YELLOWSTONE WOLF PROJECT






ANNUAL REPORT
2003

Yellowstone Wolf Project

Annual Report
2003

Douglas W. Smith, Daniel R. Stahler, and Debra S. Guernsey
National Park Service
Yellowstone Center for Resources
Yellowstone National Park, Wyoming

YCR-NR-2004-04

Suggested citation: Smith, D.W., D.R. Stahler, and D.S. Guernsey. 2004. Yellowstone Wolf Project: Annual Report, 2003. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-NR-2004-04.

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

All photos not otherwise marked are NPS photos by Douglas Smith and Daniel R. Stahler.

Table of Contents

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, where possible, native species that have been eliminated as a result of human activity. Because of its large size and the abundant prey, the greater Yellowstone area (GYA) was identified in the recovery plan as one of three areas where the recovery of wolf populations had a good chance of succeeding.

The U.S. Fish and Wildlife Service (USFWS) has the primary responsibility for ensuring compliance with the Endangered Species Act and oversees the multi-state wolf recovery program. The USFWS has proposed that 30 breeding wolf pairs with an equitable and uniform distribution throughout the three Rocky Mountain recovery areas (greater Yellowstone, central Idaho, and northwest Montana) for three successive years would constitute a viable and recovered wolf population.

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

Three full-time employees worked for the Yellowstone Wolf Project in 2003: Project Leader Douglas Smith, Biological Science Technician Debra Guernsey, and Biological Science Technician Dan Stahler. Rick McIntyre worked as a seasonal employee on the Druid Peak Pack Road Management Project. Elena West also worked on the Road Management Project, through the Yellowstone Park Foundation (YPF). Matt Metz worked the summer months and in October and November, and Janice Stroud worked October and November as a biological technician through YPF. Other volunteers (*see Acknowledgments and Appendix*) staffed the early (Nov.–Dec.) and late (March) winter study periods.

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

To facilitate monitoring and research, all of the wolves brought from Canada were radio-collared before release, and YNP maintains radio collars 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.

2003 Summary

At the end of 2003, at least 174 wolves (13–14 packs, 2 groups of wolves of undefined status, and 2 loners) had some portion of their territory within Yellowstone National Park (YNP). Thirteen packs were considered "breeding pairs"—a pair with at least two pups-of-the-year that survive until December 31, according to the USFWS definition under the criteria for delisting the wolf as an endangered species in the Rocky Mountain recovery area. The goal of 30 breeding pairs with an equitable distribution throughout the three recovery areas for three successive years was achieved in 2002. With the biological criteria met, the states of Idaho, Montana, and Wyoming must complete approved management plans to ensure adequate wolf populations in the future. When state plans are approved, the USFWS will delist wolves in this area. As of this writing, Idaho's and Montana's plans have been approved.

The discrepancy in total packs pertains to uncertainty about the Buffalo Fork pack. The only radio-collared individual in this pack died in May, after the pack had denned. Since there were no radio-collared wolves to track for the rest of the year, the status of this pack is unknown, but we believe it exists. Seven packs and one group reside in the northern portion of the park, and seven packs and one group live in the park interior. Pack sizes ranged from 2 (#302M group) to 20 (Swan Lake pack) and averaged 10.8. The increase in the population from 2002 to 2003 was mostly due to increases in pack sizes and not to the establishment of new packs. One new pack formed in 2003, but one also dissolved. At least 75 pups were born, and 59 (79%) survived to year end. Average litter size was five. Sixteen wolves were known to have died in YNP, one possibly to disease. Mange, although recorded in wolves around the park, has not been documented inside YNP.

We had our best radio-collaring year so far, with 38 wolves captured and handled. Capture efforts began in November 2003, the earliest start date yet, which was the primary reason that greater success was achieved. At year end, all but one pack in the park was collared, and 53 (30%) of 174 YNP wolves wore radio collars.

Both our early and late winter studies took place again, and a paper in the *Journal of Wildlife Management* summarized the results of the first five years of this work. In winter, wolf predation was still focused primarily on elk. The species composition of prey was 83% elk, 6% bison, 2% moose, 1% deer, and other prey (none of which exceed 1% of the diet) comprising the rest. The sex and age of wolf-killed elk was 29% cows, 27% calves, 26% bulls, with the rest (17%) elk of unknown sex and age. Wolves selected elk calves in early winter and bull elk in late winter. In summer, the importance of elk as prey decreased, and mule deer became part of the wolf diet.

Many other Wolf Project activities continued in 2003. Twelve wolf dens were visited, and 530 scats were collected from these sites and from rendezvous sites to assess summer food habits. Our study in Pelican Valley marked its fifth year, focusing on Mollie's pack as well as their interactions with grizzly bears and bison in this isolated and unique system in the middle of YNP. Collaborative efforts with other researchers and managers continued, and our multi-carnivore work was published with colleagues in an issue of the *Wildlife Society Bulletin*.

Management activities increased in 2003. Project personnel spent time planning for how to deal with habituated wolves. Park management approved a plan, *Management of Habituated Wolves in Yellowstone National Park*, should any wolves pose a threat to human safety, although none have so far. However, several wolves have shown fearless behavior near people. Again in 2003, some areas around dens were closed to public entry, and two people (plus several volunteers) were hired to manage wolf viewing in Lamar Valley.

New projects in 2003 included efforts to begin understanding summer predation. New satellite radio-collar technology may help us address this difficult-to-study and poorly understood aspect of wolf ecology. We also expanded our winter observation studies of scavengers at wolf kills to summer, and found out that summertime is a different story.

We continued to have a large and vibrant volunteer program; winter study is basically accomplished through volunteer labor. Through grants to the Wolf Project, we were also able to hire more people to work during the summer. The volunteer program has been essential, increasing the amount of work accomplished and reducing the backlog of projects to be done. Wolf Project staff published eight peer-reviewed journal articles or book chapters in 2003, and the larger staff certainly contributed to this high productivity.

The ongoing drought, now in its sixth year, continued in 2003. Lower than average snowfall during winter and lack of precipitation in summer are contributing to worsening drought conditions. This influence will be important in interpreting ecological data in the future, due to the now near catastrophic significance of a lack of moisture.

(using 95% of wolf locations)

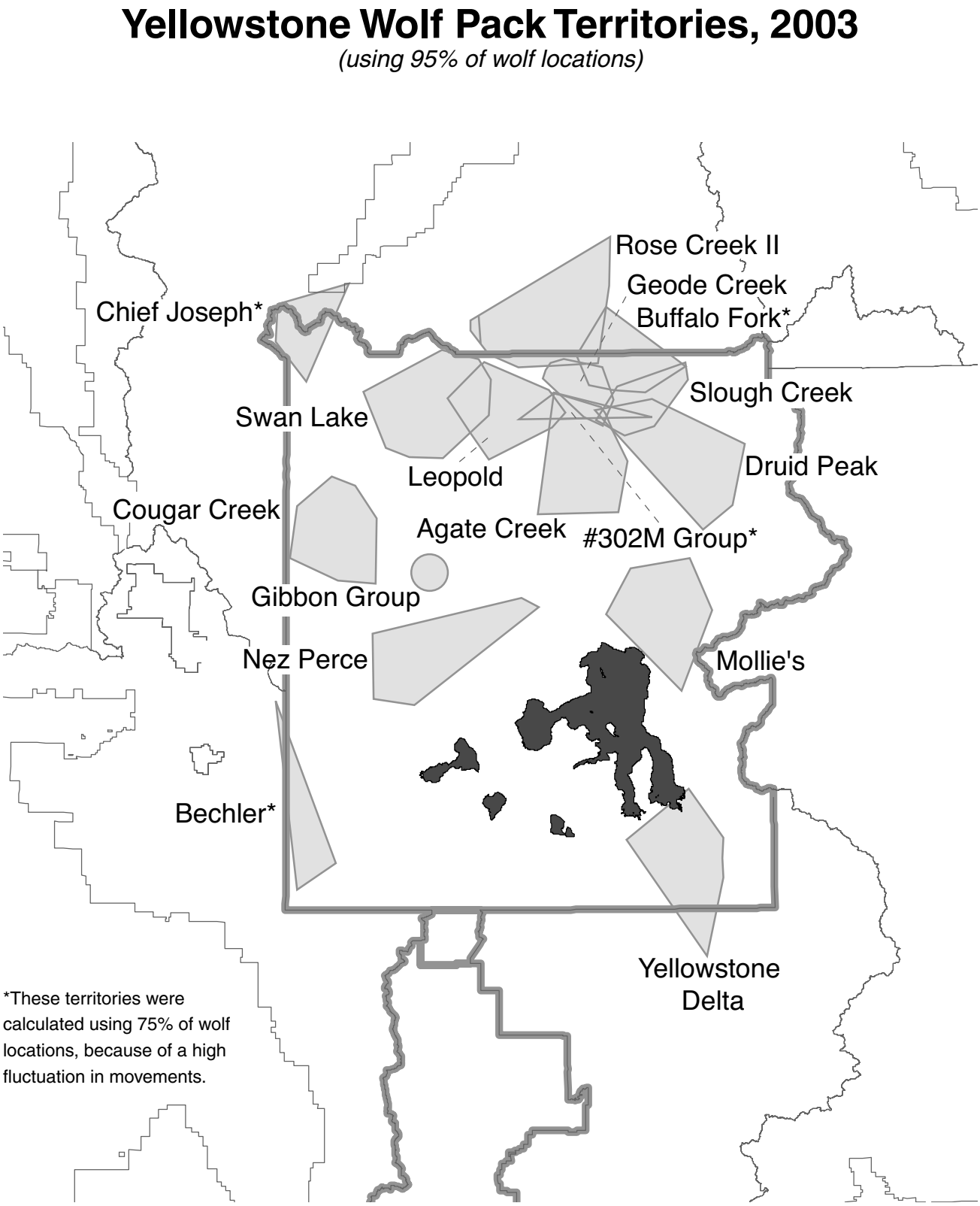


Figure 1. Wolf packs that had some portion of their territory within Yellowstone National Park in 2003.

NPS/JIM PEACO

The high visibility of park wolves continued in 2003, and helped to answer many questions about wolf behavior and ecology.

The Yellowstone Wolf Population

Population and Territory Status

At the end of December 2003, at least 174 wolves (13–14 packs, 2 groups, 2 loners) had some portion of their territory within Yellowstone National Park (Fig. 1, Table 1). This represents a population increase of about 17% from 2002, when there were 148 wolves in 14 packs. Of the 2003 packs, 13 count toward the breeding pair objective for the Yellowstone recovery area.

The Buffalo Fork pack, which numbered at least four wolves and denned in spring 2003, was present in May, but later lost its only radio-collared wolf (#105F). Its status was unknown at year end. Tracks were observed during fieldwork in the area where they resided, but it could not be determined if they were from the Buffalo Fork pack or the nearby Rose Creek pack.

Seven packs and one group (98 wolves) resided on the northern range, and seven packs and one group (74 wolves) lived throughout the rest of the park (Fig. 2). Pack sizes ranged from 2 (#302M group) to 20 (Swan Lake pack) and averaged 10.8. Pack size was not different between the northern range and the rest of the park.

One new pack formed and one was lost in 2003. The Gibbon group formed late in 2003, probably from wolves dispersing out of the Nez Perce and Cougar Creek packs, and was not considered a breeding pair. The Tower pack was lost when male #208 died of natural causes (exact cause is unknown). The pack had numbered only two wolves, and the fate of his uncollared mate is unknown.

Pack/Group*	Pup Count Nov–Dec	Adults/ Yearlings	Total Pack Size
#302M/#251F Group[1]	0	2	2
Agate Creek	4?	6	10
Bechler	4	4	8
Buffalo Fork[2]	?	3?	3?
Chief Joseph	5?	7?	12?
Cougar Creek	4?	6	10
Druid Peak	9	8	17
Geode Creek	2	5	7
Gibbon Group[3]	–	5	5
Leopold	8	11	19
Mollie's	2	5	7
Nez Perce	2	13	15
Rose Creek II	3?	2?	5?
Slough Creek	6	9	15
Swan Lake	6	14	20
Yellowstone Delta	4	13	17
Loners[4]	–	2	2
Totals	**59**	**115**	**174**

*Underline denotes breeding pair; italicized denotes Northern Range (NR) pack. Sheep Mtn. (8 wolves), which resides outside YNP but in NR, is not included.
[1]Breeding female died June '03.
[2]Breeding female died June '03, was lactating; no collars, no pups seen.
[3]Two Cougar Creek pack wolves + three uncollared wolves.
[4]Possible dispersers #213F from Nez Perce and #257M from Cougar Creek.

Table 1. Yellowstone National Park wolf population, December 2003.

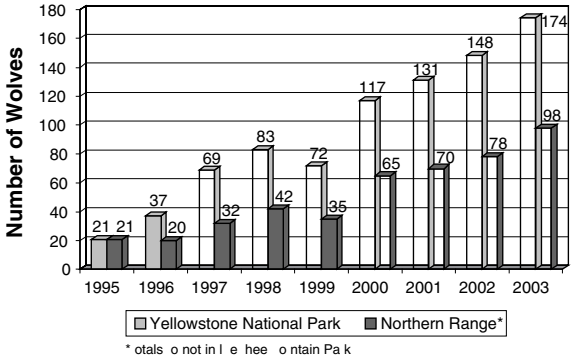


Figure 2. Yellowstone National Park early winter wolf population, 1995–2003.

With only one new pack, wolf distribution and movements were largely the same in 2003 as 2002. Most packs on the northern range showed typical movements: low elevation in winter and during denning, and high elevation for foraging in summer. Summer wolf territories were slightly larger than winter wolf territories, but this difference was not significant (Fig. 3). Average territory size for all packs residing in YNP was 223 km^2. Over time, territory size has been gradually declining.

Wolf packs that did not live on the northern range, except for the Cougar Creek pack, had extraterritorial forays outside the park in search of prey. The Nez Perce pack, for example, visited the National Elk Refuge in January, and the Yellowstone Delta pack spent significant periods of time in the Teton Wilderness. Mollie's pack moved for short periods of time into the North Fork of the Shoshone River. The Bechler pack used the Targhee National Forest and the Bechler area through the winter. They were probably able to use this deep snow area of the park because it was a mild winter. We do not expect this pattern of use to continue if more normal winters for that area return.

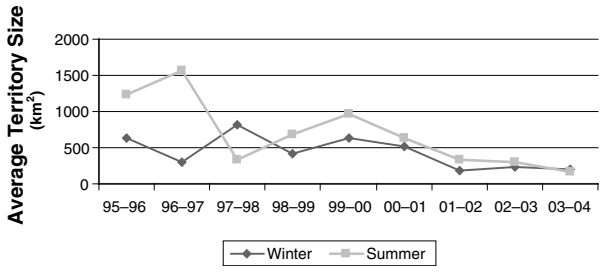


Figure 3. Winter and summer territory size averages on Yellowstone National Park's northern range. (Averages do not include the northern range outside Yellowstone National Park.)

Reproduction

At least 75 pups were born and 59 survived in 2003 (Fig. 4). At least 15 and possibly 16 total litters were born; the Druid Peak pack had at least two and possibly three litters of pups. Average number of pups born per pack was 5 and ranged from 2 to 13 (at least 2 litters). Survival varied by pack. The Geode Creek pack had eight pups but only two survived, while the Leopold pack also had eight and all of them survived. Other packs with good pup survival were Druid Peak, Slough Creek, Swan Lake, and Yellowstone Delta. Packs with poor survival were #302's group (no pups at the end of 2003) and Agate Creek. The remaining packs either had moderate pup survival or it was unknown.

Twelve wolf dens were visited in summer to measure den characteristics and collect scats for summer food habit studies. Not counting packs denning for the first time, 7 (64%) of 11 packs reused old den sites.

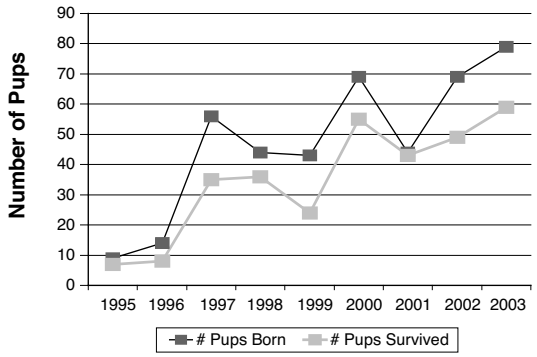
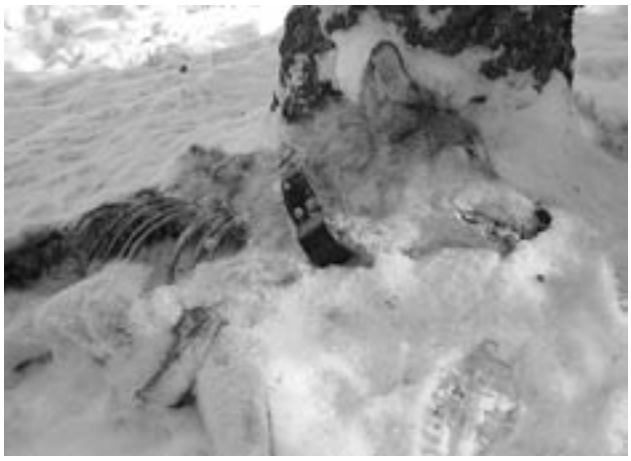


Figure 4. Yellowstone National Park pups born and survived, 1995–2003.



Female #217 was killed by other wolves in winter 2003–04, likely by her packmates.

Mortalities

Sixteen wolves were known to have died in YNP during year 2003 (Fig. 5, Table 2). This figure does not include pups that died within the first four months of life. Seven females, 7 males, and 2 of unknown sex died (1 pup was partially decayed and not possible to sex); 11 adults, 2 yearlings, and 3 pups. All the wolves that died within YNP died due to natural causes.

One of the prey-caused deaths was observed in Pelican Valley in March. A battle with a bull bison killed one of the Mollie's pack wolves, and injured two others. The bison kicked one wolf, throwing it 10–15 m in the air, and hooked another with its horn, also launching the wolf airborne for several meters. The wolves eventually killed the bison, taking all of one day to do it.

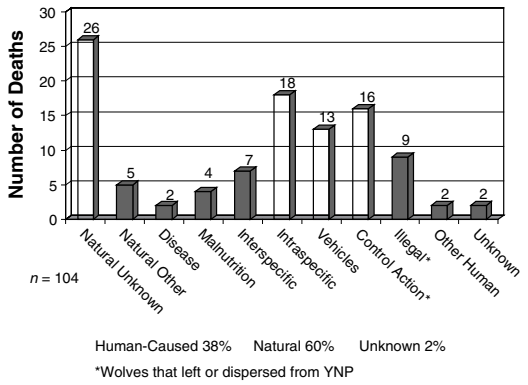


Figure 5. Yellowstone National Park causes of death for wolves, 1995–2003.

One wolf from the Agate Creek pack died from apparent disease. Although we were able to retrieve the carcass from the field the day after discovering the mortality, disease analysis on the carcass was inconclusive because of slight tissue decay. Disease experts at the Montana Fish, Wildlife and Parks lab in Bozeman, Montana, had excluded other causes of death, and other evidence from the necropsy suggested death due to unknown disease. Prior to the necropsy in Bozeman, a field trip of visiting veterinarians inspected the carcass externally, and also corroborated a disease cause of death, based on bleeding from the anus and mouth.

Mange (*Sarcoptes scabei*), an infestation of a mite that burrows under an animal's skin leading to hair loss, has been reported in wolves living around YNP. Wolves east and north of YNP have been documented to have mange, but it has not been documented in YNP wolves.

Dan Stahler necropsies a Swan Lake wolf that was killed by the Leopold pack.

# of Deaths	Wolf #/Sex	Age Class	Color	Pack	Date of Death	COD
1	105F	Adult	Black	Buffalo Fork	6/06/03	Intraspecific
2	175F	Adult	Gray	Mollie's	3/07/03	Interspecific
3	207M	Adult	Black	Rose Creek II	9/02/03	Natural unknown
4	208M	Adult	Black	Tower	4/12/03	Natural unknown
5	211M	Adult	Gray	Disperser from Leopold	1/21/03	Intraspecific
6	220F	Adult	Gray	Leopold	8/07/03	Interspecific
7	251F	Adult	Black	Agate, but possibly dispersed	6/17/03	Interspecific
8	259F	Adult	Black	Leopold	4/21/03	Natural unknown
9	260F	Adult	Black	Disperser/Rose Creek II	7/29/03	Natural unknown
10	294M	Adult	Gray	Geode Creek	4/28/03	Interspecific
11	296M	Adult	Gray	Agate Creek	3/08/03	Disease
12	309F	Yearling	Gray	Unk; found in Old Faithful area	2/04/03	Intraspecific
13	346?	Pup	Gray	Druid Peak	7/27/03	Natural unknown
14	347M	Yearling	Gray	Probably Swan Lake	11/15/03	Intraspecific
15	361M	Pup	Black	#302M Group	12/09/03	Intraspecific
16	363?	Pup	Gray	Swan Lake	12/06/03	Natural unknown

Table 2. Yellowstone National Park wolf mortalities, 2003.

Survival

A park-led effort to determine the annual survival rate of wolves in all three recovery areas of the northern Rocky Mountains is nearing completion. The average annual survival rate of a radio-collared wolf in the Yellowstone ecosystem is 80%. Pups had the lowest rate at 74%, followed by adults (>1 year old) at 80%, and yearlings at 83%. Annual survival for males and females for all age classes was 81% and 78%, respectively. Since reintroduction in 1995, annual wolf survival ranged from a low in 1997 of 62% to a high in 1999 of 90%.

Survival of wolves in the Idaho recovery area (79%) was approximately equal to the Yellowstone recovery area, whereas the northwest Montana recovery area had a significantly lower annual survival (56%).

Status of Original Reintroduced Wolves

Only two wolves from the original 31 reintroduced are still alive, both reintroduced in 1996. The last 1995 wolf to die was #2M on December 31, 2002. He was killed by wolves in the Geode Creek pack after he lost his dominant (alpha) status in the Leopold pack and was traveling alone or with a few other wolves between other wolf territories. He was eight years old when he died. Wolf #41F and #42F, both originally of the Druid Peak pack, are still alive. Number 41 dispersed from the park and lives in Sunlight Basin, Wyoming. Number 42 is alpha female of the famous Druid Peak pack and is observed by thousands of wolf watchers each year in Lamar Valley. Eight years of age and formerly black, she is now completely gray.

Pack Summaries

Chief Joseph Pack

For most of 2003, there were no radio-collared wolves in the Chief Joseph pack, but they were observed at their traditional den site in the park's northwest corner. In August, personnel from the U.S. Fish and Wildlife Service and the Montana Department of Fish, Wildlife and Parks trapped an adult female in Tom Miner Basin, establishing contact and making tracking possible.

Tracking this pack revealed patterns similar to historic territory use, showing that they spend large amounts of time outside YNP to the west, but also in Tom Miner Basin. They are counted as YNP wolves because they den in the park, but should be considered a border pack between the park and Montana. At the end of the year, we estimated their pack size to be 12 wolves, 5 of which were pups.

Swan Lake Pack

The Swan Lake pack increased in size from 16 wolves in 2002 to 20 in early winter 2003. One litter of pups was born with at least six pups surviving to year end. Three of these wolves were caught in November 2003 as part of capture efforts. One of the wolves captured was an exceptionally large male weighing 130 lbs. He is suspected to be the alpha male, but shortly after capture his collar failed to work at long distances. His collar is only audible when flying directly overhead, and then only faintly.

The largest pack in the park late in 2003, they are becoming one of the more stable packs, with little variation in their use of territory year-to-year. They range west of Lava Creek and north to Gardiner and Reese Creek, an area which includes Mammoth Hot Springs. In the winter, these wolves were tracked and seen around the Mammoth headquarters area. Each winter, several elk are also killed in this area. No incidents of wolf–human encounters have occurred, and none of the wolves have shown any signs of habituation.

Several reports during the summer of these wolves chasing horses, and in one case a llama, probably resulted from improper disposal of a dead horse in the park around July 4, which wolves, bears, and coyotes all fed on. No stock mortalities were reported. This pack has denned in the same area, near stock campsites, since 2000 with no reports of conflict, suggesting that the horse carcass may have caused the observed problems. No aversive conditioning was necessary, but the wolves and stock sites were more closely monitored the rest of the summer. In April, the Swan Lake pack killed a radio-collared cougar on Mt. Everts, which led to the death of the female cougar's two young kittens from starvation.

Leopold II Pack

One of the oldest packs in Yellowstone, the Leopold pack formed in 1996. Only the Yellowstone Delta pack is older. The Druid Peak and Chief Joseph packs formed later in 1996. Of 17 packs that have become established in Yellowstone since reintroduction in 1995, 14 of them are still in existence, showing tremendous population stability. In 2003, the Leopold pack became the Leopold

II pack; the II signifies that none of the pack's original wolves are left.

Early winter counts found 19 wolves, 8 pups, and 11 adults, making it one of the larger packs in Yellowstone. This pack and the Druid Peak pack use the same natal den virtually every year, but the Leopold pack has several other secondary dens, more than any other pack, that it rotates among each year.

Two wolves died in this pack during 2003 (#220F and #259F), both breeding females, and both from unknown natural causes. It was possible that one of them (#220) was killed by an elk, as a dead elk, fully consumed by wolves, was found near the wolf carcass. Number 220 died later in the summer and presumably all of her pups survived, as all of the surviving pups were gray, as was she. It was suspected that #220 was bred by a dispersing wolf from the Nez Perce pack (#214), who left after breeding with her. The other breeding female wolf, #259, who was black, presumably lost her entire litter of pups because six black pups were observed, but none survived to year end. Due to the breeding with a satellite male from another pack, the death of these two females, and the disappearance of the old alpha male, it is likely that the surviving pups have neither parent present. This scenario needs to be verified with genetic analyses.

This pack seems to specialize in killing bull elk, a large prey package, making frequent kills unnecessary. It is likely they do this because Blacktail Deer Plateau is a wintering area for a large number of bull elk.

Rose Creek II Pack

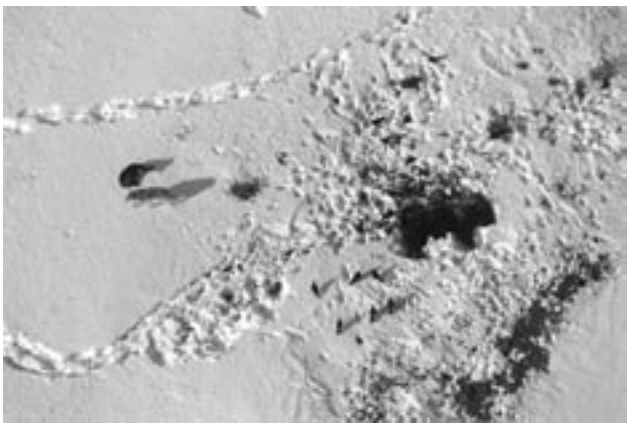
At year end, the existence of the Rose Creek II pack was in question. We estimated five wolves at the end of 2003, but neither radio-collared wolf could be located in wide searches in and beyond their territory. There were also no reports of this pack from any source. A border pack, their territory is within the park in the winter and in the Absaroka-Beartooth Wilderness of Gallatin National Forest in the summer. Two wolves (#207M and #260F) were found dead this spring and summer, both from unknown natural causes, and the longtime uncollared, yet easily distinguished alpha female (#18F) was no longer seen during aerial overflights. A litter of pups was documented, and three pups were observed mid-summer.

Druid Peak Pack

Arguably the most viewed wolf pack in the world, the Druid Peak pack numbered 17 wolves at year end. Firmly rooted in Lamar Valley, they have held a territory centered there since evicting the Crystal Creek/Mollie's pack in 1996. Many visitors specifically come to Yellowstone to see these wolves, especially #21 and #42, leaders of the pack since 1997 and 2000, respectively. These two are easily recognizable even to the casual observer, as their formerly black color has faded to blue-gray over time. At least two and possibly three litters of pups were born, as 13 were observed. Nine pups survived. It is likely (genetic tests are pending) that a dispersing wolf (#302) from the Leopold pack is the father to pups not belonging to the alpha female (#42), as he was seen breeding with both of the presumed Druid mothers west of the Druid Peak pack's territory (Little America Flats). These Druid females (three in total) left the pack during the breeding season, traveled west, paired with #302, and acted as though they would form a new pack. After breeding with #302, however, they returned to the Druid Peak pack to have their pups.

One female from this pack (#286) was fitted with a downloadable GPS (Global Positioning System) collar, one that tracks the wolf via satellites, allowing for more locations and information on nighttime movements. This detailed information will be used to answer questions about alternative tracking methods, movements, summer predation, and interactions with other carnivores. Unfortunately, the frequent tracking leads to battery limitations, making the collar unusable in 10 months. The collar then automatically detaches and is later picked up by Wolf Project staff.

Other significant news from 2003 was wolf #253's trip to Utah and his unexpected return to the pack. He was not expected to stay with Druid, as his long-distance dispersal seemed to signify a desire to disperse. He did stay, however, and is now beta male of the pack.



Although still rare, the incidence of wolves killing bison increased in 2003.

How to Win Mates and Avoid Wolves: Lessons from #302M

DANIEL R. STAHLER

Wolf #302M somehow survives and breeds by slipping between established pack territories.

From the moment the first individual wolves stepped freely onto Yellowstone's wild landscape, they've taught us valuable lessons on ecology, behavior, and politics. Some wolves more than others, however, have been particularly fascinating in this regard and, in a way, keystone to our increasing understanding of wolves as a species. These individuals have been unique, not because they exhibit superior canid qualities, but because we've been able to observe them regularly and see their life's story unfold.

In December of 1997, when a young dispersing male from the Rose Creek pack entered the Lamar Valley, home of the recently fractured Druid Peak pack absent a breeding male, Wolf Project researchers and one filmmaker observed a multi-hour event that showcased a series of behavioral interactions foundational to the population dynamics of wolves. Wolf #21M and members of the Druid Peak pack displayed a ritualized song and dance that ultimately resulted in #21M becoming the breeding male of the pack. Previously unobserved in the wild, this interaction revealed patterned social behavior seemingly essential to pair formation and reproductive success, and defined for researchers the rules of engagement for dispersing individuals. In 2003, the northern range of Yellowstone was home to over twice as many packs as in 1997, the result of budding and splitting of individuals and groups from established packs, many of which have repeated the same behavioral sequence that #21M and the Druid females performed in 1997.

Dispersing individuals in more recent years have faced challenges that wolves like #21M didn't face in their dispersal events, namely increased competition for territories and mates as influenced by significantly higher wolf densities. With these changing social conditions, individuals such as #302M have revealed other strategies of reproduction and dispersal, and how to survive in a wolf-rich landscape. For us, the story of #302M began during the breeding season of 2003, when several maturing Druid females were seemingly drawn away from their natal pack and engaged in temporary liaisons with a pair of brothers whose identity and origins were at first unknown.

On January 17, the uncollared but distinguishable Druid females U-black and Half-black were first seen engaged in a playful encounter with two uncollared black males who had boldly entered Lamar Valley. The territorial invasion did not go unnoticed by #21M, who despite many efforts to thwart the young suitors' persuasive advances on his daughters, was never successful in stopping courtship behavior. The intense chasing and physical attacks that #302M received from #21M and other Druid pack members over the next several days did not deter his hormone-driven commitment to winning mates, despite the obvious peril of such endeavors, as observed by his blood-stained hind quarter following one such attack.

At the time of these first encounters, #302M was an unknown male who had mysteriously appeared with another male. Even with the successful helicopter darting and radio collaring of this rogue duo in the heart of Druid territory on February 12, we knew little more about their origins. For the remainder of the 2003 breeding season, #302M and presumed brother #301M formed an ephemeral association with Druid females #255F, U-black, and Half-black, and was seen breeding with two of the three (#255F and U-black). Throughout this time, #302M continued to avoid what very well could have been fatal encounters with the other Druid pack members, despite his risky behavior of scavenging from their kills, shadowing their movements, and breeding with their females.

After the breeding season, #302M, #301M, and their Druid females, seemingly on track to form a new pack, disbanded after two consecutive days of aggressive interactions with both the Geode and Slough Creek packs, which resulted in #302M's group being run out of the area. The Druid females, two of which presumably were pregnant with #302M's offspring (#255F and U-black), returned to their pack, likely due to the security and cooperative social environment their natal Druid territory provided. Though #301M soon became a wolf of unknown fate, #302M revealed his true identity toward the end of March, when he was amicably received into the Leopold pack and remained with them throughout the summer of 2003, apparently opting for the safety that his natal territory offered. Circumstantial evidence strongly indicated that #302M and brother #301M were the black uncollared dispersing wolves that had accompanied their father, #2M, in his swan song journey away from his alpha role in the Leopold pack, which ended in his death on the last day of 2002, only weeks before #302M first appeared in the Lamar.

For the remainder of the summer and fall, #302M frequently traveled between his apparent natal Leopold pack on Blacktail Plateau and the Lamar Valley, where his suspected genetic investment scrambled around the rocks and sagebrush of the Druid den and rendezvous sites. Until genetic tests are completed, however, we can only speculate that some of the 13 Druid pups from 2003 are #302M's offspring. But as earlier in the year, #302M's attraction to the Lamar Valley was met with resistance by the Druid alpha pair and beta male #253M, and visitation rights were never permitted, though #302M on several occasions was observed interacting with the Druid pups in a friendly manner.

By early fall, #302M's independence and urge for his own pack drew him away from the Leopold pack, back towards the Lamar Valley, where he eventually bonded with an unknown adult female and two pups suspected to be remnants of #251F's group (an Agate Creek pack breeding female that died in summer 2003). This group lasted until mid-December, when the Agate Creek pack chased and killed at least one of the pups. But as usual, #302M managed to escape unharmed and continued his quest alone for a territory and a mate for the remainder of 2003.

Throughout the year, the road corridor of the northern range became an important part of #302M's adaptive strategy for traveling through a landscape full of risks. In the 25 miles of roadway that #302M continually traveled through, he would at any time be within one or more of five established wolf pack territories, yet somehow avoided the severity of confrontation incurred by other dispersing wolves. At times, his fondness for traveling the road corridor as a presumed avoidance strategy became blurred with apparent habituation to people and the road. We believe, however, that #302M's actions more accurately reflect wolves' behavioral flexibility in adapting to their habitat, which the road and its human occupants are clearly a part of in Yellowstone.

The social adeptness with which #302M maneuvered through these risks, displaying a combination of avoidance, persistence, and submission under attack, ultimately led to his success as a breeder. From a human perspective, #302M seems to have very good "people skills," combined with the knowledge of surviving in a habitat rich in wolves and humans. The current northern range of Yellowstone is a high stakes gamble for dispersing wolves, and individuals like #302M will continue to teach us new lessons. Only time will tell if #302M's role as a "bider" on the northern range will pay off. Not unlike the young #21M in 1997, perhaps some day #302M will assume the alpha position of a northern range pack. From decades of wolf research around the world, we have the making of a detailed mosaic of the wolf, but what Yellowstone adds is the fine grained sand to cement the tiles in place, the behavioral details that give depth and context to individuals like #302M.

Geode Creek Pack

Located centrally on the northern range with their territory between several wolf packs, a few of them large (Leopold and Slough Creek), this pack has had difficulty maintaining numbers and pups. They spend the winter amidst large concentrations of elk that draw in numerous cougars. In the summer, their territory is one of the few areas where black bears are routinely observed as well as having the typical northern range densities of grizzlies. They had poor pup survival in 2003, only two of eight pups were alive at year end.

In addition to pup mortality, the alpha male, #294, died while trying to kill an elk early in the denning season last April, and in October the presumed new alpha male, #300, fitted with a GPS collar, mysteriously disappeared after his collar was discovered intact with no sign of struggle. Events such as these support the speculation that competitive interactions with wolves and other carnivores may play a role in poor pup survival and small pack size. At year end, there was only one adult male in the pack, a yearling.

Three new wolves were collared in this pack in November, but one had dispersed by year end, and the other wolf's collar failed shortly after capture. Besides the alpha female #106, the other collared wolf in the pack was wolf #353, a small black female who routinely travels separately from the group, possibly indicating pre-dispersal movements.

Agate Creek Pack

Another relatively new pack that formed in 2002, the Agate Creek pack numbered 10 wolves at the end of the year. Two litters of four pups were born to females who denned several miles apart, but united by the end of the summer and became one unit. Only four pups from these two litters survived. Wolf #103, sister of #106 and alpha female of the Geode Creek pack, dispersed late in the year. Collar failure (after one year), prohibited tracking this wolf. The alpha male, #113, originally from the Chief Joseph pack, also has a collar that functions intermittently, making him hard to track, but at year end he was still with the pack.

This pack occupies the old territory, plus a few new areas, of the now defunct Tower pack. At least one nearly fatal interaction (#208 was badly wounded) with the Agate Creek pack may have contributed to the demise of the Tower pack. Mild winters, which allow for greater elk distribution, probably benefit Agate Creek wolves,

as their territory has substantial areas in higher elevations that have low elk densities during "normal" winters (Antelope Creek, Specimen Ridge). Despite this, Agate wolves often overlap with other pack territories (Druid, Slough Creek). Female #251 had dispersed by denning season and was seemingly on her way to starting a new pack, but died mid-summer of natural causes, leaving the fate of her litter of five pups and two uncollared adult companions unknown.

Slough Creek Pack

Another relatively new pack on the northern range that was the product of the splitting of the large Druid Peak pack, the Slough Creek pack carved out a territory between Druid Peak, Agate Creek, and Geode Creek packs. The south end of their territory is visited by these three other wolf packs. At year end there were 15 wolves, 6 of which were pups. The alpha male is originally from Mollie's pack in Pelican Valley, and the alpha female is from Druid Peak, although there is evidence that she may no longer hold that position.

Buffalo Fork Pack

The status of this pack is unknown. The only radio-collared wolf, female #105, died in May, likely due to an attack from wolves in the Rose Creek pack, as her carcass was well within their territory. Prior to her death, it was determined that the pack had denned, and tracks seen in October in the area of their den suggested that the pack might still be in existence. Without radio collars it will be extremely difficult to find this pack in the winter, capture them, and remedy the lack of marked individuals.

Of all the packs that den inside the park, this pack has the largest portion of their territory outside YNP, and spends most of their time in the Absaroka-Beartooth Wilderness.

Mollie's Pack

Located in central Yellowstone, Mollie's pack continued to prey on bison in late winter, and struggled to maintain numbers. Pack size mid-summer was 12, but by year end was 7, and only 2 pups survived out of 4 pups observed.

Male #194 was captured and re-collared in November after his old collar quit functioning. He was an extremely large specimen, weighing 130 pounds. He had been with the pack continuously since he was first captured with them in Pelican Valley in 2000 and was originally from the Rose Creek pack. His litter mate, #193, also born to the Rose Creek pack and presumably dispersing with him, has been the alpha male since 2000. Shortly after #194's capture he traveled to the northern range of YNP and was regularly observed traveling with two other wolves at year end, an uncollared female from the Druid Peak pack, and another gray wolf that is probably male. A male pup was also captured and collared with #194 in November.

Deb Guernsey with 130-pound wolf #194M, caught in Pelican Valley in November 2003.

This marked the fifth consecutive year that ground research took place in Pelican Valley. This year was unusual because we extended the study from two weeks of March to the entire month. Also, Bear Management Office personnel joined Wolf Project staff in the area to study several aspects of grizzly bear ecology and behavior.

The Pelican Valley study area.

Yellowstone Delta Pack

One of the larger packs in YNP at 17 wolves, this pack is still largely uncollared (only the alpha female #126 and a subordinate female #44 are collared, and #44's collar is barely audible). This pack splits its time between YNP and the Bridger-Teton Wilderness. Denning inside the park in the summer, the pack typically moves south in the winter in search of migrating elk. Four pups are known to have survived to year end, but not enough observations were made to know how many were born.

Nez Perce Pack

This pack decreased from 20 wolves to 15 in 2003. Only two pups were known to be in the pack in late winter, but there were probably more. Their den, hidden in lodgepole pine and rocks, makes it hard to observe during pup counts. In November, four wolves were captured in Hayden Valley during early winter capture efforts. One of these wolves was #48, the long-time alpha female whose collar had quit functioning, making this an important capture. A newly-captured wolf, adult female #340, later dispersed. Atypically for a disperser, she did not leave the pack's territory, but she also has not been observed with the main pack again. We are waiting to discover whether or not she has started a new pack within the territory of her natal pack.

Besides #340, several other wolves from this pack have dispersed: male #72 dispersed south into Wyoming; female #213 dispersed and is missing; male #214 dispersed to Pinedale, Wyoming; male #215 to Wyoming; and male #249 to the Madison Valley area of Montana.

Although they still traveled widely in 2003 and were missing at times, they did not make the extended extra-territorial forays that they have in years past (such as to Jackson Hole, Wyoming).

With many more bison in their territory than elk, bison at times can be a key food source for these wolves. This year was the first time scats were collected from their den, an area where very few elk are observed in the summer, so results from these scat samples will indicate whether or not bison is an important food source during the denning season. The bison office has reported carcasses in the area of their den that wolves had fed on, but it was unknown if wolves had killed the bison or merely scavenged it.

Cougar Creek Pack

Persisting in what we perceive to be a tough territory in which to live (the area north of the Madison River in YNP), the Cougar Creek pack continues to thrive. At 10 wolves, four of which were pups, their pack size was unchanged from 2002. Two wolves from this pack dispersed

Wolf #151, daughter of #7.

Wolf #7, mother of #151. Genetic studies should help reveal more mother/daughter pairs as well as other genetic ties between packs. This will, consequently, increase our understanding of kinship relationships between packs.

(#257M and #304M) and may have started another pack in the Norris Geyser Basin area. Reports of four uncollared wolves in this area last winter may also be members of this new pack, as a total of five wolves has been spotted, #257 and #304 included.

Female #151, originally of the Leopold pack, is the founding and only alpha female of this pack since its inception in 2000. It appears that she has had at least two different mates. She will be a high priority to collar in 2004. She was originally collared as a pup in 1999 in the Leopold pack.

Like the Mollie's and Nez Perce packs, this pack also occasionally kills bison in late winter. Scats were collected from their den this year for the first time. We suspect the use of beavers as a food item in the summer.

Bechler Pack

This last year saw a resurgence for Bechler wolves; four pups survived to year end, increasing the pack to eight wolves. Mild winters have probably also benefited this pack, as average winter snowfall could make Bechler a tough spot to spend the winter. Nonetheless, they have persisted, and not wandered far into the Targhee National Forest in search of prey, although some trips have occurred. Another pack with only one collar, they will be a high priority for capture in 2004.

Wolf Capture and Collaring

In 2003, the capture and collaring of wolves was split into two time periods. Twenty-one wolves were captured in January and February, and another 17 in November (Table 3). The November capture was the earliest in the winter that we have attempted capture operations, and it was very successful. Simply getting an early start helped considerably in reducing the strain of getting all the capture work done in just two months. Visitor impacts from low level helicopter flights were minimized because the interior of the park is closed at this time.

In total, 38 wolves were captured and handled in 2003: Leopold (6), Geode (6), Nez Perce (6), Swan Lake (6), Druid Peak (4), Cougar Creek (3), Agate Creek (2), Mollie's (2), Slough Creek (1), and loners (2). Fifteen females (40%) and 23 males (60%) were captured. The captured wolves included 12 (31%) pups, 12 (31%) yearlings, 13 (34%) adults, and 1 (4%) old adult. Weights ranged from 70 pounds (female pup in Leopold) to 130 pounds (two males, one from Swan Lake and the other from Mollie's). At the end of 2003, 53 (30%) of the 174 wolves that use YNP were radio collared.

Capture Date	Wolf #/ Sex	Age	Color	Pack
1/7/2003	286F	Yearling	Black	Druid Peak
	287M	Yearling	Black	Leopold
	288F	Yearling	Gray	Leopold
	289M	Yearling	Black	Leopold
	290F	Pup	Gray	Leopold
1/8/2003	206M	Adult	Gray	Swan Lake
	217F	Yearling	Gray	Slough Creek
	291M	Pup	Gray	Cougar Creek
	292M	Yearling	Gray	Swan Lake
	293F	Pup	Gray	Swan Lake
1/9/2003	294M	Adult	Gray	Geode Creek
	295M	Pup	Gray	Agate Creek
	296M	Adult	Gray	Agate Creek
2/12/2003	106F	Adult	Gray	Geode Creek
	300M	Adult	Black	Geode Creek
	301M	Yearling	Black	#255F's Group
	302M	Adult	Black	#255F's Group
	303M	Adult	Black	Cougar Creek
	304M	Adult	Black	Cougar Creek
2/13/2003	305M	Pup	Gray	Nez Perce
	306F	Pup	Gray	Nez Perce
11/13/2003	048F	Old Adult	Gray	Nez Perce
	194M	Adult	Black	Mollie's
	340F	Adult	Gray	Nez Perce
	341F	Yearling	Gray	Nez Perce
	342F	Pup	Gray	Nez Perce
	343M	Pup	Black	Mollie's
	344F	Yearling	Black	Leopold
	345F	Pup	Gray	Leopold
11/22/2003	348M	Pup	Gray	Druid Peak
	349M	Pup	Black	Druid Peak
	350M	Pup	Black	Druid Peak
11/23/2003	351M	Yearling/Adult	Gray	Geode Creek
	352M	Adult	Gray	Geode Creek
	353F	Adult	Black	Geode Creek
	354M	Adult	Gray	Swan Lake
	355F	Yearling	Gray	Swan Lake
	356M	Yearling	Gray	Swan Lake

Table 3. Yellowstone Wolf Project collaring operations, 2003 calendar year.

Gary Brennan, helicopter pilot, played a key role in making 2003 our record wolf capture year.

Roger Stradley, Supercub pilot, has assisted the Wolf Project since the early years.

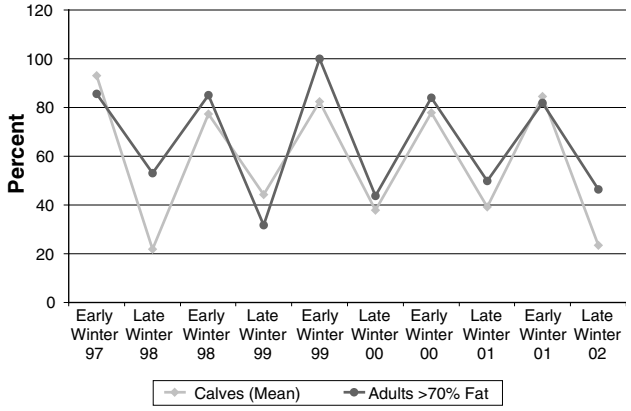


Figure 6. Percent bone marrow fat of wolf-killed ungulates, 1997–2002.

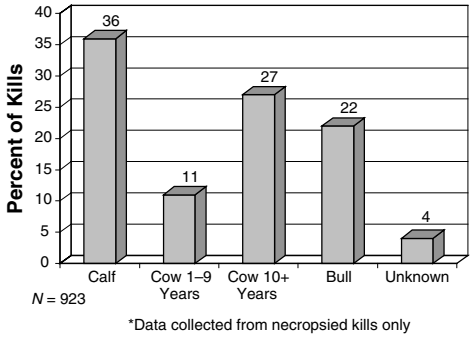


Figure 7. Yellowstone northern range wolf-killed elk by sex and age class, 1995–2003.

Wolf Predation

Wolf–Prey Relationships

Wolf–prey relationships were documented by observing wolf predation directly and by recording the characteristics of wolf prey at kill sites. Wolf packs were monitored during two winter-study sessions, 30-day periods in March and November–December during which wolves were intensively radio-tracked. The Leopold, Geode Creek, and Druid Peak packs were monitored by two person teams from the ground and from aircraft; the Swan Lake, Agate Creek, Rose Creek II, Slough Creek, Mollie's, Nez Perce, Cougar Creek, Bechler, Yellowstone Delta, Chief Joseph, and Sheep Mountain packs were monitored from aircraft only. YNP staff entered into a data base 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, Fig. 6), and characteristics of kill sites. In addition, similar data were collected opportunistically throughout the year during weekly monitoring flights and ground observations. The abundance and sex-age composition of elk within wolf pack territories were also estimated from the ground and from fixed-wing aircraft (Fig 7).

Composition of Wolf Kills

Project staff detected 99 definite, 239 probable, and 37 possible kills made by wolves in 2003, including 313 elk (83% of total), 22 bison, (6%), 7 moose (2%), 3 deer (1%), 1 cougar (<1%), 4 coyotes (1%), 4 wolves (1%), 1 porcupine (<1%), 1 sandhill crane (<1%), and 19 unknown prey (5%). The composition of elk kills was 27% calves (0–12 months), 21% cows (1–9 years old), 8% old cows (≥10 years old), 26% bulls, and 17% elk of unknown sex and/or age. Bison kills included 5 calves (unknown sex), 11 cows, 5 bulls, and 1 unknown sex and age. During winter, wolves residing on the northern range killed an average of 1.8 elk/wolf/30-day study period.

Winter Studies

During the 2003 March winter study (30 days), wolves were observed for 425 hours from the ground. The number of days wolf packs were located from the air ranged from none (Chief Joseph, Yellowstone Delta, and Bechler) to 11 (Leopold, Geode, and Druid Peak). Sixty-three definite or probable wolf kills were detected, including 57 elk, 4 bison, 1 mule deer, and 1 moose. Among elk, 10 (18%) were calves, 15 (26%) were cows, 25 (44%) were bulls, 3 (5%) were adults of unknown sex, and 4 (7%) were of unknown sex and age. During the 2003 November–December winter study (30 days), wolves were observed for 317 hours from the ground. The number of days wolf packs were located from the air ranged from 0 (Yellowstone Delta and Rose Creek) to 10 (Leopold, Druid Peak, Geode Creek, Slough Creek, Agate Creek, and #302M's group). Fifty-seven definite, probable, or possible wolf kills were detected during the November–December 2003 winter study, including 50 elk, 1 coyote, 1 moose, 1 mule deer, 2 wolves, and 2 unknown prey. Among elk, 22 (44%) of the kills were calves, 6 (12%) were cows, 4 (8%) were old cows (10+ years), 12 (24%) were bulls, 1 (2%) kill was an adult elk of unknown sex, and 5 (10%) kills were of unknown sex or age.

Summer Studies

Beginning in the summer of 2003, project staff began efforts to document summer predation patterns by wolves. Documenting the predatory habits of wolves in summer is problematic due to the lack of snow for tracking, increased nighttime activity of wolves, lack of pack cohesiveness, and smaller prey packages leading to quick consumption and loss of evidence. Traditionally, the best data concerning wolf summer food habits have come from the analysis of scat contents collected at den and rendezvous sites. In the summer of 2003, project staff collected a record of 530 wolf scats from the Bechler, Druid Peak, Leopold, Geode, Nez Perce, Cougar Creek, Swan Lake, and Slough Creek wolf packs at their den and rendezvous areas. When analyzed, these samples will give relative indexes of prey selection and consumption patterns during the summer.

In addition, the Wolf Project deployed four GPS (Global Positioning System) collars in January of 2003 to enhance our understanding of 1) seasonal predation patterns; 2) spatial and temporal interactions with other wolf packs and other carnivores; 3) movements with respect to dens during pup rearing season; and 4) territory size, use, and overlap. Some of these collars have the technology for GPS location data to be remotely downloaded from the collar on a regular basis while still on the animal. Using spatial and temporal location analysis, probable kill sites can be identified from clustered points, which can then be investigated to determine if a wolf kill is present, and what the species, age, and sex of the prey animal was. For example, through the use of summer field observations of wolf predation and downloadable GPS location data, we documented seven kills made by the Druid Peak pack for the month of June (two adult bull elk, two elk calves, and three elk of unknown sex or age). We believe our approach of combining GPS collar technology with ground efforts will yield significant advances in our understanding of summer predation, and will therefore continue in 2004 with improved GPS collar technology and field protocol.

Wolf Management

Area Closures

To prevent human disturbance of young pups, visitor entry was closed to areas surrounding the Druid Peak pack's den. This closure in the east end of Lamar Valley was about 4-mi^2 in size and was centered on the dens. A no-stopping zone was instituted along the road to Cooke City near the den of the Druid Peak pack to discourage visitors from parking their vehicles outside established pullouts and to keep them from stopping near wolves that were trying to cross the road near the den. The area around the Daly Creek trail in the northwest portion of the park was closed temporarily to off-trail hiking to protect the denning area of the Chief Joseph pack. Den sites for the Leopold and Mollie's packs were protected from disturbance incidental to closures for the Blacktail (March 15 to June 30) and Pelican Valley (April 1 to

Photos right: *Wolf #21, alpha male of the Druid Peak pack, investigates a coyote den in Lamar Valley, despite attempts from the resident coyotes to dissuade him. In this case, no coyotes were injured, but in at least three other cases like this, coyote pups were killed. Wolves have dug into coyote dens numerous times without killing any coyotes. Photos courtesy Dale and Elva Paulson.*


1


6


2


7


3


8


4


9


5


10

July 3) Bear Management Areas. Because of historically low visitor use, the areas around the den sites of the Rose Creek II, Buffalo Fork, Slough Creek, Geode, Agate, Nez Perce, Yellowstone Delta, Bechler, Swan Lake, and Cougar Creek packs were not closed.

Druid Road Management Project

Since wolf reintroduction, the Lamar Valley has become the premier location worldwide to observe free-ranging wolves. The main pack of interest is the Druid Peak pack, which has denned in the valley since 1997. In 2000, the Yellowstone Center for Resources (YCR), Resource Management and Visitor Protection, and Division of Interpretation cooperated to better deal with the opportunities and problems that accompany increasing visitor numbers. As a result, we initiated the Druid Road Management Project with the following objectives: 1) *Human Safety,* protect visitors that are viewing wolves alongside the road, and control both traffic along the road and parking to prevent an accident; 2) *Wolf Safety*, protect wolves from vehicle strikes, permit wolves to cross the roadway without harassment from visitors, and protect the closed area around the den from visitor intrusion; 3) *Visitor Enjoyment*, through protection of natural wolf behavior, preserve visitor opportunities to view wolves and interpret wolf and other wildlife ecology to visitors; and 4) *Wolf Monitoring and Research,* continue to monitor and study the denning behavior, predation, activity, and interactions of wolves with other wildlife.

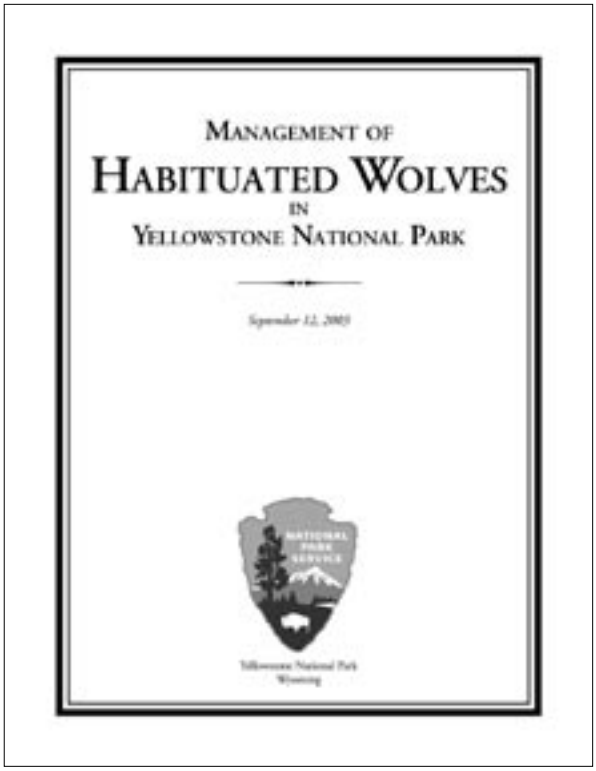
This was the fourth year that private funds were used to manage wolf viewing in Lamar Valley. Two employees (Rick McIntyre and Elena West) were hired through the Yellowstone Park Foundation, facilitated by a grant through the Twin Spruce Foundation. Three other volunteers (Ray Rathmell, John Good, and Bill Wengeler) assisted. The project began on May 6 and ended September 6, 2003. There were no accidents involving visitors, vehicles, or wolves during the 124 days of the Druid Road Management Project's fourth season. This season, wolves successfully crossed the road on 78% of their first attempts. Due to the wolves spending less time at the rendezvous site in July and August, fewer visitors saw wolves this season (9,827) than last year (12,414), and we estimate that wolves were in sight for 415 hours. We contacted 11,439 visitors this summer, about the same as 2002. In addition, we had no cases of wolf habituation during this field season.

Wolf Habituation Management

An issue of special concern is the habituation of wolves to the road, vehicles, and people. In particular, the Druid Peak pack wolves are exposed to a great deal of human contact and impact on a nearly daily basis. That exposure has led to some wolves having a casual attitude towards humans for a period of time. In the 2003 season, however, we had no identified cases of habituation occurring or unnatural behavioral response to humans from the Druid wolves. None of the current members of the Druid pack seem to be unnaturally comfortable with the road corridor. Leopold wolf #302M would often walk down the road on his periodic visits to Lamar, but would jump off the road and circle around vehicles that passed by his location. As far as we know, #302M never deliberately approached a car or a person. His pattern of using the road as a convenient travel corridor may be a strategy to avoid confrontation with other wolf packs as he travels between his natal Leopold pack territory on the Blacktail Plateau and the Lamar Valley. Due to observations of #302M breeding with Druid females in mid-winter 2003, we believe he has a genetic investment in some of this year's Druid litters, thus his frequent visits to the Lamar area. As a result, #302M's movements and behavior will be monitored by Wolf Project personnel. The Wolf Project's completion of *Management of Habituated Wolves in Yellowstone National Park* now provides a guiding document to address and prevent the habituation of park wolves. The main objectives of this plan are to:

NPS/JIM PEACO

Wolf–human interactions are closely monitored. Ultimately, it is up to humans to keep their distance from wolves.



Wolf Project staff completed a management plan for habituated wolves in 2003, as several wolves have shown fearless behavior near people.

1) maintain a wild population of wolves in YNP; 2) stop the development of habituated wolves in YNP; 3) reduce wolf–human contact; 4) prevent human injury due to an habituated wolf; 5) educate the public about wolf viewing to prevent them from habituating wolves; and 6) gather more information on habituated wolves to help manage future situations that may develop.

Wolf Depredation Outside Yellowstone

Wolves killed 42 cattle, 85 sheep, and 10 goats in the GYA during 2003. Thirty-five wolves were killed during control actions by USFWS and USDA Wildlife Services in response to livestock losses. (For further information, see the USFWS *Rocky Mountain Wolf Recovery 2003 Annual Report*.)

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 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: Adult cow elk (*Cervus elaphus*) seasonal distribution and mortality post-wolf (*Canis lupus*) reintroduction in Yellowstone National Park, Wyoming.
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 and movements of elk will be examined to evaluate the behavioral effects of wolves on elk and establish baseline data for future analyses. Individual elk radio-locations will be paired with wolf radio-locations to establish the proximity of elk to wolves. Comparisons of individual differences in cow elk distribution will be investigated with respect to several variables, including age, presence of calf, pregnancy status, nutritional condition, group size, spatial and temporal factors, and wolf density. In addition, a survival analysis will provide information on relative factors influencing mortality of cow elk in Yellowstone's northern range herd.
Project Activity in 2003: Completed fieldwork and started data analysis and writing.
Anticipated Completion Date: May 2004

Graduate Student: Julie Mao (Master of Science candidate)
Committee Chair: Dr. Mark S. Boyce, University of Alberta
Title: Habitat selection by elk before and after wolf reintroduction in Yellowstone National Park, Wyoming.
Project Narrative: Habitat associations of radio collared cow elk locations were compared between the periods of 1985–1990 (before wolf reintroduction) and 2000–2002 (after wolf reintroduction) to examine whether large scale changes in elk distribution and habitat selection occurred following the 1995 restoration of wolves into Yellowstone. In summer, elk now select areas of higher elevation, steeper slopes, and more burned forest. These shifts in habitat selection may be a combination of responses to predation risk by wolves and long-term vegetation succession following the 1988 fires. In winter, elk select more open

habitats now compared to pre-wolf times, a response that could aid in vigilance and group formation as anti-predator strategies.
Project Activity in 2003: Julie completed analysis and successfully defended her thesis.
Completion Date: August 2003

Graduate Student: Daniel MacNulty (Ph.D. Candidate)
Committee Chair: Dr. Craig Packer, University of Minnesota
Title: A behavioral analysis of the effect of predator and prey densities on wolf predation.
Project Narrative: The mathematical expression for a predator's "kill rate" (i.e., kills per predator per time) is fundamental to analyses of predator-prey dynamics. Predictions of dynamics vary widely according to how kill rate models assume that kill rate changes with predator and prey densities. Little is known, however, about the behavioral processes generating the relationship between kill rate and predator–prey densities, especially in natural environments. This is an important knowledge gap, because it hinders progress in predator–prey theory and confounds predictions of predator–prey dynamics. This study will examine the behavioral mechanisms that cause wolf kill rate to vary with elk, bison, and wolf densities in Yellowstone National Park. The analyses will be based on direct observations of wolves and ungulates recorded during eight intensive 30-day study periods from 1995 to 2003. Individual-level analyses of wolf kill rate and its behavioral parameters (i.e., attack rate, handling time, search time) will be completed with general linear and non-linear mixed models to account for correlation among repeated measurements of individual wolves. The results are expected to clarify the basic biology underlying models of wolf kill rate, and thereby strengthen attempts to anticipate the effects of wolf predation on ungulate populations.
Project Activity in 2003: Completed field work, initiated data entry and analysis.
Anticipated Completion Date: December 2004

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

Topic	***Collaborator***	***Institution***
Wolf–cougar interactions	Toni Ruth, Howard Quigley	Wildlife Conservation Society
Wolf–coyote interactions	Robert Crabtree, Jennifer Sheldon	Yellowstone Ecological Research Center
Wolf–bear interactions	Charles Schwartz, Mark Haroldson	Interagency Grizzly Bear Study Team
Wolf–scavenger relationships	Chris Wilmers, Wayne Getz; Bob Crabtree	University of California at Berkeley; Yellowstone Ecological Research Center
Wolf–elk relationships in the Firehole Watershed	Bob Garrott, Eric Bergman	Montana State University
Wolf–elk calf mortality	L. David Mech, Shannon Barber	University of Minnesota
Wolf–pronghorn	John Byers	University of Idaho
Wolf–willow	Francis Singer	USGS
Wolf–aspen	William Ripple	Oregon State University
Wolf–trophic cascades	L. David Mech; Mark Boyce, Nathan Varley; Rolf Peterson	USGS; University of Alberta; Michigan Technological University
Wolf predation	Tom Drummer	Michigan Technological University
Wolf survival	Dennis Murray	University of Idaho; Trent University

Rolf Peterson, of Michigan Technological University, has participated in the Visiting Scholars program several times. Here he examines a bull elk kill by the Druid Peak pack.

Not all wolf work is glamorous. Here, Katie Yale, Matt Metz, and Janice Stroud clean elk mandibles. Some bones from wolf kills are collected and cleaned for study, providing clues as to why wolves killed a particular prey animal.

Matt Metz digs in for another metatarsus.

Public Involvement

Volunteer Program

Nineteen volunteers worked a total of 7,384 hours in 2003, worth $94,441 at the GS-5 level (*see Appendix*), which was equal to approximately 3.5 full time GS-5 employees. Volunteer positions continued to be highly competitive with three to four applicants applying for each position. Chosen volunteers received free housing and a $200/month food stipend.

Most 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 resume to the Yellowstone Wolf Project, P.O. Box 168, Yellowstone National Park, Wyoming 82190.

Visiting Scholars Program

Two distinguished scholars visited the Yellowstone Wolf Project in 2003: Drs. Dennis Murray from Trent University in Peterborough, Ontario, and Francisco Fonseca from The University of Lisbon in Lisbon, Portugal. Dr. Murray visited in February to discuss wolf survival. He is collaborating on a Yellowstone Wolf Project-led effort to analyze wolf survival rates over the last 20 years for the 500 radio-collared wolves monitored in the northern Rocky Mountain Wolf Recovery Area. Dr. Fonseca came and participated in our November–December winter study, which he participated in every day of the study, despite not having warm winter boots! We appreciate what we learned from these two scholars/scientists, and appreciate the time they took to visit Yellowstone in the winter. Our work will be better for it in the future.

Acknowledgments

The work of the Wolf Project in Yellowstone is a collaborative effort. We are graced by the interest and resources of many disparate groups. First and foremost, the basic support of the National Park Service and the Yellowstone Park Foundation keep us going year-to year. Our volunteers and temporary staff are the next most important aspect of our project. Part of this group, the winter study volunteers, continue to make us marvel at their hard work and dedication. The winter study is a cornerstone of the Yellowstone Wolf Project, therefore the volunteers are, too. We thank all of them, and Rick McIntyre, Matt Metz, Janice Stroud, and Elena West, all of whom worked with us as temporary staff. We also thank John Good, Ray Rathmell, and Bill Wengler for helping with the Druid Road Management Project.

We appreciate those individuals who continued to invest in the collar sponsorship program, and to all other individuals, corporations, and foundations who donated

funds to keep our work going. Approximately 40% of the project is supported by private donations. We also thank our editor, Tami Blackford. The printing of this report was made possible by the Yellowstone Park Foundation.

Appendix

Yellowstone Volunteer Wolf Project Roster, 2003

Name	Period of Involvement	Hours Worked
Almberg, Emily	11/10/2003–12/15/2003	288
Brown, Paul	11/10/2003–12/15/2003	288
Eaton, Mitch	03/02/2003–03/14/2003	104
Evans, Shaney	05/01/2003–12/31/2003	720
Geremia, Chris	02/28/2003–04/01/2003 & 11/10/2003–12/15/2003	544
Hudson, Tim	02/28/2003–04/01/2003 & 11/10/2003–12/15/2003	544
MacNulty, Daniel	03/02/2003–03/31/2003	240
Metz, Matt	01/04/2003–04/01/2003 & 11/10/2003–12/15/2003	1,112
Miller, Guy	11/10/2003–12/15/2003	288
Paul, Kylie	02/28/2003–04/01/2003	256
Schlickeisen, Derek	07/28/2003–08/22/2003	120
Sterling, Heather	02/28/2003–04/01/2003	256
Sterling, John	02/28/2003–04/01/2003	256
Stroud, Janice	01/07/2003–05/16/2003 & 11/10/2003–12/15/2003	1,112
Turner, Lisa	11/10/2003–12/15/2003	288
Weigert, Grant	11/10/2003–12/15/2003	288
Wunderlin, Aaron	02/28/2003–04/01/2003	256
Yale, Katie	01/07/2003–04/01/2003	336
York, Judy	02/28/2003–03/10/2003	88
Total		**7,384***

**Equivalent to 3.5 GS-05 employees.*

Publications in 2003

Ballard, W.B., L.N. Carbyn, and D.W. Smith. 2003. Wolf interactions with non-prey. In: *Wolves: behavior, ecology, and conservation* (Ed. by Mech, L.D. & Boitani, L.), pp. 259–271. Chicago: University of Chicago Press.

Carroll, C., M.K. Phillips, N.H. Schumaker, and D.W. Smith. 2003. Impacts of landscape change on wolf restoration success: planning a reintroduction program based on static and dynamic spatial models. *Conservation Biology,* 17(2): 536–548.

Eberhardt, L.L., R.A. Garrott, D.W. Smith, P.J. White, and R.O. Peterson. 2003. Assessing the impact of wolves on ungulate prey. *Ecological Applications*, 13(3): 776–783.

Ruth, T.K., D.W. Smith, M.A. Haroldson, P.C. Buotte, C. Schwartz, H. Quigley, S. Cherry, K.M. Murphy, D.B. Tyers, and K. Frey. 2003. Large-carnivore response to recreational big-game hunting along the Yellowstone National Park and Absaroka-Beartooth Wilderness boundary. *Wildlife Society Bulletin*, 31, 1150–1161.

Service, U.S.F.W., Tribe, N.P., Service, N.P. & Services, U.W. 2003. Rocky Mountain Wolf Recovery 2002 Annual Report. *USFWS, Ecological Services,* 64.

Smith, D.W., R.O. Peterson, and D. Houston. 2003. Yellowstone after wolves. *BioScience*, 53(4), 330–340.

Smith, D.W., D.R. Stahler, D.S. Guernsey. 2003. Yellowstone Wolf Project: Annual Report 2002. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-NR-2003, 1–14.

Smith, D.W., and D.R. Stahler. 2003. Management of habituated wolves in Yellowstone National Park. Yellowstone National Park: Yellowstone Center for Resources, National Park Service.

Stahler, D.R., D.W. Smith, R. McIntyre, E. West, B. Phillips, B. Chan, M. Ross, J. Knuth Folts, D. Chalfant, and B. Suderman. 2003. Managing wolves and humans in Lamar Valley: A final report on the Druid road project 2003. YNP Report. 9 pp.

Wilmers, C.C., D.R. Stahler, R.L. Crabtree, D.W. Smith, and W.M. Getz. 2003. Resource dispersion and consumer dominance: scavenging at wolf- and hunter-killed carcasses in Greater Yellowstone, USA. *Ecology Letters*, 6, 996–1003.

Wilmers, C.C., R.L. Crabtree, D.W. Smith, K.M. Murphy, and W.M. Getz. 2003. Trophic facilitation by introduced top predators: gray wolf subsidies to scavengers in Yellowstone National Park. *Journal of Animal Ecology* 72: 909–916.

Wright, G.J. 2003. An analysis of the northern Yellowstone elk herd: population reconstruction and selection of elk by wolves and hunters. M.S. thesis, Michigan Technological University, 124 pp.