to track in the summer. Wide ranging movements were evident, possibly because of a forest fire and associated aircraft traffic north of Nez Perce Creek.

Cougar Creek Pack

Possibly because of an aging alpha female (#151 is eight years old), this pack had no surviving pups for the second consecutive year, and numbered only four wolves at year's end. Based on radio-tracking, they localized at a den, but no pups were observed, and about a month after denning their movements indicated that if they had produced pups, they were no longer tending them. Wintertime elk densities in this area seem to be low, and while the pack's territory is situated on a major bison migration trail out of the park toward West Yellowstone and an occasional bison is killed, they subsist mostly on bull elk. Their territory is also in an area of high beaver density, and scat samples indicate that the pack consumes some beaver in summer.

Wolf Capture and Collaring

Twenty-six wolves in 12 packs were captured and handled in 2006 (Table 3). Wolf Project objectives are to maintain radio collars in all packs in the park. Because of the potential for collar loss, this requires more than one wolf per pack being collared. Five pups, 2 yearlings, 15 adults, and 2 old adults (>5 years) were handled and marked with collars (no wolves were ear tagged). In addition to collaring, each wolf was measured, weighed, and had blood drawn for genetic and disease analyses. At year's end, 37 (27%) of 136 wolves were collared.

In addition to standard VHF and GPS collars, a new satellite collar was deployed in 2006. Three ARGOS collars, which track wolves via satellites that are capable of emailing wolf locations to the Wolf Project office, were used in the most remote packs (Yellowstone Delta, Bechler, and Mollie's). These collars have been particularly valuable in packs that are hard to track via fixed-wing aircraft. All three of these packs occupy territory near the YNP boundary and spend time outside the park, primarily in Wyoming but also in Idaho. For this reason, the Wyoming Game and Fish Department had an interest in the movement patterns of these wolves and helped fund the project.

Capture Date	Wolf #/ Sex	Age	Color	Pack
1/19/2006	113M	Old Adult	Gray	Agate
	380Fb	Adult	Black	Slough
	524F	Pup	Gray	Agate
	525F	Yearling	Black	Agate
	526F	Yearling	Black	Slough
	527F	Adult	Black	Slough
	529F	Yearling	Black	Druid
1/25/2006	287M	Adult	Black	Hellroaring
	353F	Adult	Black	Hellroaring
	528M	Adult	Gray	Hellroaring
	534M	Adult	Gray	Leopold
	535M	Adult	Black	Leopold
	536F	Adult	Gray	Leopold
	537F	Adult	Gray	Gibbon
	538M	Adult	Gray	Gibbon
	539F	Pup	Gray	Gibbon
1/26/2006	540F	Adult	Gray/ White	Hayden
	541M	Adult	Gray	Hayden
	303M	Adult	Black	Cougar Creek
2/7/2006	193M	Old Adult	Black	Mollie's
	486F	Adult	Gray	Mollie's
2/8/2006	542F	Adult	Gray	Yellowstone Delta
	543M	Pup	Black	Bechler
	544M	Pup	Black	Bechler
	545F	Pup	Black	Bechler
	546M	Yearling	Gray	Cougar Creek II

Table 3. Yellowstone Wolf Project collaring operations, 2006 calendar year.

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 by intensive radio-tracking during two 30-day winter study sessions in March and November–December. The Leopold, Slough, and Hellroaring packs were the three main packs monitored by two-person teams from the ground and from aircraft. In addition, crews opportunistically monitored the Agate, Druid, Mollie's (March), and Oxbow Creek (November–December) packs and collected data on prey selection and kill rates. The Swan Lake, Cougar Creek, Hayden, Gibbon Meadows, and remnant Nez Perce wolves were monitored from aircraft only. The Yellowstone Delta and Bechler packs were rarely located by air due, in part, to their absence from the park or poor conditions for aerial monitoring in southern YNP. Wolf Project staff recorded and entered into a database behavioral interactions between wolves and prey, predation rates, interactions with non-prey, the total time

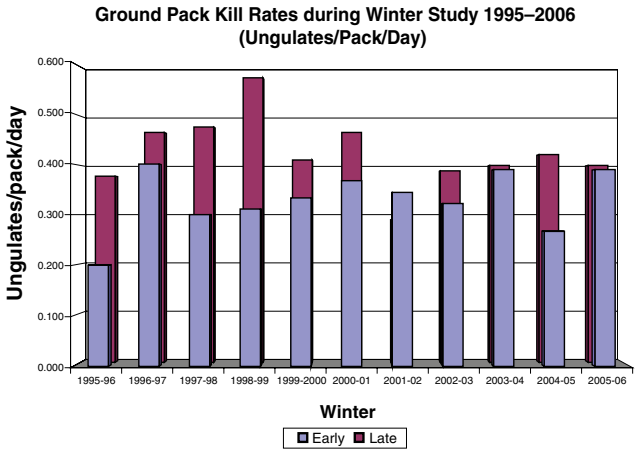

Figure 6. Minimum kill rates for wolf packs on the northern range, 1995–2006.

NPS/KATIE YALE

Wolf Project staff head to the Rose Creek pen for annual maintenance.

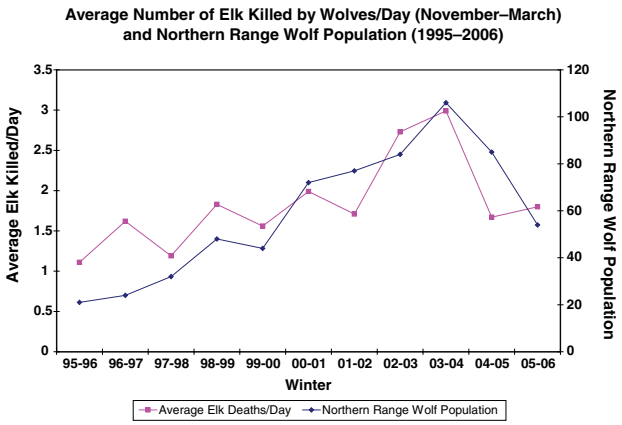

Figure 7. Elk deaths per day caused by wolves on Yellowstone's northern range during winter, 1996–2006.

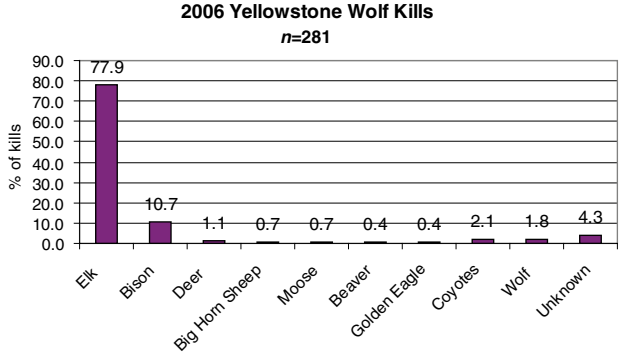

Figure 8. Wolf-killed species in Yellowstone National Park, 2006.

wolves fed on their kills, percent consumption of kills by wolves and scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites. In addition, similar data were collected opportunistically throughout the year during weekly monitoring flights and ground observations.

Probably because deep, crusted snow made elk and bison more vulnerable to wolf predation (Figure 6), kill rates per wolf (kgs/wolf/day) increased during winter 2005–2006. Despite the increased kill rate per wolf, total elk killed (elk deaths/day) declined due to fewer wolves (Figure 7).

Composition of Wolf Kills

Wolf Project staff documented 281 kills (definite, probable, and possible combined) by wolves in 2006, including 219 elk (80%), 30 bison (14%), 6 coyotes (2%), 5 wolves (2%), 3 deer (1%), 2 bighorn sheep (<1%), 2 moose (<1%), 1 beaver (<1%), 1 golden eagle (<1%), and 12 unknown prey (4%) (Figure 8). The composition of elk kills was 32% calves (0–12 months), 31% bulls, 16% cows (1–9 years old), 14% old cows (≥10 years old), and 7% elk of unknown sex and/or age. Bison kills included 12 calves (unknown sex), 11 cows, 3 bulls, and 2 of unknown sex and age.

This represents an increase in the percentage of elk calves and a decline in the percentage of bull elk taken, a switch after two years of high selection for bull elk. Use of cow elk remains low, especially prime age cows, and has historically been so. Use of bison has increased.

Winter Studies

March. During the 30-day March 2006 winter study, wolves were observed for 423 hours from the ground. The number of days wolf packs were located from the air ranged from 11 (Swan Lake) to 18 (Leopold, Slough, Hellroaring). Fifty-seven definite or probable wolf kills were detected, including 41 elk, 11 bison, 2 bighorn sheep, 1 mule deer, and 2 unknown species. Among elk, 20 (49%) were cows, 15 (37%) were bulls, 5 (12%) were calves, and 1 (2%) was an adult of unknown sex. In addition, 31 winter-killed ungulates (21 elk, 8 bison, and 2 unknown) were scavenged by wolf packs. Not since the heavy winterkill of late winter 1997 have Wolf Project staff documented such a high degree of winterkill, and this was reflected in the degree to which packs incorporated such carcasses into their biomass consumption for the month. The Hayden Valley and Mollie's packs

were found to live exclusively off bison (as detected by monitoring), and most other packs killed or scavenged at least one bison during the month, suggesting the importance of this ungulate in late winter diets for wolves. In a rare event, the Slough Creek pack killed two bighorn sheep that they encountered in an island of rocky habitat on one of the pack's main travel routes.

November–December. During the 30-day November–December 2006 winter study, wolves were observed for 271 hours from the ground. The number of days wolf packs were located from the air ranged from 3 (Bechler) to 13 (Leopold, Hellroaring Creek, Slough Creek, Oxbow Creek, Agate Creek, Swan Lake). Aerial monitoring was hampered by poor weather conditions. Sixty-two definite or probable wolf kills were detected during the November–December study. Wolf Project staff documented elk only being killed by wolves, including 43 (63%) calves, 9 (15%) bulls, 7 (11%) cows, and 3 (5%) of unknown sex and age.

Compared to the prey selection in recent November–December studies in which selection for bulls predominated, this year use of elk calves showed an increase. Although it is unclear to what degree these calf:cow ratios will contribute to population and predator–prey dynamics in the near future, data on prey selection during this year's winter study suggests a response to greater availability of this age class in the northern elk herd.

Summer Studies

Summer Predation. During summer 2006, Wolf Project staff continued efforts to document wolves' summer predation patterns. Documenting their predatory habits in summer is problematic because of the absence of snow for tracking, increased nighttime activity of wolves, lack of pack cohesiveness, and smaller prey packages leading to quick consumption and loss of evidence. Traditionally, the best data concerning wolf summer food habits have come from analysis of scat contents collected at den and rendezvous sites. Although efforts to collect scat continued in 2006, downloadable GPS collars were used to facilitate a greater understanding of summer wolf predation.

In the 2006 capture season, Wolf Project staff deployed four downloadable GPS (Global Positioning System) 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.

NPS/YOLANDA CORTEZ

Wolf Project volunteer Brian Teets takes a closer look.

Using GPS collars with downloadable data acquisition technology, the goal was to gather weekly data from collars programmed to collect location data every 30 minutes. This approach has proven successful in previous years by yielding high-resolution wolf movement data that reveals prey selection (including newborn elk calves) and kill rates.

As has been the case over the past several years, a combination of malfunctioning collars and the deaths of wolves wearing GPS collars made summer predation patterns difficult to document. Hellroaring wolf #528M, slated to be one of our main summer study wolves, was killed by the Slough Creek pack several weeks after his collar was deployed in January. A summer predation collar on Leopold's #535M worked well until mid-March, but then malfunctioned, preventing any GPS monitoring of the Leopold pack. Slough Creek's #527 was one of the breeding females involved in the conflict with the unknown pack during the denning season. She disappeared after losing her litter, and when staff attempted to download data from her collar in mid-summer, the collar malfunctioned and dropped off prematurely. Agate wolf #525F's collar performed well, but because the pack's summer range is within the Antelope Creek Bear Management Closure, Wolf Project staff were not able to conduct weekly downloads and cluster searches. However, when #525 spent time outside the closure, Wolf Project staff were able to locate wolf kills from her data points, an affirmation that the technology is adequate for studying summer predation if the collars work properly. Although future summer predation efforts are planned, more reliable and cost-effective GPS collar technology will be necessary.

NPS/KATIE YALE

Seasonal Wolf Project biological technician Emily Almberg hauls male #377, killed by other wolves, from Slough Creek.

NPS/MATT METZ

A male Gibbon wolf carries food back to the den.

Summer Scavenging. An important aspect of wolf restoration as it relates to the Yellowstone ecosystem is its effect on scavenger guilds. Research on wolf and scavenger interactions has been conducted since 1998 with support from Canon U.S.A., Inc., and the Yellowstone Center for Resources (YCR). This research, largely conducted in the winter, monitors how wolves influence the abundance and distribution of carrion, both spatially and temporally, as well as how they facilitate food acquisition by other carnivores. Although a great deal has been learned about the magnitude and relative importance of wolf-killed carcasses to the winter scavenger communities, little is known about the impact on summer scavengers, both vertebrate and invertebrate communities. The effect that wolves may be having on insect communities that feed off of their kills remains unexplored. Prior to the reintroduction of wolves, two studies revealed an enormous community of insects utilizing elk carcasses in the summertime.

In summer 2006, Wolf Project staff conducted carrion insect research in collaboration with Dr. Chris Wilmers (University of California–Davis). Staff collected data on invertebrate diversity and abundance at summer carcasses. This data will be used to test the effects of wolf reintroduction on this community. Invertebrate samples were collected at eight bison and elk carcasses from May 15 to July 20. Members of the order *Coleoptera* (including beetles) dominated the sampling, particularly those in the family *Silphidae* (carrion beetles). Insect samples will be identified by entomologists at the end of the study, which will continue in 2007. Once completed, this diverse and abundant component of the Yellowstone scavenger guild will be analyzed and compared to pre-wolf data sets to test hypotheses on community structure and potential changes associated with wolf recovery.

Population Genetics

A collaborative effort with the University of California at Los Angeles (UCLA) continued in 2006 in which genetic techniques were used to construct a population pedigree for all wolves handled in YNP, and to understand gene flow between the three Rocky Mountain wolf recovery areas. DNA samples from over 500 wolves from Idaho, Montana, and Wyoming were analyzed in the canid genetics lab of Dr. Robert Wayne at UCLA for genotyping and determination of diversity. In September, Dan Stahler began work on his PhD at UCLA, joining doctoral student Bridgett vonHoldt in Wayne's lab to combine field-based data with laboratory-based genetic analysis in order to integrate social, ecological, and genetic information. In 2006, Wolf Project staff made considerable efforts to get DNA samples from key breeders in the population that will allow for greater understanding of pack lineages, parentage, and relatedness among packs.

Through an internship with the Dog Genome Project at the National Institute of Health (NIH), Bridgett vonHoldt learned new molecular techniques that will enable higher resolution of analysis in the future and collaboration with researchers who have identified the gene responsible for coat color in wolves. At the end of 2006, parentage analysis and population pedigrees for wolves from 1995–2004 were nearly complete, along with analyses of relatedness within and between packs and breeding pairs, genetic diversity of the population, and levels of gene flow. Using the population pedigrees and genetic parameters, Dan Stahler will address questions about how social and ecological factors influence reproductive

strategies and their outcomes, as well as how kinship mediates wolf pack formation, interactions, and territoriality. Scientific papers on Yellowstone genealogies and genetic structure of the Rocky Mountain recovery areas are being written for submission in 2007.

Hellroaring Creek wolves try to fish something out of a creek before freeze-up.

Wolf Management

Area Closures

The Slough Creek den area was initially closed, but was opened by late May after the wolves were supplanted by another pack and abandoned their den. The Hayden Valley pack also denned within view of the road and a closure was put in place. Initially, a segment of the nearby trail was closed, then the entire trail, and finally, the area was closed to off-trail hiking. Despite this level of protection, there were numerous human intrusions on the pack's den and rendezvous site. This pack has become the most human-tolerant of any pack in the park. Because of their proximity to the road, the prevention of habituation to vehicles and people is an issue of special concern for this pack.

Wolf (Formerly Druid) Road Management Project

Since wolf reintroduction, Lamar Valley and other areas in the park have become premier locations worldwide to observe free-ranging wolves. The main pack of interest has been the Druid Peak pack, which denned in the valley from 1997 to 2004. In recent years, other packs, such as Slough Creek and Agate Creek, have filled the void when the Druid pack was less visible. Each year visitor numbers have increased and in 2000, the Yellowstone Center for Resources, Division of Resource and Visitor Protection, and Division of Interpretation cooperated to better deal with the opportunities and problems that accompany an increase in visitors viewing wolves. As a result, the Druid Road Management Project was initiated with the following objectives: 1) human safety: protect visitors that are viewing wolves alongside the road, and control both traffic along the road and parking to prevent an accident; 2) wolf safety: protect wolves from vehicle strikes, permit wolves to cross roadways without harassment from visitors, and protect the closed area around the den from visitor intrusion; 3) visitor enjoyment: through protection of natural wolf behavior, preserve visitor opportunity to view wolves and interpret wolf and other wildlife ecology to visitors; and 4) wolf monitoring and research: continue to monitor and study the denning behavior, predation, activity, and interactions of wolves with other wildlife. Because the Druid Peak pack has recently been less visible than in the past, the project has evolved to manage other packs and educate visitors where they encounter wolves.

This was the seventh year that private funds were used to manage wolf viewing. Unlike the previous summer when the Slough Creek pack was the most visible pack, this summer two other packs were seen on a regular basis: the Druid Peak pack in Round Prairie and the Agate Creek pack in Antelope Creek. The Druid Peak pack denned in a forested area east of the Pebble Creek Campground. Pups were visible there to visitors from the end of June through early July, after which time they moved east into Cache Creek. The Agate Creek pack denned in the Antelope Creek area near the road. Scores of visitors were able to view both pups and adults on an almost daily basis from mid-June to mid-September. The Slough Creek wolves were visible in April, but after the attack from the Unknown pack, they abandoned their den and were not easily or predictably observed.

Because wolf viewing was not concentrated in one location, project staff split up and varied their daily schedule to meet visitors and observe wolves. Yet even with numerous areas to monitor that changed on a daily basis, there were no accidents or close calls with wildlife. In all, it is estimated that more than 13,000 visitors were able to view wolves during summer 2006.

Severely impacted teeth on wolf #524F are probably a result of distemper. Photo taken in 2005.

The Hayden Valley pack in the interior of the park has become a reliable viewing opportunity for summer visitors in recent years. As with the northern range packs, the Hayden Valley wolves must regularly negotiate the road corridor in order to hunt, bring food back to their pups, and maintain their territory. Wolf Project staff therefore worked closely with the Division of Resource and Visitor Protection and Division of Interpretation to monitor and manage visitors and situations involving wolves to ensure that the objectives of wolf and human safety, education, and research were met.

Wolf Depredation Outside Yellowstone

Information on wolf depredation in the greater Yellowstone recovery area is available at <www.r6.fws.gov/wolf/annualrpt06>.

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 work, much of which is pioneering research.

Wolf Project Students: Direct Assistance

Two new students, Daniel Stahler and Emily Almberg, began work in collaboration with the Wolf Project in 2006. Both long-time employees on the project, they moved on to work in a new capacity and are partially supported by project funding. Dan's project focuses on combining behavioral data gathered in the field with genetic data gleaned from blood samples and overlaying the two techniques to better understand wolf social behavior. Dan works with Dr. Robert Wayne at the University of California at Los Angeles. Emily's project focuses on wolf diseases from both a current and historical perspective. With severe mortality caused by disease in 2005 and evidence of a smaller outbreak in 1999, Emily plans to fully explain the role of diseases for wolf population ecology. Emily works with Dr. L. David Mech at the University of Minnesota.

Graduate Student: Daniel Stahler (PhD candidate)
Committee Chair: Dr. Robert Wayne, University of California, Los Angeles
Title: Linking socioecological factors to reproductive success in complex kin-structured societies.
Project Summary: The evolution of complex societies, such as that seen in wolves, is greatly influenced by how 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 will investigate the link between socioecological conditions and these aspects of wolf ecology in Yellowstone. This project will take advantage of long-term datasets 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 ask questions concerning breeding strategies, reproductive success, 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 2006: Coursework and development of research questions.
Anticipated Completion Date: May 2010

Graduate Student: Emily Almberg
Committee Chair: Dr. L. David Mech, University of Minnesota, St. Paul
Title: A comprehensive survey of the infectious diseases and parasites of Yellowstone wolves: implications for population dynamics and management.
Project Summary: In 1999 and 2005, the Yellowstone wolf population experienced significantly reduced pup recruitment suggestive of a disease outbreak. These two suspected outbreaks have highlighted how little is known about the presence and role of disease in the Yellowstone wolf population. The present study seeks to 1) identify and describe the spatial and temporal patterns of select pathogens and parasites in the Yellowstone National Park (YNP) and the Greater Yellowstone Ecosystem (GYE) wolf populations; 2) understand the impacts of disease on population parameters such as adult wolf mortality and pup survival; 3) track the distribution, prevalence, and population-level effects of sarcoptic mange among wolves in YNP and the GYE; and 4) address the potential role of domestic dogs and sympatric carnivores in pathogen/parasite invasion and persistence in YNP. The study will begin its first field season in summer 2007.
Project Activity in 2006: Coursework and development of research questions.
Anticipated Completion Date: May 2010

Indirect Assistance or Collaborative Work with the Wolf Project

Topic	***Collaborator***	***Institution***
Wolf–cougar interactions	Toni Ruth	Wildlife Conservation Society
Wolf–coyote interactions	Robert Crabtree, Jennifer Sheldon	Yellowstone Ecological Research Center
Wolf–bear interactions	Charles Schwartz, Mark Haroldson, Kerry Gunther	Interagency Grizzly Bear Study Team, Bear Management Office (YCR)
Wolf–carnivore interactions	Howard Quigley	Beringia South
Wolf–scavenger interactions	Chris Wilmers	University of California, Davis
Wolf population genetics	Robert Wayne, Bridgett vonHoldt, Daniel Stahler	University of California, Los Angeles
Wolf–elk relationships, Madison–Firehole watershed	Bob Garrott, Matt Becker, Claire Gower, P.J. White	Montana State University, YCR
Wolf–pronghorn	P.J. White, John Byers, Kerey Barnowe-Meyer	YCR, University of Idaho
Wolf–willow	Evelyn Merrill, Roy Renkin, William Ripple, David Cooper, Tom Hobbs, Don Despain	University of Alberta, YCR, Oregon State University, Colorado State University, USGS
Wolf–aspen	William Ripple, Eric Larsen, Roy Renkin, Matt Kauffman	Oregon State University, University of Wisconsin at Stevens Point, YCR, University of Montana
Wolf–trophic cascades	L. David Mech, Mark Boyce, Nathan Varley, Rolf Peterson, Dan MacNulty	USGS, University of Alberta, Michigan Technological University, University of Minnesota
Wolf predation	Tom Drummer, John Vucetich, Rolf Peterson, Dan MacNulty	Michigan Technological University, University of Minnesota
Wolf survival	Dennis Murray	Trent University
Wolf population genetics	Robert Wayne, Daniel Stahler, Bridgett vonHoldt, John Pollinger	University of California, Los Angeles
Wolf diseases and parasites	L. David Mech, Emily Almberg	USGS, University of Minnesota
Wolves, willows, and songbirds	Andy Hansen, Lisa Baril	Montana State University
Wolf movements/dispersal	Douglas McWhirter, L. David Mech, Mike Jimenez	Wyoming Game and Fish, USGS, USFWS

NPS

Wolf Project staff and November–December winter study volunteers. Standing, from left: Andy Shepard, Tim Hudson, Abby Nelson, Libby Williamson, Nicole Legere, Bill Bridgeland, Robin Rauch, Deb Guernsey, Douglas Smith (with Hawken and Sawyer Smith). Kneeling, from left: Erin Albers, Sarah Malick, Matt Metz.

Staff and Public Involvement

Volunteer Program

Nineteen volunteer field technicians worked a total of 6,200 hours in 2006, equal to 1.8 full-time GS-5 employees and worth $52,147.20 at the GS-5 level (see Appendix I). Volunteer field positions continued to be highly competitive, with three to four applicants applying for each position. Chosen volunteers received free housing and $500/month food stipend.

Most positions are available during winter, when studies of wolf behavior and predation rate take place. A background in biological science is required. Interested persons should mail a cover letter and resume to the Yellowstone Wolf Project, P.O. Box 168, Yellowstone National Park, Wyoming, 82190.

Staff

Three full-time employees worked for the Yellowstone Wolf Project in 2006: Project Leader Douglas Smith and Biological Science Technicians Debra Guernsey and Daniel Stahler. This concludes a four-year term appointment for Dan, but he will continue as a student temporary employee while he is at UCLA.

The Wolf Project was able to hire paid seasonal staff through the Yellowstone Park Foundation and Yellowstone Association to assist in several key aspects of our annual work. Erin Albers, Emily Almberg, Matt Metz, Abby Nelson, Jesse Newby, and Katie Yale worked for the summer and fall field season and were crucial to summer den monitoring, invertebrate scavenger study, summer GPS predation work, as well as other duties. Erin, Emily, Matt, and Abby also worked during the winter months. Rick McIntyre worked diligently year-round for the Wolf Project with six months as a seasonal National Park Service employee and six months as a volunteer. Emily and Rick worked primarily for the Wolf Road Management Project during the summer, but also assisted in many other project goals during winter months. All seven spent many hours collecting data throughout the year and contributed largely to the increased research productivity of the Yellowstone Wolf Project in 2006.

NPS/ABBY NELSON

Matt Metz (foreground) and Rick McIntyre observe a wolf–wolf clash.

Outreach

Yellowstone Wolf Project staff gave more than 100 talks at scientific conferences and to the general public. Douglas Smith was interviewed 60 times about park wolves (see Appendices III and IV).

For the sixth year Smith and U.S. Forest Service personnel rode horseback into outfitter camps adjacent to the park boundary to discuss wolf issues. This year three camps on the north boundary in the Gallatin National Forest were visited. Besides Smith, Gardiner District Ranger Ken Britten, Gardiner District Wildlife Biologist Dan Tyers, and NPS Center for Resources Chief Tom Olliff participated in the rides and outreach. In previous years, camps in the Bridger-Teton Forest were visited.

Acknowledgments

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 wolves. We also thank for their donations and support five major institutions and organizations: an anonymous donor, the Tapeats Foundation, the Perkins–Prothro Foundation, Canon U.S.A., Inc., and the National Science Foundation grant DEB-0613730. We recognize the above because our work would not be possible without their support and involvement. In addition to these major donors, we are supported by numerous smaller donors, especially ones through the collar sponsorship program, that add significantly and are also necessary for our research, management, outreach, education, and publications. We know that a successful program needs a strong base of support and to all of the above we are indebted. In terms of this report, we thank Virginia Warner and Tami Blackford, who every year, keep us on track, on time, and under budget.

Appendices

Appendix I. Wolf Project Volunteer Roster, 2006

Name	Period of Involvement	Hours Worked
Erin Albers	2/22/2006–3/31/2006	256
Jessica Auer	2/22/2006–3/31/2006	304
Jack Bean	2/22/2006–3/31/2006	304
Aude Bourgeois	3/16/2006–3/31/2006	128
Bill Bridgeland	11/9/2006–12/16/2006	296
Guillaume Chapron	3/16/2006–3/31/2006	128
Yolanda Cortez	11/9/2006–12/2/2006	184
Patrick Degeorges	3/16/2006–3/31/2006	128
George Heinz	2/22/2006–3/31/2006	304
Tim Hudson	11/9/2006–12/15/2006	296
Nicole Legere	11/6/2006–12/31/2006	416
Sarah Malick	11/9/2006–12/16/2006	296
Rick McIntyre	3/1/2006–5/29/2006 & 9/5/2006–12/31/2006	1,664
Antoine Nochy	3/16/2006–3/31/2006	128
Michael Nordell	2/22/2006–3/31/2006	304
Robin Rauch	11/20/2006–12/16/2006	208
Andy Shepard	11/9/2006–12/16/2006	296
Brian Teets	11/9/2006–12/11/2006	264
Libby Williamson	11/9/2006–12/16/2006	296
Subsistence Allowance Hours Paid		**3,840**
Total Volunteer Hours		**6,200**

Appendix II. Publications in 2006

Smith, D. W. 2006. Coexisting with large carnivores: lessons from Greater Yellowstone (book review). *BioScience* 56(10):848–849.

Smith, D. W. 2006. Re-introduction of gray wolves to Yellowstone National Park, USA. *Re-Introduction News* 25:29–31.

Smith, D. W., D. R. Stahler, D. S. Guernsey, and E. Bangs. 2006. Wolf Restoration in Yellowstone National Park. *In* World Natural Heritage Site Yellowstone and Shiretoko: conservation of wildlife in national parks. Editors: D. R. McCullough, K. Kaji, and M. Yamanaka. Shiretoko Nature Foundation Press.

Smith, D. W., D. R. Stahler, and D. S. Guernsey. 2006. Yellowstone Wolf Project: Annual Report 2005.

National Park Service, Yellowstone Center for Resources, Yellowstone national Park, Wyoming, YCR-2005-02.

Stahler, D. R., D. W. Smith, and D. S. Guernsey. 2006. Foraging and feeding ecology of the gray wolf (*Canis lupus*): lessons from Yellowstone National Park, Wyoming, USA. *Journal of Nutrition* 136:1923S–1926S.

Wondrak Biel, A. and D. W. Smith. 2006. Diseases investigated as possible cause of wolf decline. *Yellowstone Discovery*. 21:6–7.

Wright, Gregory J., R. O. Peterson, D. W. Smith, T. O. Lemke. 2006. Selection of northern Yellowstone elk by gray wolves and hunters. *Journal of Wildlife Management* 70(4):1070–1078.

NPS/ABBY NELSON

Helicopter pilot Mark Duffy and state of Montana wildlife biologist Mike Ross with Agate Creek wolf #590.

Appendix III. Talks Given by Douglas Smith, 2006

#	Date	Group	Location
1	October 2005	American Museum of Natural History	New York City, NY
2		School for the Disabled	Washington, D.C.
3		National Geographic Society	NGS Headquarters, Washington, D.C.
4		National Wildlife Federation	NWF headquarters, Washington, D.C.
5	November 2005	National Park Foundation field trip	YNP
6	December 2005	University School	Cleveland, Ohio
7		Cleveland Museum of Natural History	Cleveland, Ohio
8		Montana Fish, Wildlife and Parks staff training	Helena, Montana
9		Xanterra snowcoach drivers	YNP
10		YNP winter interpretive rangers (training field trip)	YNP
11		National Park Service park guides	Old Faithful, YNP
12		National Geographic Society field trip	YNP
13	January 2006	Houston Zoo	Houston, Texas
14	February 2006	National Geographic Society	YNP
15		Wildlife Conservation Society, Russian group	YNP
16		Gardiner High School	Gardiner, Montana
17		International Wolf Center tour group	YNP
18		National Geographic Society	YNP
19	March 2006	International Wolf Center tour group (with Dave Mech)	YNP
20		U.S. Forest Service district rangers	Chico Hot Springs, Montana
21		Yellowstone Association	YNP
22		Antioch College group	YNP
23		Japan-Rakuno-Gakuen University group	YNP
24	April 2006	Chico Wolf Conference	Chico Hot Springs, Montana
25		18th Annual North American Wolf Conference field trip	YNP

#	Date	Group	Location
26		Montana State University Department of Ecology field trip	YNP
27		Montana State University Department of History seminar (with Brett Walker)	YNP
28		Annual Lake States Wolf Stewardship Meeting	Watersmeet, Michigan
29		College of Southern Idaho	Twin Falls, Idaho
30	May 2006	Western Wolf Managers Workshop	West Yellowstone, Montana
31		UCLA, Applied Conservation Biology in National Parks class	Los Angeles, California
32		UCLA Department of Organismal Biology seminar	Los Angeles, California
33		YNP interpretive rangers (seasonal training)	YNP
34		Yellowstone Assoc. Institute course (*Issues for Wolves*)	YNP
35		Yellowstone Assoc. Institute course (*Issues for Wolves*)	YNP
36	June 2006	National Parks Conservation Association	YNP
37		Greater Yellowstone Coalition	West Yellowstone, Montana
38		Yellowstone Center for Resources staff field trip	YNP
39		Defenders of Wildlife field trip	YNP
40		U.S. Forest Service training (with Jim Claar)	YNP
41		U.S. Forest Service, Gallatin District, seasonal training	Gardiner, Montana
42		Defenders of Wildlife lecture	YNP
43		YNP Canyon staff (presentation wolf habituation)	YNP
44		Tri-State Area Elk–Wolf Working Group	Missoula, Montana
45		*Expedition: Yellowstone!* hike (kids aged 8–12)	YNP
46		Explore Yellowstone	YNP
47	July 2006	Yellowstone Association Institute course	YNP
48		Yellowstone Association Institute course	YNP
49		YCC Camp volunteers	YNP
50		Michigan Technological University class	YNP
51	August 2006	American Association of State Colleges and Universities, American Democracy Project	YNP
52		Milwaukee, Wisconsin, area technical college class	YNP
53		Montana Fish, Wildlife and Parks seminar	Ennis, Montana
54		Canon U.S.A., Inc., Senior Vice Presidents	YNP
55	September 2006	Silver Tip Guest Ranch	Montana
56		Yellowstone Assoc. Institute (*Roosevelt Rendezvous*)	YNP
57		The Wildlife Society National Meeting	Anchorage, Alaska
58		Montana Festival of the Book (2006 Montana Book Award)	Missoula, Montana
59	October 2006	International Wolf Center	YNP
60		Western Montana University	Dillon, Montana
61		Miami University, Department of Biology	Miami, Ohio
62		Miami University, University-wide talk	Miami, Ohio
63		Miami University, Zoology class	Miami, Ohio
64	November 2006	Yellowstone Assoc. Institute course	YNP
65		Yellowstone Assoc. Institute course	YNP

#	Date	Group	Location
66		Yellowstone Wolf Project Winter Study training	YNP
67		Wyoming Game Commission	Sundance, Wyoming
68	December 2006	Associated Press Journalists	YNP
		Xanterra snowcoach drivers	YNP
69		YNP interpretive rangers (seasonal training)	YNP
70		YNP winter outfitters and guides	YNP

NPS/MATT METZ

Gibbon Meadows wolves near Spruce Creek.

Appendix IV. Interviews and Media Contacts with Douglas Smith, 2006

#	Date	Interviewer
1	January	National Public Radio
2		*Bozeman Daily Chronicle*
3		Becky Bohrer, Associated Press
4		Mike Stark, *Billings Gazette*
5		Scott McMillion, *Bozeman Daily Chronicle*
6		*Missoula Independent*
7		*New York Times*
8		Billings Western Livestock Reporter
9		CBC News Toronto
10		60 Minutes Australia
11		BBC Radio England
12	February	CBS News (YNP Anniversary Special)
13	March	CBC News Canada
14		Bill Campbell, PBS
15		Bill Campbell, PBS
16		Becky Bohrer, Associated Press
17		*Washington Post*
18		Wind Cave National Park
19		Associated Press
20		The Hokkaido Shimbun Press
21	April	Robert Bateman
22		UP (Upper Peninsula) Radio Michigan
23	May	PBS Now
24		Marlene Foard, Authors' Guide to Wolves in the Classroom
25		Shelli Johnson, *Yellowstone Journal*
26		BBC England
27		Japanese Television
28	June	Paul Tolme, *National Wildlife Magazine*
29		Laura Bailes, Aqua Vita Films (Bristol, England)
30		Caroline Campbell, Sea Studios Foundation (San Francisco, California)
31	July	University of Edinburgh
32		*High Country News*

#	Date	Interviewer
33		Sidney Wildsmith, Wild Side News (Internet Radio)
34		Tom Arrandale, *Yellowstone Journal*
35		TV Endemol U.K.
36		Aqua Vita Films (Bristol, England)
37		Michigan Technological University
38	August	Brian Armstrong, National Geographic Channel
39		Mercantour National Park, France
40		Mike Stark, *Billings Gazette*
41		Nicholas Read, *Vancouver Sun*
42		Linda Sweeney, *Highlights for Children Magazine*
43		Iberian Wolf Recovery Centre, Grupo Lobo, and University of Lisbon (consulting)
44	September	David Nolt, *Livingston Weekly*
45		Janice Stroud, Southern Illinois University–Carbondale
46		National Geographic Channel
47		*Terre Sauvage Magazine*, France
48	October	Edward Harvey, Harvey Economics Consulting
49		Therese Johnson, Rocky Mountain National Park
50		Margaret Wild, *Draft Environmental Impact Statement/ Elk and Vegetation Management Plan, Rocky Mountain National Park*
51		UK Wolf Conservation Trust
52		Patrick Degeorges, French Government Wolf Manager
53		Michael Babcock, *Great Falls Tribune*
54		Brodie Farquhar, *Yellowstone Journal*

#	Date	Interviewer
55		Emma Peace and Lizzie Bewick, BBC Planet Earth
56		Endemol London
57	November	Polly Wheeler, U.S. Fish and Wildlife Service, Alaska
58	December	Emma Peace, BBC Planet Earth
59		Wanda Jones, National Geographic Channel
60		German Christmas in Yellowstone National Park