



YELLOWSTONE WOLF PROJECT



ANNUAL REPORT
2000

Yellowstone Wolf Project

Annual Report
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YCR-NR-2001-02



Suggested citation: Smith, D.W., K.M. Murphy, and D.S. Guernsey. 2001. Yellowstone Wolf Project: Annual Report, 2000. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-NR-2001-02.

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.

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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.

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 native species that have been eliminated as a result of human activity if adequate habitat exists to support them and the species can be managed so as not to pose a serious threat to people or property outside the park. Because of its large size and abundant prey, the greater Yellowstone area was identified in the recovery plan as one of three areas where the recovery of wolf populations had a good chance of succeeding.

The goal of the wolf restoration program is to maintain 30 breeding wolf pairs with an equitable distribution throughout the three Rocky Mountain recovery areas—greater Yellowstone area, central Idaho, and northwest Montana. Once 30 pairs are established and reproduce for three successive years, the gray wolf can be removed from the list of endangered species in Idaho, Montana, and Wyoming. The U.S. Fish and Wildlife Service (FWS), which has the primary responsibility for ensuring compliance with the Endangered Species Act, oversees the multi-state recovery program. In Yellowstone, two NPS wildlife biologists are dedicated full-time to the project, with one technical assistant and from two to six seasonal volunteers.

Following an extended period of public planning and input, wolf restoration to the greater Yellowstone area (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.

Wolves reintroduced into Yellowstone were classified by the FWS as “nonessential experimental” under section 10(j) of the Endangered Species Act and are managed under special rules that permit managers 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 the intention is for YNP to maintain radio collars on up to half of the wolves in the population. 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, including this one.

2000 SUMMARY

At the end of 2000, at least 177 wolves were present in the greater Yellowstone area (GYA), including 18 packs and 13 breeding pairs—pairs with at least two pups-of-the-year that survive until December 31, as defined under the criteria for delisting the wolf as an endangered species in the Rocky Mountain recovery area. A total of 28 breeding pairs were recorded in the northern Rockies (including nine in Idaho and six in northwest Montana); 30 breeding pairs with an equitable distribution throughout the three recovery areas for three successive years are needed in order to meet the requirements for delisting. Acceptable wolf management plans from the states of Wyoming, Idaho, and Montana are also required.

As the GYA wolf population grew, Yellowstone National Park (YNP) and the U.S. Fish and Wildlife Service (USFWS) monitored wolves in the Yellowstone ecosystem. YNP staff were primarily responsible for wolves that resided largely in the park, so this report contains more details about these wolves.

Seventy-one to 77 of the pups born in the GYA in 2000 survived to the end of the year. Pup survival in YNP was higher than in 1999. The 13 packs with breeding pairs produced 16 litters of pups, including three litters in the Druid Peak pack and two in the Rose Creek pack. (Because these packs contained only a single breeding male, each pack was counted as a single breeding pair for recovery purposes.) Parturition (*i.e.*, birth) dates ranged from April 6 to May 6 and averaged April 16, three days later than the 1999 average. Twenty of 21 pups born in the Druid Peak pack survived to year-end.

Fourteen wolves were known to have died in 2000 in the GYA: nine adults, four yearlings, and one pup (not including uncounted pup mortality at dens). Half of these deaths were human caused.

Six new packs were established in 2000, one inside YNP (the Swan Lake pack) and five outside: Taylor Peaks (Madison Valley, MT), Beartooth (Sunlight Basin, WY), Absaroka (Sunlight Basin, WY), Gravelly (Gravelly Range, MT), and Mill Creek (Paradise Valley, MT). Two packs outside YNP (Sheep Mountain and Washakie) reestablished themselves after management actions taken by the USFWS due to livestock depredations disturbed pack dynamics. Two packs in YNP were renamed (Crystal Creek became Mollie's, and Soda Butte became Yellowstone Delta) because of turnover and geographic relocations. Two large packs, Druid Peak (27 wolves) and Nez Perce (22 wolves), made several extraterritorial moves in early winter 2000, and the Druid Peak pack usurped area from the smaller Rose Creek pack.

For the third year, systematic wolf captures were conducted to put on radio collars and collect standard measurements and blood samples for genetics and disease monitoring. In YNP in January and February, 12 wolves were captured from six packs. Of at least 177 wolves in the GYA at year-end, 43 (24%) were collared.

In YNP, project staff detected 113 definite and 210 probable kills made by wolves in 2000, including 281 elk (87% of total), 10 bison (3%), 4 moose (1%), 5 deer (1.5%), 4 coyotes (1%), 1 wolf, and 17 unknown prey (5%). The composition of elk kills was 34% calves (0–12 months), 34% cows, 19% bulls, and 13% unknown sex and age. Kill rates were higher (fewer days in between kills by wolves) in late winter than early winter.

Familial relationships among Yellowstone wolves continued to be estimated using microsatellite analysis of DNA collected from live-captured and dead wolves. A wolf pedigree has been constructed from 114 free-ranging wolves, including 79 offspring, born to 14 different packs (26 total litters) and genotyped at 12–23 loci.

Serum samples collected from 1995 through 1999 from 85 wolves were tested for the presence of canine distemper virus, canine parvovirus, and *Brucella canis* antibodies.

Collaborative research continued to be an important part of Yellowstone wolf studies. As part of a new cow elk study, 45 female elk were collared in March 2000 to learn more about cause specific mortality and habitat use post-wolf reintroduction. A pre-wolf data set is available for comparison.

Twenty-one volunteers worked a total of 12,528 hours valued at \$141,817 for the National Park Service. Three noted professionals participated in the Wolf Project's visiting scholars program in 2000.

Greater Yellowstone Wolf Pack Territories, 2000

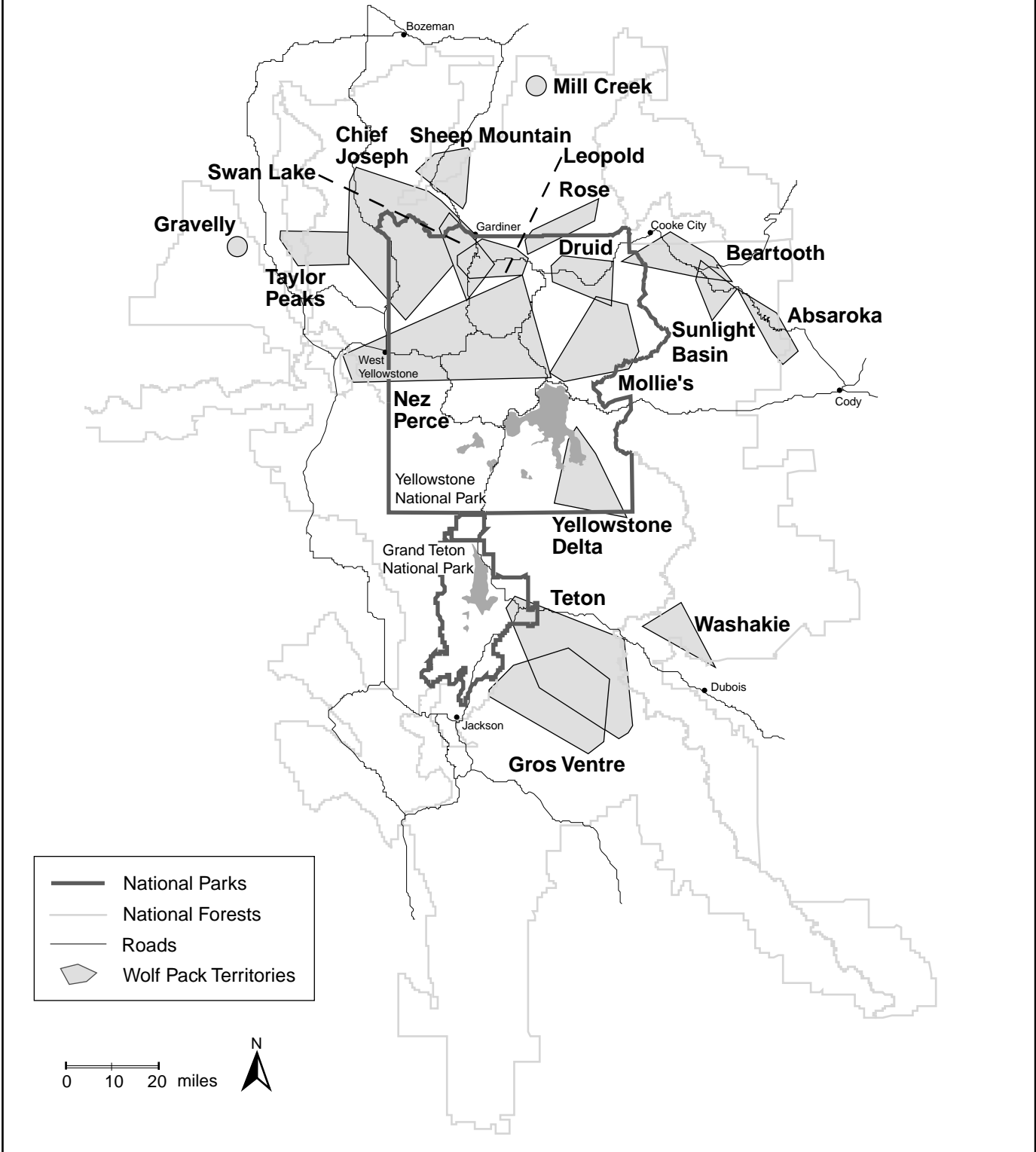


Figure 1. Wolf pack territories. At least 177 wolves—18 packs and 2 wolves without established territories—occupied the GYA in 2000.

THE YELLOWSTONE WOLF POPULATION

Population Status

At the end of 2000, at least 177 wolves in 18 packs were present in the greater Yellowstone area (Table 1; Fig. 2). Of the 28 breeding pairs in the northern Rockies, 13 (46%) were in the GYA. For removal of the gray wolf from the endangered species list, there must be 30 breeding pairs distributed throughout the three Rocky Mountain recovery areas (GYA, central Idaho, and northwest Montana) for three successive years. Under the recovery plan standards, a "breeding pair" is a pair with at least two pups-of-the-year that survive until December 31, and includes only one pair per alpha male.

When the wolf reintroduction program began in 1995, Yellowstone National Park (YNP) staff were responsible for population data ecosystem-wide. Since February 1999, Michael Jimenez of the U.S. Fish and Wildlife Service (USFWS) has reported on Wyoming wolf packs outside YNP, and the Helena office of the USFWS has reported on Montana packs outside YNP. GYA wolf population data as presented in this report therefore distinguishes between inside YNP and outside YNP; the sum of these numbers is the GYA total.

At the end of 2000, approximately 119 wolves were located in YNP (8 packs) and 58–60 outside YNP (10 packs: 6 in Wyoming and 4 in Montana; Fig. 1). Of the eight YNP packs, only Mollie's pack (formerly Crystal Creek) did not produce a litter. One new pack formed



A Druid Peak pack pup. In 2000, 21 pups were born to three females in this pack, and 20 survived to year-end. Compared to other wolf pups in Yellowstone, the Druid pups were slightly smaller. Photo by Douglas Smith.

TABLE 1. WOLVES IN THE GYA AS OF DECEMBER 31, 2000.

YELLOWSTONE NATIONAL PARK

Pack	Adults & Yearlings	Pups Born	Pups Survived	Total
Chief Joseph	7	8	6	13
Swan Lake	2	4–5	5	7
Leopold	6–8	10	5–7	13
Rose Creek (2 grps)	10–13	11	5–8	18
Druid Peak	7	21	20	27
Mollie's	4	0	0	4
Yellowstone Delta	6	7	7	13
Nez Perce	15	7	7	22
Loners	2	0	0	2

YNP Total 59–64 68–69 55–60 119
(8 packs; 7 breeding pairs; mean pack size = 14.6)

OUTSIDE YELLOWSTONE NATIONAL PARK

Pack	Adults & Yearlings	Pups Born	Pups Survived	Total
Sunlight Basin	6	4	4	10
Absaroka	2	5	3	5
Beartooth	3	2?	0	3
Teton	4	0	0	4
Gros Ventre	3	3	3	6
Washakie	4–5	?	2–3	6–8
Taylor Peaks	3	4	2	5
Sheep Mountain	7	0	0	7
Gravelly Range	?	?	?	5?
Mill Creek	3+	?	2+	7
Loners	0	0	0	0

Outside YNP Total 35–36 16–18 16–17 58–60
(10 packs; 6 breeding pairs; mean pack size = 5.8)

GREATER YELLOWSTONE ECOSYSTEM TOTAL

Pack	Adults & Yearlings	Pups Born	Pups Survived	Total
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Grand Total 94–100 84–87 71–77 177–179
(18 packs; 13 breeding pairs; mean pack size = 9.3)

2 Wolf Population

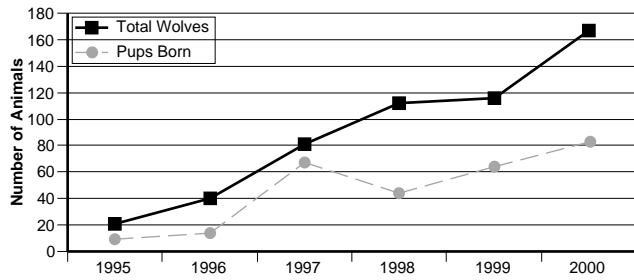


Figure 2. Wolves in the GYA, 1995–2000.

inside YNP when a dispersing female from the Leopold pack paired with an uncollared wolf and had a litter of at least four pups in the Swan Lake–Spulcher area. They were named the Swan Lake pack. Two new packs formed northeast of YNP, the Absaroka and Beartooth packs; two northwest of YNP, the Taylor Peaks and Gravelly packs; and one north of YNP, the Mill Creek pack. Pack size in the GYA ranged from 3 to 27 and averaged 9.3 wolves. Average pack size inside YNP (mean = 14.6) was larger than outside YNP (mean = 5.8).

Two YNP packs were renamed because they no longer live in the area for which they were named, and none of the original, reintroduced wolves were still in the pack, although their descendents were. The Crystal Creek pack, which resides in Pelican Valley was renamed Mollie's pack after the late Director of the U.S. Fish and Wildlife Service, Mollie Beattie, to recognize her extraordinary contribution to wolf recovery in the northern Rockies. The Soda Butte pack was renamed the Yellowstone Delta pack after the Yellowstone River delta, an area of YNP where they were often located in 2000.

Reproduction

Approximately 71 to 77 pups survived to year-end in the GYA (Fig. 3). Fifty-five to 60 of these pups were born in YNP. Pup survival was higher in YNP in 2000 (55 of 68, 80%) than in 1999 (18 of 40, 45%). Although diagnostic confirmation is lacking, canine parvovirus was a possible cause of the low survival in 1999. All captured wolves in 1999 and 2000 tested positive for the disease, and mortality occurred at a time (post-weaning) when pups are most vulnerable to infection. To positively identify mortality due to parvovirus a dead pup must be collected, and no such carcass has been retrieved yet.

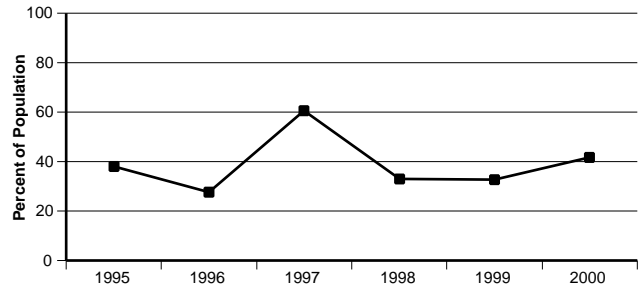


Figure 3. Percentage of pups in the GYA wolf population as of December 31, 1995–2000.

Sixteen litters were born to 13 packs with breeding pairs in the GYA. Two packs had more than one litter: the Druid Peak pack had at least three; and the Rose Creek pack had two. Because both of these packs had only a single breeding male (polygyny), each had only one breeding pair for the purposes of meeting the delisting criteria. Litter size ranged from 2 to 10 and averaged 5.7 (N = 15). With three females breeding, the Druid Peak pack raised 20 pups (out of a minimum of 21 counted) to year-end.

Whelping dates ranged from April 6 (Rose Creek) to May 6 (Yellowstone Delta). Average parturition date was April 16, as compared to April 13 in 1999. As in prior years, two remote telemetry systems were used to monitor den site attendance.



In 1999, wolf #9F dug this den below a Douglas-fir tree near Sough Geek. In 2000, this den was used by her daughter #18. Photo by Douglas Smith.

TABLE 2. KNOWN WOLF MORTALITIES IN THE GYA DURING 2000.

Wolf	Pack	Age	Sex	Cause of Death
008M	Rose Creek	Adult	Male	Natural
014F	Yellowstone Delta	Adult	Female	Natural
016F	Sheep Mountain	Adult	Female	Human (handling/capture)
024F	Teton	Adult	Female	Human (illegal)
040F	Druid Peak	Adult	Female	Natural (wolves)
120M	Mollie's	Adult	Male	Unknown
124M	Yellowstone Delta	Adult	Male	Unknown
129F	Gros Ventre	Adult	Female	Control Action
163M	Druid Peak	Yearling	Male	Natural
187F	Chief Joseph	Pup	Female	Vehicle
188F	Sheep Mountain	Adult	Female	Control Action
197F	Sheep Mountain	Yearling	Female	Human (handling/capture)
199M	Druid Peak	Yearling	Male	Vehicle
230F	Gros Ventre	Yearling	Female	Control Action

Mortalities

In addition to undocumented pups that died during spring and summer, 14 GYA wolves were known to have died in 2000 (Table 2): eight deaths were human-caused, four died from natural causes (as a result of injuries inflicted by elk, moose, other wolves, etc.), and two from unknown causes. The mortalities included nine adults (6F:3M), four yearlings (2M:2F), and one pup (F); eight of the mortalities occurred in YNP (57%) and six outside (43%). All of the human-caused deaths occurred outside YNP: control actions (3), vehicles (2), handling/capture (2), and illegal (1). At least half of the known wolf deaths since reintroduction have been human-caused (Fig. 4).

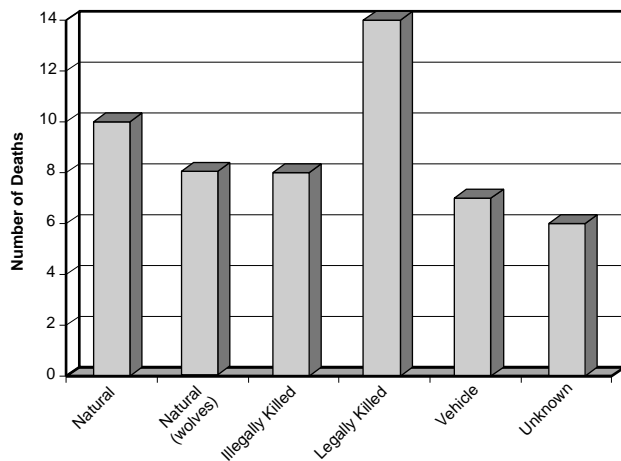


Figure 4. Cause of mortality for radio-collared wolves in the GYA, 1995-2000.



Wolf #14F was killed by a moose in April 2000 on the Yellowstone River Delta just south of the southeastern tip of Yellowstone Lake. A necropsy of her remains revealed that she had broken her leg and it had mended itself (middle object in photo). A normal femur is below the pen for comparison. The top of the photo is what was left of her skull upon recovery. Photo by Douglas Smith.

Wolf #14F, who arrived from Canada in 1995, died in April at five years of age. The other wolves in her pack (Yellowstone Delta) were observed feeding on a moose while she lay dead 400 meters away. The remote location and scavenger feeding precluded timely and conclusive necropsy, but circumstantial evidence indicates she probably died due to injuries sustained while killing the moose. Wolf #8M, another 1995 arrival, was found dead in Slough Creek in June. He had aspirated water but was in relatively shallow water, indicating he may have drowned after being injured by an elk. (It is common for elk to seek protection from wolves in water.) Wolf #40F was killed by her pack mates (see story page 6).

Population Movements and Territories

Wolf population expansion was considerable outside YNP in 2000, and some established packs within YNP shifted their territorial boundaries. Six new packs were established in 2000, one inside YNP (the Swan Lake pack) and five outside: Taylor Peaks (Madison Valley MT), Beartooth (Sunlight Basin, WY), Absaroka (Sunlight Basin, WY), Gravelly (Gravelly Range, MT), and Mill Creek (Paradise Valley MT). Two packs outside YNP (Sheep Mountain in Paradise Valley and Washakie in DuNoir Valley) reestablished themselves after management actions taken by the USFWS due to livestock depredations disturbed pack dynamics. Two packs in YNP were renamed (Crystal Creek became Mollie's and Soda Butte became Yellowstone Delta) because of turnover and geographic relocations. Two large packs, Druid Peak (27 wolves) and Nez Perce (22 wolves), made several extraterritorial moves in early winter 2000.

The Druid Peak pack, which swelled to 27 wolves because of high survival in three litters (20 pups total), usurped Rose Creek pack territory west of its traditional home range. The Rose Creek pack appeared to be in decline. Down from a high of 24 wolves in 1998, by the end of 2000 they had split into two groups, referred to as the Main Rose group (seven wolves) and the Tower group (six wolves). One territorial trespass was observed in December on Slough Creek, traditional Rose Creek territory, when two wolves in the Rose Creek pack survived an attack by Druid wolves.

The large Nez Perce pack (22 wolves) was also observed making an extraterritorial move in December. For approximately two weeks, this pack moved onto the

northern range, an area of higher elk density than their traditional territory in the Madison–Firehole area. Most of this time was spent in Leopold territory, but no interactions were recorded as the Leopold pack (13 wolves) apparently avoided an encounter. 🐾

PACK SUMMARIES

Chief Joseph Pack

The Chief Joseph pack's territory extends across YNP's northwest boundary, and it spent most of 2000 in the park, but it also traveled outside the park and dened in Cinnabar Basin on private land. The location of this den site was problematic, and USFWS personnel attempted to move the breeding female (#33F) and pups to the pack's traditional den site on Daly Creek inside YNP. The operation was successful, but only #34M (breeding male) and #198F (a female yearling) were captured and moved, which probably led to #33 moving the pups to the desired location. Eight pups were counted in early summer and six were still alive at the end of 2000. At year-end the pack included 13 wolves.

Swan Lake Pack

A new pack formed in 2000 when #152F dispersed from the Leopold pack and paired with an uncollared male of unknown origin. They settled in the Swan Lake–Sepulcher area just west of traditional Leopold pack territory and had at least three pups in 2000. Aerial identification of pups is difficult in early winters by that time young wolves in YNP can approach the size of adults. Operating very closely to the larger Leopold pack, this new pack avoided confrontation with them, perhaps because of #152's familiarity with Leopold territory.

Leopold Pack

The Leopold pack has been perhaps the most stable pack in YNP during the last five years. An apparently monogamous pair (#2M and #7F) reproduced for the fifth consecutive year (more than any other pair in the GYA), although high pup counts in June (10 pups) could mean that more than one female bred. Definitive results will not be known until blood samples from four captured pups are analyzed for maternity and paternity. During this five-year period, the Leopold pack has used only two den

sites, and its territory changed very little in 2000, with Mt. Everts and Blacktail Deer Plateau at the core. At year-end the pack included 13 wolves.

Rose Creek Pack

A pack very much in decline (24 wolves in 1998), the Rose Creek pack has split into two groups totaling 13, with five loosely associated wolves. The Main Rose group led by #18F included seven wolves and the Tower group had six. The two groups had little spatial overlap, as the Main group stayed north of the Yellowstone River and the Tower group south of it. The December attack by the Druid Peak pack on Main Rose wolves on Slough Creek was significant because Slough Creek was formerly a Rose Creek pack stronghold. The two attacked wolves, probably both pups, survived.

Druid Peak Pack

The largest pack in the park at 27 wolves, the Druid Peak pack produced at least three litters in 2000. The alpha female since 1997 (#40) was killed by other pack members, most likely by three of the other four adult females (see story page 6). Number 40 had behaved very aggressively toward these subordinate females, directing particular harassment at her sister #42. After #40's death, her pups were cared for by the rest of the pack at her den site. Twenty-one pups matured through the summer and 20 were still alive at year-end. As the new alpha female, #42 behaved much less aggressively toward the other adult females in the pack.



Mollie's Pack (formerly Crystal Creek)

This pack, renamed in honor of the late Director of the U.S. Fish and Wildlife Service, Mollie Beattie, declined from 15 wolves in 1998 to four wolves in 2000 that did not breed. Originally released near Crystal Creek, they lived in Pelican Valley during 2000 with none of the original "founder" wolves in the pack remaining. Wolf #5F, the first wolf carried in by Mollie Beattie, dispersed and was missing at year-end. Mollie's pack has interacted with grizzly bears on a regular basis. During March and April, the pack killed six bison in six weeks and each carcass was usurped by grizzly bears within hours.

Yellowstone Delta Pack (formerly Soda Butte)

The Soda Butte pack was renamed because they no longer live near Soda Butte and none of the original members were left. The pack has often used the Thorofare area in the southeastern corner of YNP, but there had already been a Thorofare pack, so this pack was renamed after the Yellowstone River delta on the southeast arm of Yellowstone Lake. Although the alpha female (#14) was found dead in April (see "Mortalities"), seven pups from her litter survived to year-end, along with six adult and yearling wolves.

Nez Perce Pack

The second largest pack in the GYA with 22 wolves, the Nez Perce pack denned and lived in the Madison–Firehole area of YNP during 2000. The maximum pup count for the pack was seven. This pack has learned to prey on bison, probably because of the great abundance of this animal in their territory. As with Mollie's pack, bison predation by the Nez Perce pack has typically occurred in late winter when bison are more vulnerable. 🐾

*Kerry Murphy examines wolf #40F after she was killed by her pack mates (see story page 6).
Photo by Douglas Smith.*

DEATH OF A QUEEN

DRUID'S ALPHA FEMALE KILLED BY PACK MATES



Wolf #40 (left) was the alpha female of the Druid Peak pack from 1997 to 2000. She was killed by pack mates in May 2000. Her sister #42 (right), took over the alpha position. Photo courtesy Monty Dewald.

On May 8, 2000, alpha female #40 was found wounded on the side of the road in Lamar Valley and died soon afterward. Independent necropsies by both the Yellowstone Wolf Project and the Montana Department of Fish, Wildlife and Parks lab in Bozeman, Montana, concluded that the death had resulted from an attack by other wolves. Multiple wounds riddled her body and many of the teeth marks were the same distance apart as a wolf's canine teeth. Of all the wolf carcasses that have been recovered and determined killed by other wolves in Yellowstone, #40's was the most mutilated. How could such an event happen? Wolves, including dethroned alphas, commonly depart from packs for various reasons—but killed by other wolves? What follows are the events that led to #40's death.

Wolf #40 was a pup in the 1996 shipment of wolves from British Columbia, brought with her mother, #39, and two sisters, #41 and #42. In the Rose Creek pen they were introduced to male wolf #38. Shortly after they were released as the Druid Peak pack in April 1996, #39 left the pack and #40 became the dominant female. In

1997, the three sisters all mated with #38, but apparently only #41 and #42 produced litters. When #39 returned that May, she was not welcomed by #40, and both #39 and her daughter #41 left the pack permanently in November. While the pack was temporarily outside the park, the alpha male #38 was illegally shot in December 1997, and #21 from the Rose Creek pack became the new Druid Peak alpha male. Only #40 and her sister #42 were left from the original Druid Peak pack, and relations between them were not good.

As the alpha female, #40 totally dominated #42, often so brutally that she relinquished her attack only after her sister assumed complete submission: tail tucked, on her back, licking #40's face. Number 40 bit and held #42 with the restraint typical of within-pack dominance fights, but the bites she delivered were undoubtedly painful. In 1999, when #42 dug a den hole and localized around it, she was attacked by #40, who had produced a litter of her own. It is not known if #42 had any pups; pseudopregnancy was possible, but after the attack #42 was not found by her den hole again.

In 2000, three females in the Druid Peak pack (#40, #42, and #106) produced a total of 21 pups. The three mothers had separate dens, but the two non-breeding adult females in the pack, #103 and #105 (daughters of #41 or #42), showed an affinity for #42's den, not visiting #40's or #106's dens. For the most part, #40 and #42 remained apart; only two encounters were observed in six weeks, when #40 was seen briefly visiting #42's den site without incident. The alpha male (#21) stayed primarily with #40 at the traditional Druid Peak den site, but he did make regular visits to #42's den and possibly to #106's den.

On the evening of May 7, at about the same time that #42 and #105 left #42's den and traveled toward #40's den, #40 left her den accompanied by #21 and traveled toward them. The wolves met in the Chalcedony Creek area, where #40 immediately attacked #42 and then #105. Both attacks were vicious and both #42 and #105 submitted to #40. After the attacks all four wolves headed toward #42's den near Amethyst Creek, when it became too dark for further observation. The next morning, #40 was found by the road fatally wounded. She had probably sought the road as the lesser of two evils, knowing the other wolves would avoid the pavement, which was associated with humans.

No radio-collared wolves from other packs were located in Lamar Valley and it is unlikely that other wolves would have made such an attack, given that #42's den was in the center of Druid Peak pack territory, not near the edge where a trespass would be more likely. Instead, years of abuse of her female pack members had caught up with #40, and the period when #40 and #42 were apart after denning probably contributed to the strengthening of social bonds between #42, #103, and #105 and the weakening of ties with #40. When she neared #42's den, her proximity to #42's pups could have caused a strong reaction from #42 that brought the help of #103 and #105, and a three-versus-one fight ensued.

After #40's death, both #42 and #106 moved their litters to what had been #40's den. During the rest of the summer, all of the pups were raised by the pack operating as a cohesive unit, and 20 pups were still alive at year-end. Number 42 assumed the role of alpha female and was not observed aggressively dominating any other wolf in the pack.

WOLF CAPTURE AND COLLARING

In YNP in January and February, helicopter darting was used to capture 14 wolves (8 males and 6 females) from seven packs: Rose Creek (4), Leopold (2), Mollie's (2), Nez Perce (2), Chief Joseph (1), Druid Peak (1), and Sheep Mountain (2). (Although the Sheep Mountain pack is otherwise counted as a pack outside of YNP, they are included here and in wolf predation studies because they are important for purposes of northern range research.) The age composition of the captured wolves (9 adults and 5 pups) was unusual; typically more than 80% of the wolves captured in YNP have been pups. However, below normal pup survival in 1999 was likely a contributing factor to the smaller percentage of pups captured in early 2000. In addition to attaching radio collars, YNP staff collected standard measurements and blood samples for genetics and disease monitoring from all of the captured wolves.

Of the approximately 177 to 179 wolves in the GYA at year-end, 43 (24%) were collared, including 32 (27%) of the approximately 119 wolves in YNP and 11 (19%) of the known wolves outside YNP.

This was the third consecutive year in which wolves were systematically captured by helicopter darting in YNP in mid-winter. The average number of wolves captured over the three winters was 22 (including members of the Sheep Mountain pack). YNP staff plan to capture a similar number of wolves in 2001. 🐾



Carter Niemeyer poses with Rose Creek wolf #156F. Since 1999, Carter has been integral to the success of the winter capture program. Photo by Douglas Smith.

WOLF PREDATION

Wolf-prey relationships were documented by observing wolf predation directly and by recording characteristics of wolf prey at kill sites. Wolf packs were monitored during two winter-study sessions, 30-day periods in March and November–December during which wolves were radio-tracked daily. The Leopold, Rose Creek, and Druid Peak packs were monitored by two-person teams from the ground and from aircraft; the Chief Joseph, Mollie's, Nez Perce, Sheep Mountain, and Yellowstone Delta packs were monitored from aircraft only. YNP staff recorded and entered into a data base information about behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, percent consumption of kills by wolves and scavengers, characteristics of wolf prey (e.g., nutritional condition), and characteristics of kill sites. The abundance and sex-age composition of elk within wolf pack territories were also estimated from the ground and from fixed-wing aircraft.

Composition of Wolf Kills

Project staff detected 113 definite and 210 probable kills made by wolves in 2000, including 281 elk (87% of total), 10 bison (3%), 4 moose (1%), 5 deer (1.5%), 4 coyotes (1%), 1 wolf and 17 unknown prey (5%). The composition of elk kills was 34% calves (0–12 months), 34% cows, 19% bulls, and 13% unknown sex and age. Bison kills included three calves, one cow, one bull, and four adults of unknown sex. Moose kills included two cows, and two of unknown age and sex. Most bison and moose were killed during late winter.

Winter Studies

During the March winter study wolves were observed for 261 hours from the ground. The number of days wolf packs were located from the air ranged from 10 (Yellowstone Delta) to 23 (Leopold, Rose Creek, Druid Peak, and Nez Perce packs). Eighty-five definite or probable wolf kills were detected, including 70 elk, 5 bison, 1 mule deer, 3 moose, 1 coyote, and 5 prey of unknown species. Of the elk kills, 30 (43%) were calves, 23 (33%) were cows, 14 (20%) were bulls, 2 (3%) were adults of unknown sex, and 1 (1%) was an elk of un-

known sex and age. Packs that resided on the northern range averaged one ungulate kill every one to three days.

During the November–December winter study wolves were observed for 309 hours from the ground. The number of days wolf packs were located from the air ranged from 11 (Yellowstone Delta) to 21 (Swan Lake, Leopold, and Rose Creek packs). Sixty-seven definite or probable wolf kills were detected, including 63 elk, 1 bison, 1 coyote, and 2 unknown prey. Of the elk kills, 15 (24%) were calves, 19 (30%) were cows, 24 (38%) were bulls and 5 (8%) kills were elk of unknown sex and age. Packs that resided on the northern range averaged one ungulate kill every two to three days. 🐾



A bull elk killed by the Rose Creek pack in November 2000. Bull elk are typically killed more often during the March portion of our winter study. Photo by Douglas Smith.

WOLF MANAGEMENT

Area Closures

To prevent human disturbance of young pups, visitor entry was closed to areas surrounding three dens. The two dens of the Rose Creek pack—"Little Buffalo 1" and "Mom's Ridge" (both used by maternal female #18)—were closed from April 18 to June 30 and from May 2 to June 30, respectively. The "Hitching Post" den (maternal female #40) of the Druid Peak pack was closed from April 18 to July 20. Each closure was about four square miles and was centered on the dens. A no-stopping zone was also instituted along the road to Cooke City near the den of the Druid Peak pack to discourage visitors from parking outside established pullouts and to keep them from stopping near wolves that were trying to cross the road near the den. Two people were hired using private funds raised by the Yellowstone Park Foundation to direct traffic, monitor wolf activity and educate the public about YNP wildlife and Rocky Mountain ecosystems. Hiking trails in the vicinity of the Rose Creek and Druid closures remained open.

The Daly Creek drainage southeast of the Daly Creek trail was closed to protect Chief Joseph pups from April 15 to June 15. The trail and the area northwest of the trail remained open to hiking. Den sites for the Leopold, Mollie's, and Nez Perce packs were protected from disturbance as a result of Bear Management Area closures: Blacktail (March 15 to June 30), Pelican Valley (April 1 to July 3), and Firehole (March 10 to about May 26). The area around the den site of the Yellowstone Delta pack near the upper Yellowstone River was not closed to public entry, but three campsites and one section of trail (0.25 miles in length) were closed during July and August to reduce disturbance to pups.

Pen Removal

The wolf acclimation pen near Nez Perce Creek and the remaining portions of the Trail Creek, Fishing Bridge, and Blacktail Deer Plateau pens were removed from the field during August and stored near Stephens Creek. Only one pen left from the 1995 reintroduction in Lamar Valley was still standing at year-end.

Wolf Depredation Outside Yellowstone

Wolves killed 7 cattle, 39 sheep and 8 dogs in the

GYA outside the park during 2000. In response to these losses, the USFWS and Wildlife Services (USDA/APHIS) killed at least three wolves during control actions and translocated six wolves. 🐾

WOLF GENETICS

Familial relationships among Yellowstone wolves continued to be estimated using microsatellite analysis of DNA that was collected from live-captured or dead wolves. A wolf pedigree has been constructed from 114 free-ranging wolves, including 79 offspring, born in 14 different packs (26 total litters) and genotyped at 12–23 loci. Preliminary results suggested that Yellowstone wolves were more polygynous immediately after reintroduction than are wolves in areas characterized by long-standing populations. This work has been a collaborative effort involving Eric Mathur and Dorris Hafenbradl at Diversa Corporation, Janet Zeigle and Larry Joe at Celera Gen Corporation, Dr. Karl Broman at Johns Hopkins University, Dr. Michael McClelland at Sidney Kimmel Cancer Center, and John Varley and Sarah Stevenson at the Yellowstone Center for Resources. Three publications relating to Yellowstone wolf genetics were in preparation at year-end. 🐾

WOLF SEROLOGY

Serum samples collected from 1995 to 1999 from 85 wolves were tested for the presence of canine distemper virus (CD-IgG and CD-IgM), canine parvovirus (CPV-IgG), and *Brucella canis* antibodies. Forty (47%), 12 (14%), and 79 (93%) wolves exhibited positive responses to CD-IgG, CD-IgM, and CPV-IgG, respectively. All wolves exhibited negative responses to *Brucella canis*, except one 'suspect' individual. Titer frequencies for pups ranged annually from 13 to 100% (average 38%), 0 to 75% (average 15%), and 50 to 100% (average 95%) for CD-IgG, CD-IgM, and CPV-IgG, respectively. Similarly, annual titer frequencies for yearlings and adults ranged from 0 to 92% (average 70%), 0 to 20% (average 11%), and 67 to 100% (average 91%) for CD-IgG, CD-IgM, and CPV-IgG, respectively. Annual frequencies of CD-IgG for pups were not correlated with annual pup mortality rates. 🐾

COLLABORATIVE RESEARCH

The Wolf Project and the Yellowstone Park Foundation provided direct and indirect support for collaborative research with scientists at other institutions, primarily universities. Most of the studies represent pioneering work on wolves within the scientists' topic of interest.

Wolf Project Students—Direct Assistance

Graduate Student: Shaney Evans (Master of Science candidate)

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

Title: Elk (*Cervus elaphus*) seasonal distribution and adult mortality post-wolf (*Canis lupus*) reintroduction in Yellowstone National Park, WY

Project Narrative: As part of a three-tiered study, "Multi-trophic level ecology of wolves (*Canis lupus*), elk (*Cervus elaphus*), and vegetation in Yellowstone National Park, Wyoming," seasonal distributions of elk will be examined to estimate the behavioral effects of wolves on elk. Individual elk locations will be paired with wolf locations to establish the proximity of elk to wolves. In addition, patterns of distribution will be compared for cows with calves versus cows without calves and for gravid versus non-gravid females. Biologists John Cook and Rachel Cook will estimate the nutritional status of cow elk during capture using ultrasonography and body condition scoring. The extent that elk distribution patterns (group size and location) are correlated with elk nutritional condition and age will also be examined. They will compare a new model of predation risks for cow elk to empirical data collected during this study.

Project Activity in 2000: Shaney assisted with elk capture, continued fieldwork, and attended courses during fall 2000.

Anticipated Completion Date: May 2003

Graduate Student: Amy Jacobs (Master of Science)

Committee Chair: Dr. Rolf O. Peterson, Michigan Technological University

Title: Leadership: Ecological implications of social behavior in gray wolves

Project Narrative: This study examined the relation-

ship between the behavioral dominance of a wolf, its breeding status (e.g., breeding male, breeding female, non-breeding wolf), and the extent it leads in important pack behaviors such as travelling or hunting. Leadership did not equate with being in the front of a line. In fact, decision-making behaviors, especially for wolves in non-frontal positions, best identified individuals that directed collective pack behavior and activity. Only dominant breeding wolves scent-marked. Leadership assignment between breeders and non-breeders was dependent on pack size.

Project Activity in 2000: Amy completed her thesis in December 2000.

Graduate Student: Julie Mao (Master of Science candidate)

Committee Chair: Dr. Mark S. Boyce, University of Alberta

Title: Habitat selection by elk (*Cervus elaphus*) following wolf (*Canis lupus*) reintroduction in Yellowstone National Park

Project Narrative: Habitat selection by elk will be modeled using data from pre-wolf (1987–1990) and post-wolf reintroduction (2000–2001) periods. Forty-five cow elk were captured on the northern range during March 2000 and fitted with VHF radio collars. Beginning in late June, each animal was located from the air every 7 to 14 days. During spring and summer, elk dispersed from their winter range to higher elevations on the Buffalo Plateau, Upper Cache Creek, Upper Lamar River, Quadrant–Mt. Holmes, and Heart Lake–Lewis Lake area. All radio-collared elk migrated back to the northern winter range during October and November. Initial analysis of 2000 summer habitat use data suggested strong selection for mosaics of grass-forb vegetation and burned, regenerating forest. Radio-collared elk will continue to be tracked through 2001. Preliminary models of elk habitat selection and distribution constructed for pre-fire (1988), post-fire, and post-wolf periods will be compared.

Project Activity in 2000: Julie continued her course work and began data collection.

Anticipated Completion Date: May 2002

Graduate Student: Carrie Schaefer (Master of Science)
Committee Chair: Dr. Rolf O. Peterson, Michigan Technological University
Title: Spatial and temporal variation in wintering elk abundance and composition, and wolf response on Yellowstone's northern range
Project Narrative: Different methodologies were used to estimate population parameters of elk within wolf pack territories on Yellowstone's northern range. Between-observer variance of various elk group sizes was negligible. Calf:cow ratios were calculated for each period from ground-based observations. Wolf density was greater in areas of greater calf abundance. There was a statistically significant positive correlation between airplane-based estimates of calf:cow ratios obtained in this study and estimates obtained by members of the Northern Range Cooperative Wildlife Working Group. Wolf kill rates were not correlated with elk density and did not have limiting or regulating effects on the northern range elk herd. However, wolf density was strongly related to elk density. Kill rates were significantly higher during the late winter than the early winter periods.
Project Activity in 2000: Carrie completed her thesis in May 2000.

Graduate Student: Linda Thurston (Master of Science candidate)
Committee Chair: Dr. Jane Packard, Texas A&M University
Title: Homesite attendance as a measure of alloparental and parental care by gray wolves in northern Yellowstone National Park
Project Narrative: This study focused on parental and alloparental (non-breeder) care by gray wolves.

Four packs were observed during two denning seasons (1997–98) using radio telemetry supplemented by direct observations. Thirty comparisons were made of homesite attendance by individuals that were matched for breeding status, age, and opposite gender. Homesite attendance by parental females and alloparental females was greater than or equal to attendance parental males and alloparental males, respectively, in 100% of the cases. Alloparental care was less than or equal to parental care in 75% of the cases. High variation in the trends of both parental and alloparental care was found.

Project Activity in 2000: Linda defended her thesis and will graduate in 2001.

Graduate Student: Gregory Wright (Master of Science candidate)
Committee Chair: Dr. Rolf O. Peterson, Michigan Technological University
Title: An analysis of Yellowstone National Park's northern range elk herd
Project Narrative: The first objective of this study is to document the demographics of elk (*Cervus elaphus*) on the northern winter range using population reconstruction. This technique requires age, sex, and date-of-death information from a sample of elk mortalities each year. Based on these data, retrospective estimates of population size and sex-age composition are made based on elk longevity. The second objective is to compare characteristics of northern herd elk killed by gray wolves (*Canis lupus*) to those harvested by hunters.
Project Activity in 2000: Greg assisted with wolf project field operations and began his coursework.
Anticipated Completion Date: May 2002



Bob Hawkins (helicopter pilot, left) and Mike Jimenez (right) of the U.S. Fish and Wildlife Service handle captured wolves of the Yellowstone Delta pack in the Thorofare. Photo by Douglas Smith.

Other Research—Indirect Assistance or Collaborative Work with the Wolf Project

TOPIC	COLLABORATOR	INSTITUTION
Wolf–cougar interactions	Howard Quigley Toni Ruth	Hornocker Wildlife Institute
Wolf–coyote interactions	Bob Crabtree, Jennifer Sheldon	Yellowstone Ecosystem Studies
Wolf–elk relationships in the Firehole watershed	Bob Garrott, Rose Jaffe	Montana State University
Wolf stress hormones	Scott Creel, Jennifer Sands	Montana State University
Wolf–scavenger relationships	Wayne Getz, Chris Wilmers; Bob Crabtree	California State University, Berkeley; Yellowstone Ecosystem Studies
Wolf howling	John and Mary Theberge	University of Waterloo, Canada 🐾

PUBLIC INVOLVEMENT***Volunteer Program***

Twenty-one volunteers worked a total of 12,528 hours in 2000, valued at \$141,817 at the GS-5 level (see Appendix). Total hours worked was less than 1999, when 22 volunteers worked for 15,408 hours. Volunteer positions continued to be highly competitive, with three to four applicants applying for each position. Volunteers received free housing and a \$200/month food stipend.

More positions are available during winter when studies of wolf behavior and predation rate take place. In some cases a minimum stay of three months is required. Interested persons should mail a cover letter and resumé to the Yellowstone Wolf Project, P.O. Box 168, Yellowstone National Park, Wyoming 82190.

Visiting Scholars Program

Typically the visiting scholars program invites one scholar for whom housing is provided for several months. In 2000, the fifth year of the program, three distinguished scientists participated, but each individual spent only several weeks in Yellowstone: Bernd Heinrich in February, L. David Mech in March, and Adrian Wydeven in November. Heinrich was wrapping up several years of research on ravens with Daniel Sahler. Mech continued his involvement in the wolf project by initiating studies on female elk. Forty-five elk were radio-collared in late

March to examine elk movements and mortality. Wydeven, Wolf Project Leader from Wisconsin, made a site visit to exchange ideas and update Yellowstone staff on the Wisconsin situation.

The involvement of visiting scholars in 2000 contributed to Dan Stahler's thesis, and submission of a manuscript to *Animal Behavior* authored by Stahler, Heinrich, and Douglas Smith. The *Journal of Wildlife Management* has accepted a manuscript by Mech, Smith, Kerry Murphy, and Dan MacNulty comparing predation of wolves on elk during severe and mild winters 🐾

ACKNOWLEDGMENTS

As usual, many people helped this year, and they are, more than ever, too many to mention. We are especially grateful for the continued success of the volunteer program. Without volunteers, much of our work would not get done. Volunteers have been an integral part of the Wolf Project since the beginning. We also thank Shaney B. Evans for her work, made possible from a grant by the Yellowstone Park Foundation.

We are thankful for the contributions from individuals, corporations, and foundations that donated funds to the various needs and causes of the Yellowstone Wolf Project in 2000. Finally we thank Tami Blackford and Mary Ann Franke for their efforts on editing and publishing this report. 🐾

APPENDIX

Yellowstone Wolf Project Volunteer Roster, 2000

Name	Period of Involvement	Hours
Andre, Melissa	02/27/2000–03/31/2000	272
Buchwald, Robert	11/06/2000–12/15/2000	320
Chin, Susan	01/01/2000–12/31/2000	2,928
Cole, Dana	02/27/2000–03/31/2000	272
Frame, Paul	03/24/2000–03/31/2000	64
Gerum, Scott	02/27/2000–03/31/2000	272
Gray, Rachel	11/06/2000–12/10/2000	280
Hallingstad, Eric	02/27/2000–04/22/2000	448
Honness, Kevin	03/24/2000–03/31/2000	64
Koitzsch, Ky	11/06/2000–12/20/2000	360
Lyons, Macneil	11/06/2000–12/15/2000	320
MacNulty, Dan	03/17/2000–03/31/2000	120
McIntyre, Rick	02/27/2000–03/31/2000	272
Nelson, Julia	11/06/2000–12/15/2000	320
Peer, Melissa	02/27/2000–03/26/2000 and 11/06/2000–12/15/2000	552
Stahler, Dan	05/30/2000–07/31/2000	496
Thurston, Linda	01/01/2000–12/31/2000	2,928
Totten, Charles	11/13/2000–12/15/2000	264
Varley, Nathan	03/17/2000–03/31/2000	120
Wright, Greg	02/27/2000–05/15/2000	632
Zieber, Tom	01/01/2000–06/01/2000	1,224
Total Volunteer Hours Worked		12,528

Publications

Evans, S., D.W. Smith, and K. Murphy. 2000. Evaluation of wolf activity along the Tower to Canyon road in Yellowstone National Park, 1995–1999. YNP report, 17 pp.

McIntyre, R., and D.W. Smith. 2000. The death of a queen: Yellowstone mutiny ends tyrannical rule over Druid pack. *International Wolf* 10:(4)8–11.

Smith, D.W., L.D. Mech, M. Meagher, W.E. Clark, R. Jaffe, M.K. Phillips, and J.A. Mack. 2000. Wolf–bison interactions in Yellowstone National Park. *Journal of Mammalogy* 81:1128–1135.

Smith, D.W., and M.K. Phillips. 2000. Northern Rocky Mountain wolf. Pages 219–223 in R.P. Reading and B. Miller, editors. *Endangered animals: A reference guide to conflicting issues*. Greenwood Press, Westport, CT. 🐾



Wolf #153F of the Rose Geek pack, captured and collared near Sough Geek in 1999, is now the alpha female of the Absaroka pack east of Yellowstone National Park. Photo by Douglas Smith.



Wolf #124M of the Yellowstone Delta pack died of unknown causes and was mostly decomposed when wolf project staff recovered him in Mountain Creek. Photo by Douglas Smith.