YELLOWSTONE WOLF PROJECT

ANNUAL REPORT
1998

Yellowstone Wolf Project

Annual Report
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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 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 the abundant prey that existed here, Yellowstone was an obvious choice as a place where wolf restoration would have a good chance of succeeding. The designated recovery area includes the entire Greater Yellowstone Area.

The goal of the wolf restoration program is to maintain at least 10 breeding wolf pairs in Greater Yellowstone as it is for each of the other two recovery areas in central Idaho and northwestern Montana. Once ten pairs are established and reproduce in each of the three recovery areas 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 clerical 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 FWS as "nonessential experimental" under section 10(j) of the Endangered Species Act and are to be managed under special rules that permitted 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 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.

1998 SUMMARY

In sharp contrast to the winter of 1996–1997, the winter of 1997–1998 was mild. Warm temperatures and moderate to low snow accumulation resulted in virtually no winter ungulate mortality. Early winter 1998–1999 was likewise mild. Snowfall in November and December was below normal for all elevations, and temperatures were above average.

Prior to 1998, wolf capture was conducted on an "as needed basis," usually for management purposes. This was the first year wolves were systematically captured for research or monitoring objectives. Twenty-seven wolves were captured, either by helicopter netting or darting, in January or March. Helicopter Wildlife Management from Salt Lake City, Utah, donated their services and netted 21 of the 27 wolves captured. The other six wolves were darted with the aid of personnel from Wildlife Services and pilots and helicopters from Hawkins and Powers Aviation of Greybull, Wyoming.

Other wolf project activities included the bi-annual 30-day winter study in early and late winter, den study during the spring and early summer, scat collection, routine population monitoring, retrieval of wolf carcasses, outreach to various publics, and general wolf management (e.g., den closures, tending penned wolves).

At year's end about 112 wolves in 11 packs inhabited the Yellowstone ecosystem. The number of breeding pairs declined from nine in 1997 to six in 1998. Adult breeders were lost and not replaced in each case. Forty-four pups in ten litters were born to the six breeding packs. Four packs had two litters. Litter size averaged 5.5 pups. Thirty-six (81%) of these pups survived to the end of the year.

Eighteen wolves died in 1998: eight pups, four yearlings, and six adults. Twelve of the mortalities involved natural causes and six were human-caused. Two pups were killed on highway 191 in the northwest corner of the park, an area of high wolf mortality due to vehicle strikes.

Wolves continued to prey mostly on elk (86% of the total wolf kills). Forty-three percent of elk taken were calves, 21% were adult females, 21% were adult males, and 15% were of unknown age and sex. Wolves tended to kill more adult cows and fewer elk bulls in early winter and more bulls in late winter. Calves were the primary age class preyed on in early and late winter. Other animals killed by wolves included bison, coyotes, moose, mule deer, pronghorn antelope, and other wolves. Three cattle and one dog were confirmed to be killed by wolves in the GYA in 1998.

Volunteers continued to play an integral role in fieldwork. Winter study and den study were centerpiece projects staffed mostly by volunteers. Eighteen different volunteers contributed work in 1998. Five graduate students also continued work on their respective projects.

In March, Kerry Murphy took over as project biologist allowing Douglas Smith to assume full-time duty as project leader.

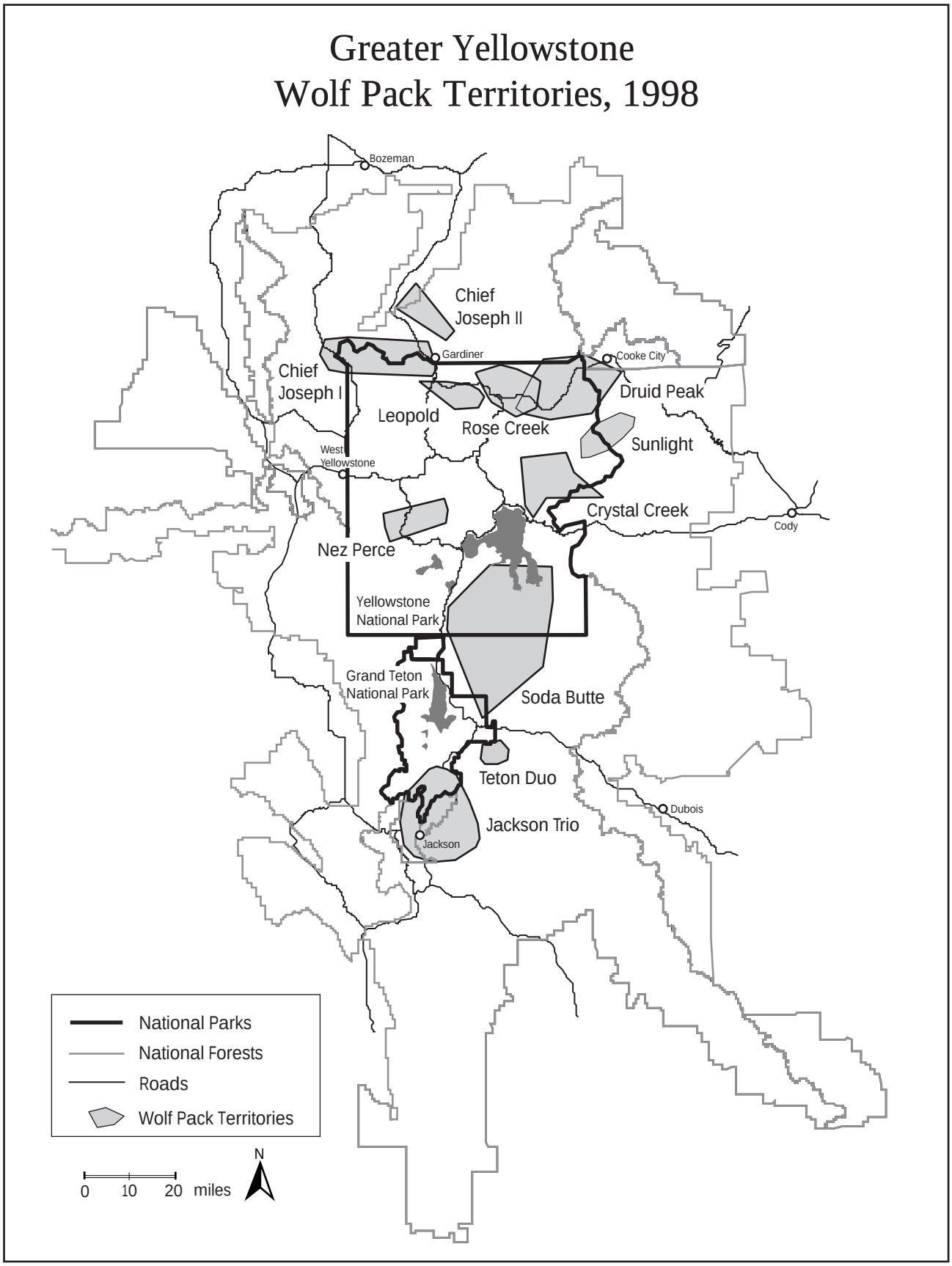

Figure 1. Wolf pack territories. Eleven groups including ten packs with a total of 112 wolves occupied the GYA in 1998.

Wolf #95F from the Leopold Pack was one of the first wolves captured by helicopter in Yellowstone National Park in January 1998. Photo by William Campbell.

THE YELLOWSTONE WOLF POPULATION

Population Status and Reproduction

The number of wolves in the GYA increased in 1998 (Fig. 1), but the number of breeding pairs declined. The total population increased from 86 at the end of 1997 to 110–120 at the end of 1998. An increasing number of uncollared wolves make it difficult to give an exact population estimate (Table 1). Only six packs were known to have bred in 1998 compared to nine in 1997. Wolf packs that did breed were the Chief Joseph, Leopold, Rose Creek, Druid Peak, Crystal Creek, and Nez Perce packs. The Soda Butte, Washakie, and Thorofare packs bred in 1997, but they did not breed in 1998 because of the loss of one or both adults. The breeding male, #13, in the Soda Butte Pack died of old age in March 1997 and he was not replaced in 1998. The breeding male, #15, in the Washakie Pack was killed by USDA Wildlife Services according to terms of special rules following livestock depredations in October 1997, causing that pack not to breed in 1998. Both breeders in the Thorofare Pack died; the male, #35, was killed by other wolves and the female, #30, died in an avalanche, essentially ending the pack's existence. Their pups subsequently dispersed.

Forty-four pups in ten litters were born to these six breeding packs (Fig. 2). Litter size ranged from two to eight pups (average = 5.5). Thirty-six (81%) of these pups survived to year's end. Four packs, the Chief Joseph, Rose Creek, Druid Peak, and Nez Perce packs, had two litters. Wolf #34 (Chief Joseph) again bred two females, #16 and #33, but #16 lived separately from #34 and raised her pups alone. The Rose Creek and Druid Peak packs had two females whelp and use the same den, so the packs raised the pups that survived communally. The two litters

Table 1. Wolves in the GYA as of December 31, 1998.

Pack	Pups	Yearlings	Adults	Total
Crystal Creek	8	7	1	16
Leopold	5	4	4	13
Rose Creek	10	7	5	22
Druid Peak	1	3	3	7
Soda Butte	0	4	3	7
Chief Joseph I	5	4	2	11
& Chief Joseph II	5	0	1	6
Nez Perce	3	1	3	7
Teton Duo	0	1	1	2
Jackson Trio	0	2	1	3
Sunlight	0	0	2	2
Others	0	11	5	16
Total	37	44	31	112

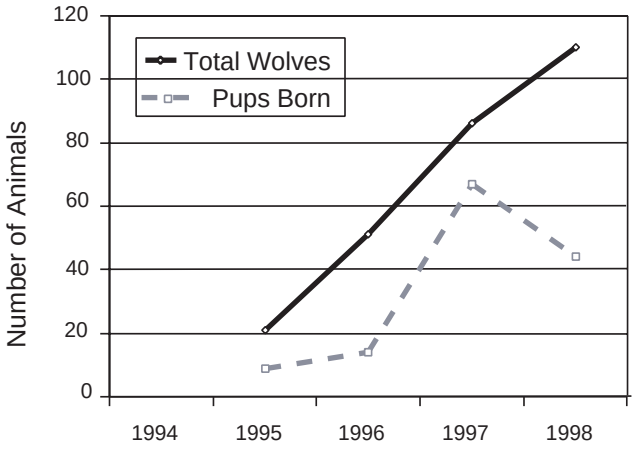

Figure 2. Wolves born in the GYA, 1995–1998.

William Campbell

Four pups were born in the Nez Perce pen in 1998. Breeding in pens was much more common than predicted and occurred in five of eight cases where wolves were held during the breeding season from 1995 to 1998.

born to the Nez Perce Pack were from two different males and females, one on the inside of a pen, the other on the outside. The wolves united after they were released from temporary captivity in June.

Population Movements and Territories

Wolf range in the GYA expanded in 1998 (Fig. 1). Three new or recently formed packs (tentatively called the Teton Duo, Jackson Trio, and Chief Joseph II packs) established territories outside of Yellowstone, and one pack (Soda Butte) which formerly restricted its range to mostly inside YNP, roamed south several times to the National Elk Refuge near Jackson, Wyoming (Fig. 1). One wolf from the southern portion of the GYA traveled to near Powell, Wyoming, and was killed by a M-44 "coyote-getter," otherwise no wolves traveled outside the GYA in 1998.

Wolf pack territory sizes ranged from 135 (Leopold Pack) to 955 mi^2 (Soda Butte Pack); territory sizes were included only for packs that were radiolocated $\geq$ 25 times during the year. Average territory size for six of the GYA packs was 359 mi^2.

Denning Ecology

All wolf den sites were monitored from the air, and some were monitored from the ground. This monitoring allowed us to estimate birthing dates and numbers of pups produced. Remote telemetry equipment was employed to gain continuous data on wolf den site attendance at some of the dens. Opportunistic observations also took place.

Most wolf packs that had bred previously in Yellowstone reused their old den sites. All birthing dates were in April. The Druid Peak, Rose Creek, and Leopold packs all had their pups in early April (April 3–10). Chief Joseph and Crystal Creek packs had their pups in mid-April (April 17–23), and the Nez Perce Pack had their pups in late April (April 23–29).

Mortality

Eighteen wolves died in the GYA in 1998: six adults, four yearlings, and eight pups from either the 1997 or 1998 cohort (three were known to have died and five disappeared and were presumed to have died) (Table 2). Causes of natural mortalities included interpack killing by other wolves, avalanches, elk, and possible disease. Six human-caused mortalities resulted from control actions, illegal take, and wolves being struck by vehicles. Highway 191 in the northwest corner of the park was again the location where wolves were hit by vehicles.

Sixty collared or uncollared wolves died in the GYA from 1995 through 1998 (Fig. 3). Despite these mortalities, the wolf population has continued to steadily grow.

Pack Summaries

Crystal Creek Pack

The Crystal Creek Pack at 16 was the second largest

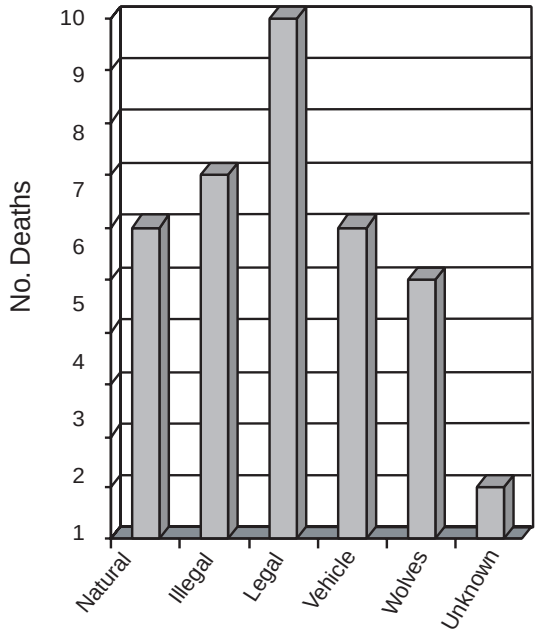

Figure 3. Cause of mortality for radio-collared wolves, 1995–1998.

wolf pack in Yellowstone. They bred successfully in 1997 and 1998. Living in Pelican Valley most of the year, they were seen interacting regularly with grizzly bears to mostly benign outcomes, although the bears tended to "win" when a carcass was in question. The alpha male, #6, died in August from an injury caused by an elk; the wolf's femoral artery was severed. Fifty meters away the elk was found dead and consumed by #6's packmates. Within a month a yearling male (#104) from the Druid Peak Pack dispersed and joined the Crystal Creek Pack. The alpha female (#5) is the only original member of the Crystal Creek Pack left—she, in fact, was the first wolf carried into a pen in 1995 by Secretary of the Interior Bruce Babbit, the late Mollie Beattie (former Director of the Fish and Wildlife Service), Superintendent Michael Finley, and Maintenance Foreman James Evanoff.

Soda Butte Pack

Also a pack with only one survivor from the original 1995 reintroduction transplant (female #14), this pack ranged across the southern portion of Yellowstone from Heart Lake to the Thorofare region. The pack was comprised of seven wolves until November, when #24 dispersed and started her own pack with #133, a Washakie disperser. Number 24 was one of the first pups born to the new Yellowstone wolf era in 1995; she was the only pup in the first Soda Butte litter. Number 24 and #133, now referred to as the Teton Duo, settled near Grand Teton National Park. Number 14, #24's mother, did not breed in 1998 because her mate (#13) died of old age in March 1997, and at year's end, she still had not found a new mate.

Table 2. Known wolf mortalities in the GYA during 1998.

Wolf	Pack	Age	Sex	Cause of Death
006M	Crystal Creek	Adult	Male	Natural (elk)
026F	Washakie	Adult	Female	Control Action
030F	Thorofare	Adult	Female	Avalanche
035M	Thorofare	Adult	Male	Wolves
039F	Druid Peak	Adult	Female	Illegally Killed
067F	Nez Perce	Adult	Female	Control Action
083M	Rose Creek	Yearling	Male	Natural (elk?)
085F	Rose Creek	Yearling	Female	Wolves
111F	Chief Joseph II	Yearling	Female	Disease?
127?	Thorofare	Pup	?	Avalanche
135M	Washakie	Yearling	Male	Control Action
139?	Druid Peak	Pup	?	Disappeared
141M	Chief Joseph I	Pup	Male	Vehicle
142F	Chief Joseph I	Pup	Female	Vehicle
181?	Chief Joseph II	Pup	?	Disappeared
?	Rose Creek	Pup	?	Disappeared
?	Nez Perce	Pup	?	Disappeared
?	Nez Perce	Pup	?	Disappeared

Douglas Smith

The Crystal Creek Pack makes its way from Pelican Valley to the upper Lamar River. Wolves often travel in single file because of deep snow common to the interior of Yellowstone National Park.

Rose Creek Pack

At 22 wolves, this pack was the largest in the GYA. Roaming the central northern range within YNP, Rose Creek for the second year had more than one litter: #9 and #18 had litters of five and six pups, respectively. Interestingly, rather than denning separately as they did in 1997, the females shared the traditional Rose Creek den, which was used by #18 alone in 1997. Several uncollared individuals dispersed from this pack, one pup disappeared, and two known mortalities occurred. A yearling male (#83) died of injuries probably inflicted by an elk. Female wolf #85 was observed being killed by the seven Druid Peak wolves at the territorial boundary between the two packs. (Three wolves have died along this boundary since 1996—all within a 1.5– km radius—and four wolves have succumbed to the aggression of the Druid Peak Pack. Number 4, the alpha male of the Crystal Creek Pack, was killed in 1996 by the Druid Peak Pack near Soda Butte.)

Leopold Pack

The Leopold Pack still occupied the Blacktail Deer Plateau and numbered 13 wolves, but several uncollared individuals were hard to track, not always being with the pack. The Leopold territory included Swan Lake Flats and sometimes areas as far south as Norris Geyser Basin. They had a litter of five pups in 1998.

Chief Joseph Pack

Considered as one pack with two breeding females in 1997, the Chief Joseph Pack again had two breeding females in 1998, but were segregated into two units, Chief Joseph I & II. Male wolf #34 apparently bred both female wolves #16 and #33 in 1998, but tended only #33's litter (Chief Joseph I). Number 16 raised her litter of six pups alone (Chief Joseph II) and had a territory that did not overlap with #33 and #34's, as it did the year before. Chief Joseph I ranged in the northwestern part of the park and had seven pups. Two of these pups were hit on highway 191 in October and November. Chief Joseph II established a territory north of the park in the Absaroka-Beartooth wilderness and had six pups with four surviving to year's end.

Druid Peak Pack

This pack, arguably the most viewed wolf pack in the world, spent most of their time in and around Lamar Valley. They denned approximately 400 meters from the road, causing traffic congestion, a den closure area, and a no stopping zone on the road. Like Rose Creek, two females had pups in this pack in 1998, but only two pups were ever recorded and only one pup survived (#163). It is likely that #42's litter was lost for unknown reasons, so that the only surviving pups were from #40.

Thorofare Pack

In January 1998, the Soda Butte Pack trespassed onto the Thorofare Pack's territory, killing the alpha male (#35) and likely causing the death of the alpha female (#30) and one pup. When we visited the site where #35 was found, only hair, urine, blood, and his collar remained in a wind-blown concavity underneath a log along the Yellowstone Lake shoreline. His mate and pup, #30 and #127, perished in an avalanche, likely fleeing the Soda Butte Pack. The five remaining pups, only one of which was radio-collared, stayed together the rest of the winter and part of the spring, but tracking uncollared wolves was difficult and inaccurate. Through the summer aerial observations indicated that the wolves had split up. The collared wolf, female #129, with what was probably her uncollared sibling (#137), settled in Grand Teton National Park and the adjacent National Elk Refuge near Jackson, Wyoming, with a dispersing male (#29) from the Nez Perce Pack and were referred to as the Jackson Trio. The fate of the remaining uncollared pups is unknown at this time.

Washakie Pack

The Washakie Pack also disbanded in 1998 because of the loss of the adult wolves. In October 1997, the adult male (#15) was shot by Wildlife Services agents outside of Yellowstone for killing livestock. In June 1998 the adult female (#26) was also shot for the same reason. Four yearling wolves were left, two of which were collared. The collared wolves left the DuNoir Valley, where the pack had lived, and ranged widely over the southern portion of the GYA. The uncollared wolves were harder to track, but based on observations by local residents, were still in the area. At the end of December

Douglas Smith

Douglas Smith

Above: Bush pilot Roger Stradley of Gallatin Flying Service has been with the wolf project since 1995. He has been flying the GYA since 1952 and is responsible for much of the success of the aerial tracking and the spotting for the helicopter capture operations. Left: Kerry Murphy (radio tracking on Big Game Ridge in the southern portion of Yellowstone) joined the wolf project in March 1998 as project biologist.

The Story of Wolf #9

Since reintroduction in 1995, the Yellowstone recovery effort has received a lot of attention, and the subjects of this attention have been remarkably visible. Park visitors commonly view wolves from the road; ironically, staying on the road and not venturing into the backcountry is the best way to see wolves. We estimate that approximately 30,000 people have seen wolves in Yellowstone from 1995 through 1998. Of all those wolves sighted, no wolf has gained more notoriety and attention than wolf #9.

Number 9 came with her daughter, #7, a pup at the time, in the first shipment of wolves from Canada to Yellowstone on January 12, 1995. She and #7 were placed together in the Rose Creek pen. On January 19, another shipment of wolves arrived, and an unrelated male, wolf #10, was placed inside the pen with the two females. The rest is history, as they say.

The three wolves remained together only temporarily. Number 7 struck out on her own, wandered solo for six months, and then formed the Leopold Pack with male wolf #2. Number 9 and her new mate, #10, made their way to Red Lodge, Montana, where #10 was illegally shot, just as #9 had a litter of eight pups—one of the ecosystem's first in more than 60 years. Number 9 and her pups were recaptured, brought back to a pen in Yellowstone, held throughout their first summer in YNP, and released for a second time on October 11, 1995. Number 8, a disperser from the Crystal Creek Pack, was waiting for her on the outside—her second mate in ten months, and third in two years. Thus began a second start for the Rose Creek Pack. Together the pack carved out a territory ranging from the Lamar Valley along the Yellowstone River downstream to almost Gardiner, Montana. They had pups in 1996, 1997, and 1998.

By this time, #9 was the one wolf most visitors wanted to see. Unfortunately, probably in part because of her popularity, none of the pups from her 1997 litter survived. That year #9 and two of her daughters bred with the pack's new alpha male. Her daughter, #18, occupied #9's 1996 den, which forced #9 to choose another den site across the Lamar River and near a main park road. Proximity to the road apparently caused her to visit her den infrequently and move her pups before any other wolves did that year, a risky undertaking. Number 9's pups survived until at least late June and were last seen

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Rose Creek wolves #8, first in line, followed by #9 produced pups in 1996, 1997, and 1998. Wolf #9 has been especially important in repopulating the GYA. Every pack in the northern tier of the park has a wolf—usually a breeding wolf—that is related to her. Photo by William Campbell.

by the flood-stage Lamar River. One pup was actually found dead there.

Despite the failed litter of 1997, her offspring have gone on to become breeding animals in many packs and have carried her matriarchal lineage to packs throughout the entire northern portion of Yellowstone and beyond. All four of her daughters born in 1995 (#16, #17, #18, and #19) bred in 1997. In the Chief Joseph Pack #34 bred #16 and #17. Number 16 and pups stayed apart and were called Chief Joseph II. Number 19, also part of the Rose Creek Pack, probably bred with her brother #21 and denned alone, but was killed by the Druid Peak Pack. All four of her pups died from exposure. (These pups are on display at the Mammoth Visitor Center. The adult wolf in the display, however, is not #19). Finally, #9's daughter from 1994, #7 of the Leopold Pack, had successfully bred in 1996 and 1997.

In 1998, four of her offspring—#7, #16, #18, and #21—all bred, as did #9 herself, but this time she shared the traditional Rose Creek den with #18. The 1998 litter marked, as a minimum, five years of reproduction for #9. Number 21 was a male from #9's 1995 litter who dispersed and became the alpha male in the neighboring Druid Peak Pack. Number 52, a male born to #9 in 1996, also dispersed and paired with #41 from the Druid Peak Pack in March 1998, too late to have young that year. But as of December 31, the pair was still together in Sunlight Basin and was likely to breed in 1999. In short, #9's genes are part of the Chief Joseph, Leopold, Rose Creek, Druid Peak, and Sunlight Basin packs. She, possibly more than any other wolf, has put the Yellowstone wolf population back on the map.

What is most thrilling is that the story has not ended. When she arrived in Yellowstone she was a black wolf, but by 1998 had turned completely silver-gray. She was no longer seen bringing down prey, leaving that to #8, #18, or the younger wolves in the pack. She was at least six years old and probably older. Wolf watchers still seek her out more than any other wolf in greater Yellowstone. The wolf project staff has already been contacted about a fund to preserve her remains when she finally does slip away. Since her collar is old and will likely not be replaced, when her last day comes, we may not know it. For now, it is good to know that she is still thriving in some of the best and most secure wolf habitat in the world.

1998, wolf #132 was still ranging widely and had not, to our knowledge, paired with a female. The other collared yearling, #133, paired with the dispersing Soda Butte female #24 and settled near Grand Teton National Park (see Soda Butte summary).

Nez Perce Pack

This pack of five wolves was recaptured and placed inside the Nez Perce acclimation pen in late 1997 because of livestock depredations outside of YNP. Male wolf #29 escaped over the top (for the third time) and paired with free-ranging wolf #48, his sister, also born to the Nez Perce Pack (in 1996). The duo anchored their movements around the pen for the winter and bore a litter of at least one pup. Two wolves inside the pen also had a litter of at least four. There was some concern about releasing the penned wolves so close to the pair and newborn pups outside the fence, though the wolves had behaved amicably through the chain-link fence. The penned wolves were released in June 1998, and the two wolf groups formed one group at a nearby den site. They moved together to Hayden Valley for the rest of the summer. Then in August, the adult female wolf that had wintered inside the pen (#67), abruptly dispersed and was legally controlled for chasing livestock west of Yellowstone. (She had already killed livestock on two occasions so relocation was not an option). In early winter only three pups were sighted, so at least two pups had died because four pups were released from the pen, and at least one pup and possibly more, were born in the den outside the pen. In November, male #29 dispersed and formed the Jackson Trio (see Thorofare Pack). The rest of the Nez Perce Pack remained, and at year's end were ranging in the Firehole River drainage.

Sunlight Basin Pack

Wolf #52 from the Rose Creek Pack and wolf #41 from the Druid Peak Pack dispersed in late 1997 and early 1998. The two found each other in the Sunlight Basin area of Wyoming, paired in March 1998—too late for them to breed—and were together for the remainder of 1998. Their movements were primarily restricted to Sunlight Basin, although they occasionally traveled west and through the eastern portion of YNP.

William Campbell

Wolves were systematically captured by helicopters in 1998. Twenty-one wolves were captured by netting, as pictured here, and six were captured by darting.

Wolf Capture and Collaring

Before 1998, wolf capture and collaring had occurred sporadically and was usually associated with management activity. This year the first capture and collaring operation was organized specifically to maintain contact with packs, and dispersing pups, and to document new pack formation. The primary objective of collaring is to monitor wolf population dynamics, which is germane to documenting delisting criteria (10 breeding pairs for 3 successive years) but also to gathering ecological data relevant to the wolf's return to the GYA.

Twenty-seven wolves from eight packs were captured in January and March. Twenty-one wolves were captured by helicopter net-gunning, and another six were captured by helicopter darting, both safe and proven ways to capture wolves. Helicopter Wildlife Management from Salt Lake City, Utah, donated helicopter time and personnel for the collaring and netting of the 21 wolves. Hawkins and Powers of Greybull, Wyoming, provided the helicopter for darting, and Carter Niemeyer of Wildlife Services was the darter. Seventeen pups (63%), two yearlings (7%), and eight adults (30%) were captured without injury to wolves or humans. Thirty-seven percent of the pups in the 1997 cohort were collared.

Notable in the effort was the size and condition of the wolves. The individuals captured were large and in some of the best condition recorded for wolves (subjectively determined by field personnel with broad handling experience). For example, average weight for male and female pups was 95 and 85 pounds, respectively. A yearling male in the Leopold Pack weighed 120 pounds, more than his father (117 pounds). One male pup captured in the Soda Butte Pack in January weighed 105 pounds. The alpha male of the Crystal Creek Pack weighed 141 pounds but an estimated 10–15 pounds of that was meat consumed from a fresh elk kill. This was the heaviest wolf weighed so far in Yellowstone.

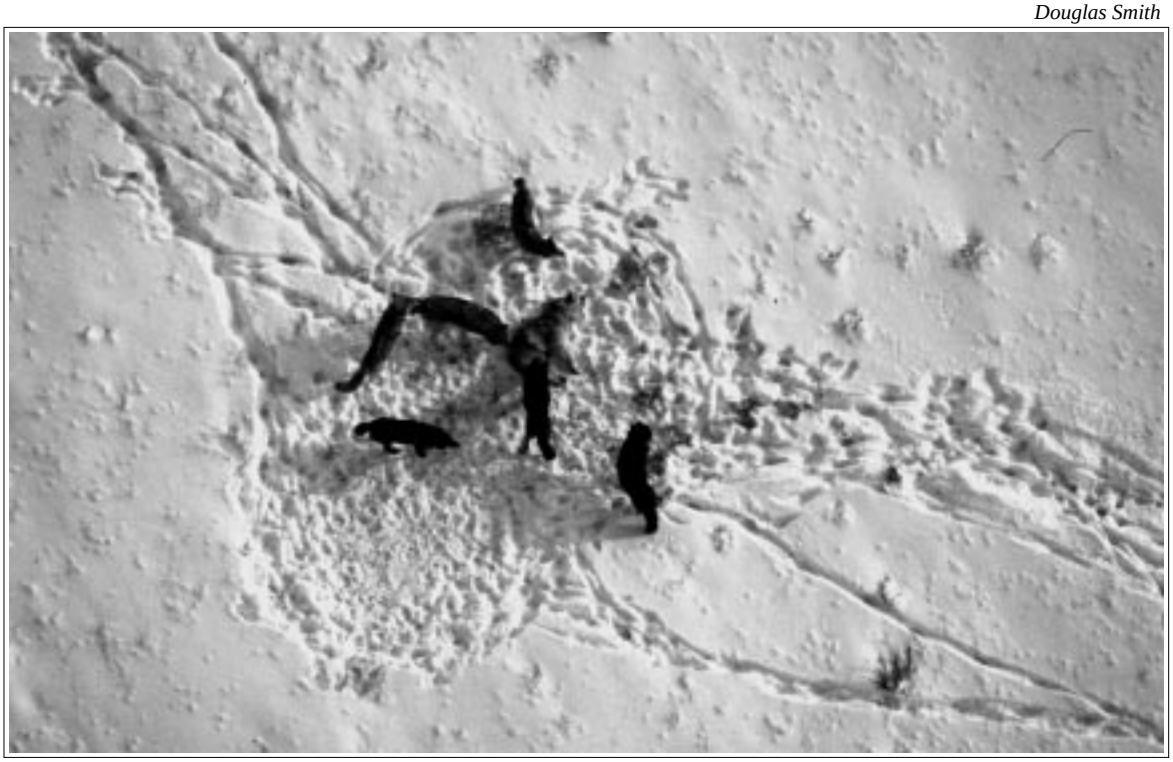
Wolf Predation

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, periods of time in which wolves were intensively radio-tracked and snow-tracked each day for 30 consecutive days, during March and November-December. The Leopold, Rose Creek, and Druid Peak packs were monitored by teams of two persons from the ground and from aircraft; the Chief Joseph, Crystal Creek, Thorofare, Soda Butte, and Nez Perce packs were monitored from aircraft only. 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 were recorded and entered into

William Campbell

Amy Jacobs, a wolf project volunteer, carries wolf #29 during a capture operation near Dillon, Montana. Number 29 was captured and moved because of livestock depredation. Livestock depredation, however, has occurred less than what was predicted in the wolf reintroduction plan and environmental impact statement.

Douglas Smith



In December 1998 the Druid Peak Pack killed a yearling female wolf from the Rose Creek Pack along their territorial boundary.

a data base. The abundance and sex-age composition of elk within wolf pack territories were also estimated from the ground and from aircraft

Composition of Wolf Kills

Project staff detected 109 definite and 120 probable kills made by wolves in 1998, including 197 elk (86% of total), 6 mule deer (3%), 7 coyote (3%), 6 pronghorn (3%), 5 bison (2%), 3 moose (1%), 4 unknown prey (2%), and 1 wolf. The composition of elk kills was 43% calves (0–12 months), 21% cows, 21% bulls, and 15% elk of unknown sex or age. Mule deer kills included 1 fawn and 5 individuals of unknown sex or age. All pronghorn kills were fawns. Bison kills included 2 calves, 1 bull, and 2 adults of unknown sex. Bison were either killed in late winter or they were calves. Moose kills included 2 calves and 1 yearling.

Winter Studies

During the March winter study, wolves were observed for 279 hours from the ground. The number of days wolf packs were located from the air ranged from 7 (Thorofare Pack) to 17 (Chief Joseph and Rose Creek packs). Sixty-nine definite or probable wolf kills were detected, including 66 elk, 2 coyotes, and 1 unknown prey. Among elk, 32 (48%) kills were calves, 8 (12%) were adult females, 19 (29%) were adult males, 3 (4%) were adults of unknown sex, and 4 (6%) were elk of unknown sex and age. Packs that resided on the northern winter range averaged 1 ungulate kill per 2–3 days.

During the November-December winter study, wolves were observed for 258 hours from the ground. The number of days wolf packs were located from the air ranged from 6 (Soda Butte) to 12 (Chief Joseph, Leopold, and Rose Creek packs). Forty-seven definite or probable wolf kills were detected, including 41 elk, 1 bison, 1 mule deer, 2 coyotes, 1 wolf, and 1 unknown prey. Among elk, 15 (37%) were calves, 14 (34%) were adult females, 8 were adult males (19%), and 4 (10%) were adults of unknown sex. Packs that resided on the northern winter range averaged 1 ungulate kill per 3–4 days.

Wolf Management

Area Closures

Visitor entry to an area defined by a one-mile radius around the dens of the Rose Creek and Druid Peak packs was prohibited from approximately April 15 to June 30, 1998. Den areas were closed to prevent human disturbance of pups while they were young. Trails were not affected by the closures. 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 their vehicles outside established turnouts and to keep them from stopping near wolves trying to cross the road. Newborns at the Leopold, Crystal Creek, and Nez Perce packs' den sites were protected from disturbance incidental to the closures for the Blacktail, Pelican Valley, and Firehole Bear Management Areas.

After the release of the Nez Perce wolves in June (see Pack Summaries, Nez Perce Pack), no wolves were captured and placed in pens. Long-term plans for wolf acclimation pens involve disassembly and removal of one pen per year.

Livestock Predation

Three calves and at least one dog were killed by wolves in the GYA during 1998. Three wolves were killed and none were translocated in control actions related to livestock losses. Defenders of Wildlife paid about $500 to compensate livestock producers or pet owners for their losses to wolves.

Monty DeWald

Wolf #42F of the Druid Peak Pack pursues a coyote in Lamar Valley. Wolves have aggressively pursued and killed coyotes since their reintroduction to the GYA.

1) *April, June 1998*. Members of the Washakie Pack killed at least one dog and three calves on the Diamond G ranch near Dubois, Wyoming. No control action was initiated in response to the dog killed during April, but alpha female #26 and yearling male #135 were killed by Wildlife Services personnel after the cattle depredations in June. The removal left four yearling wolves in the area, which roamed widely in the southern GYA thereafter.
2) *August 1998*. Female #67 was killed after she harassed livestock in the Centennial Valley, Montana. This was the third time she was involved in incidents with livestock. She was formerly a member of the Nez Perce Pack and was released during June 1998 from the Nez Perce pen.
3) *October 1998*. One unconfirmed loss of a dog to the Chief Joseph Pack was reported by personnel at the Anderson Ranch, Tom Miner Basin, Montana. The wolf project supplied a radio receiver to the Andersons to enable them to monitor activities of this pack when in the area. No subsequent incidents occurred.

Collaborative Research Studies

The wolf project and Yellowstone Foundation provided financial and in-kind support for collaborative research with research scientists at other institutions, primarily universities. These investigations required wolf project staff to assist in supervising graduate students, outstanding student biologists dedicated to their individual research projects (described below) and the conservation of wolves. Most of these studies represent pioneering work on wolves within the topic of interest.

Graduate Student: Amy Jacobs (Master of Science candidate)
Committee Chair: Rolf Peterson, Michigan Technological University
Title: Leadership behavior of wolves in Yellowstone National Park
Anticipated completion date: May 2000
Project Activity in 1998: Amy attended classes at the university during the spring and fall 1998 terms. She returned and collected wolf leadership data from September to December.

Project Narrative: The question of which wolf "leads" in free-ranging wolf packs has never been addressed. The reintroduction of wolves that remain highly visible in YNP has afforded the rare opportunity to consistently identify individuals. The focus of this study is to examine the relationship between the dominance status of a wolf, its breeding activity, and leadership behaviors it exhibits in pack activities (e.g., hunting).

Graduate Student: Daniel MacNulty (Master of Science candidate)
Committee Chair: L. David Mech, University of Minnesota
Tentative Title: Hunting success of wolves and their behavioral interactions with prey in Yellowstone National Park
Anticipated completion date: May 2000
Project Activity in 1998: Dan attended classes at the university for four quarters and completed a study plan. No appreciable fieldwork occurred during 1998.
Project Narrative: Interactions between wolves and their prey are frequently observed in YNP. The goal of this study is to describe wolf-prey interactions, identify behaviors used by wolves that improve their chances of capturing prey, and identify behaviors used by prey that improve their probability of escaping predation.

Graduate Student: Carrie Schaefer (Master of Science candidate)
Committee Chair: Rolf Peterson, Michigan Technological University
Tentative Title: Statistical and ecological methods for estimating the abundance and composition of wintering elk on Yellowstone's northern range
Anticipated completion date: May 2000
Project Activity in 1998: Carrie collected and compiled field data from January to August. She began her coursework at the university during the fall and wrote a detailed study proposal. During December, Carrie collected additional data during the 1998 November–December winter study period.
Project Narrative: Predation by wolves, cougars, coyotes, grizzly bears, black bears, and humans may have limiting (depressing), compensatory, and/or regulatory effects on the northern Yellowstone elk herd. The goal of this study is to develop field methods usable by wolf project personnel on the ground and in airplanes to estimate elk abundance and composition within wolf pack territories with minimal bias and imprecision. Long-term data generated using these methods will be extremely valuable in assessing the effects of wolves on their prey within wolf territories.

Graduate Student: Daniel Stahler (Master of Science candidate)
Committee Chair: Bernd Heinrich, University of Vermont
Title: Behavioral interactions between avian scavengers and wolves
Anticipated completion date: May 2000
Project Activity in 1998: Dan collected field data intermittently from January to August. He began his coursework at the university during the fall semester and completed a study plan. He returned to Yellowstone and completed an experiment documenting temporal and behavioral responses of scavengers to simulated wolf-killed prey that he placed in the field.
Project Narrative: Little quantitative data are available concerning the extent to which wolves interact with scavengers. This work focuses on behavioral interactions between wolves and common ravens. How do ravens find and communicate the presence of wolf-killed prey in the environment? Dan's hypothesis is that ravens follow wolves as a primary foraging strategy, drawing upon innate behavioral flexibility that is reinforced through learned experiences.

Graduate Student: Linda Thurston (Master of Science candidate)
Committee Chair: Jane Packard, Texas A & M University
Tentative Title: Denning behavior of wolves on Yellowstone's northern range
Anticipated completion date: December 1999
Project Activity in 1998: Linda collected field data on wolf attendance at four dens for continuous 48-hour

periods each week from late April to July. She attended classes at the university during the fall semester, completed her coursework, and drafted a study proposal.
Project Narrative: Although wolves have been studied at their dens before, most work has involved radio telemetry or visual observations, rarely both. Linda's work combines around-the-clock telemetry data with behavioral observations of known individuals at the dens. Her focus is understanding parental care by the male and female breeders, and the role of auxiliary wolves—do they help or are they "parasites?"

Graduate Student: Chris Wilmers (Doctor of Philosophy candidate)
Committee Chair: Wayne Getz, University of California, Berkeley
Other collaborators: Bob Crabtree, Yellowstone Ecosystem Studies, Bozeman, Montana
Tentative Title: The disposition of carrion biomass: energy flow and ecological relationships between wolves, wolf-killed prey, and scavengers.
Anticipated completion date: May, 2003
Project Activity in 1998: From March to August, Chris developed a preliminary data collection protocol and gathered data in the field. He attended classes at the university during the fall semester.
Project Narrative: What is the fate of wolf-killed prey? This study focuses on wolf predation after the wolves finish feeding on the carcass. A large scavenger community—from beetles to grizzly bears—swarms these wolf-provided meals. How are these carcasses located, what animals use them, and how the resources are divided are major questions of the study.

Public Involvement

Legal Issues

In December 1997, U.S. District Judge William Downes ruled that the reintroduction of wolves to the GYA and central Idaho was illegal. Judge Downes ruled that although the administrative procedures had been followed and the reintroduction itself was legal, the special rules reduced protection of wolves that might disperse into the experimental areas from northwestern Montana, violating the Endangered Species Act (see *Yellowstone Wolf Project Annual Report 1997*). In 1998 the U.S. Justice Department appealed the ruling on behalf of the U.S. Fish and Wildlife Service. Defenders of Wildlife, the Earth Justice Legal Defense Fund, the National Wildlife Federation, a Wyoming couple, and the American Farm Bureau Federation were also part of the litigation. At the end of the year no hearing date had been scheduled.

Media Interest

For the fourth consecutive year all forms of local, national, and international media followed the Yellowstone wolf story. Newspaper and radio pieces were too frequent to list individually. Notable projects were an IMAX film on wolves partially filmed in Yellowstone, and a National Geographic wolf documentary filmed entirely in Yellowstone.

Volunteer Program

Eighteen different volunteers worked a total of 17,760 hours in 1998, worth $186,480 at the GS-5 level (Appendix). This was the most time volunteers have yet spent working on the wolf project in any one year. Volunteer positions continued to be competitive with an acceptance rate of about one per six applicants. If accepted, the wolf project's volunteers earned subsidized or free housing and $200/month food stipend.

More positions are available during our winter field season. In some cases a minimum stay of three months 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.

Visiting Scholars Program

The visiting scholars program was established in 1995 with the intent of bringing a distinguished individual to Yellowstone each year to help with some aspect of the wolf program. The park provides housing and office space. Specific objectives and projects are worked out before arrival in Yellowstone. In return, the visiting scholars have helped in fieldwork and data analyses, and have presented their own work in seminars to Yellowstone employees.

This year marked the fourth year visiting scholars

assisted Yellowstone. John and Mary Theberge from the University of Waterloo in Ontario, Canada, stayed from October through December. John and Mary have been studying wolves in Canada since the 1960s. Their work has focused mostly on Algonquin Provincial Park wolves, but has also involved ecosystem studies in the arctic. John and Mary are personally responsible for establishing Kluane National Park in the Yukon Territory. John received his master's degree under Douglas Pimlott who, with Durward Allen, is one of the founding fathers of modern day wolf research. John and Mary's recent book, *Wolf Country,* published in 1998, referred to the Yellowstone wolf situation several times. Their visit focused on social aspects of wolves such as factors that affect pack size.

Interpretation and Education

The number of presentations on wolf recovery given both inside and outside the park by park interpreters, wolf project staff, and other Yellowstone Center for Resources staff remained high for the fourth consecutive year. The project leader, Douglas Smith gave 40 talks, up from 35 in 1997, to approximately 2,500 people. Project biologist Kerry Murphy gave 20 talks to approximately 600 people. Deb Guernsey, program assistant, gave 2 talks to about 80 people. Sue Consolo Murphy, resource interpreter, gave 10 wolf talks to approximately 300 people. The wolf project office fielded about 2,000 phone calls during 1998, up from 1,200 in 1997, and due partly to the hiring of Kerry Murphy. More information requests continued to be handled by other YCR, public affairs, and interpretive staff.

Douglas Smith

The Crystal Creek Pack lived in Pelican Valley for most of the winter. This area of Yellowstone experiences extremely harsh winters and all of the elk migrate to lower elevations. As a result, the Crystal wolves had learned how to kill bison, some of which do not migrate.

Acknowledgments

We were again amazed at the selfless offerings of help on behalf of Yellowstone wolves during 1998. Since the beginning this has been the case, and since the beginning the list has been so long we have not listed people individually, partly too because we are so fearful that someone will inadvertently be left out. Please accept our sincere heartfelt thank you to all of you who helped; you know who you are. If any of you are ever frustrated with the amount of attention that an offer to help or phone call of interest receives, remember that all good things take time and development.

We thank Sarah Broadbent, Sue Consolo Murphy, Mary Ann Franke, and Renee Evanoff who edited and produced this report. And, like the previous annual reports, it is much better because of their efforts. Some extra words about one of the aforementioned: all of us at the wolf project will mourn the departure of Sarah Broadbent, who is leaving Yellowstone and will be missed. She has been a great friend to the wolves and the wolf project from the beginning in a humble, behind-the-scenes, thankless way. She has contributed mightily, and we thank her. All of us hope that your new life where wolves don't roam will be as fulfilling, although nothing is like wolf country.

Finally, we deeply appreciate all the contributions from individuals, corporations, and foundations that donated through various funds to the Yellowstone wolf project.

Appendix

Yellowstone Wolf Project Volunteer Roster, 1998

Name	Period of Involvement	Hours
Brooks, Tracy	4/9/98–7/3/98	688
Bucki, Adam	4/25/98–7/12/98	632
Campbell, Craig	1/1/98–3/31/98 and 11/7/98–12/16/98	1,040
Cayou, Joe	1/4/98–3/31/98	696

Evans, Shaney	2/19/98–12/31/98	2,528
Fitzherbert, Emily	7/10/98–8/31/98	416
Honness, Kevin	1/1/98–7/3/98	1,472
Jacobs, Amy	1/1/98–2/28/98, 6/1/98–6/24/98, and 11/30/98–12/31/98	920
Lindsay, Scott	11/9/98–12/18/98	320
Lineweaver, Deb	4/1/98–8/10/98	1,056
MacNulty, Dan	8/22/98–9/6/98	128
McDonald, Jennifer	11/9/98–12/16/98	304
Pils, Andy	11/9/98–12/16/98	304
Schaefer, Carrie	1/1/98–1/31/98, 4/15/98–8/17/98, and 11/29/98–12/31/98	1,504
Stahler, Dan	1/1/98–7/25/98	1,648
Thurston, Linda	1/5/98–8/26/98	1,872
Wilson, Jason	4/1/98–8/10/98	1,056
Zieber, Tom	2/14/98–7/10/98	1,176
Total Volunteer Hours Worked		**17,760**

Publications

Phillips, M.K. and D. W. Smith. 1998. Gray wolves and private landowners in the Greater Yellowstone Area. Transactions of the 63rd North American Wildlife and Natural Resources Conference 63:443-450.

Nonprofit Support

Wolf restoration in Yellowstone continues to depend on the financial assistance of many individuals and organizations. Most or all of your contributions to the following organizations will provide direct funding to Yellowstone wolf restoration or help pay for needed professional services.

Nonprofit Government Affiliates Accepting Direct Donations for Yellowstone Wolves

- Yellowstone Park Foundation Wolf Fund
  The Yellowstone Park Foundation
  37 East Main Street, Suite 4
  Bozeman, Montana 59715
  406-586-6303

- National Park Foundation
  1101 17th Street NW, Suite 1102
  Washington, D.C. 20036
  202-785-4500

- National Fish and Wildlife Foundation
  1120 Connecticut Avenue NW, Suite 900
  Washington, D.C. 20036

Nonprofit Organizations Working on Behalf of Yellowstone's Wolves

- Defenders of Wildlife
  Northern Rockies Regional Office
  1534 Mansfield Avenue
  Missoula, Montana 59801
  406-549-0761

- International Wolf Center
  5930 Brooklyn Boulevard
  Minneapolis, Minnesota 55429
  218-365-4695

- The Wildlife Science Center
  5463 West Broadway
  Forest Lake, Minnesota 55025
  612-464-3993

- The Wolf Education and Research Center
  PO Box 917
  Boise, Idaho 83707
  208-343-2248

- The Wolf Recovery Foundation
  PO Box 44236
  Boise, Idaho 83711
  208-321-0755

- The WolfStock Foundation
  PO Box 17847
  Salt Lake City, Utah 84117
  801-272-2981