Yellowstone Center for Resources
Yellowstone National Park
Mammoth Hot Springs, Wyoming

National Park Service
U.S. Department of the Interior

YELLOWSTONE NATIONAL PARK

WOLF PROJECT ANNUAL REPORT

2013

Deep in remote Yellowstone: a Delta pack wolf.

Authors: Douglas Smith, Daniel Stahler, Erin Stahler, Matthew Metz, Kira Quimby, Rick McIntyre, Caitlin Ruhl, Molly McDevitt

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Yellowstone National Park Wolf Project Annual Report 2013

Yellowstone National Park
National Park Service
Box 168
Mammoth Hot Springs, Wyoming, USA 82190

www.nps.gov/ycr

Executive Summary

There were at least 95 wolves in 10 packs and one group (8 breeding pairs) living primarily in Yellowstone National Park during December 2013. These totals are slightly higher than reported in 2012, but similar to previous years when about 100 wolves were counted. Wolf numbers have decreased by about 45% since 2003 when the population estimate was 172. This is likely due to fewer elk in the ecosystem. Wolf numbers decreased less in the interior of the park than in northern Yellowstone, likely due to supplemental feeding on bison by those packs.

State-managed wolf hunts during 2013 did not significantly affect wolves primarily living in the park and the occurrence of mange continued to decrease in 2013. There was no evidence of distemper being a mortality factor as compared with previous years. Pack size ranged from 2 to 18 and averaged 8.6 wolves. Nine of 10 packs, plus one lone female, had pups. The average number of pups was 4.6, which is higher than the previous two years. At least 41 pups survived to the end of the year.

Project staff detected 269 kills that were definitely, probably, or possibly made by wolves during 2013, including 193 elk (72%), 16 bison (6%), 13 mule deer (5%), and low occurrences of other or unidentified species. The composition of elk kills was dominated by calves and yearlings (43%), followed by cows (33%) and bulls (14%). Some kills could not be identified to age or sex. Bison kills included nine calves, two yearlings, two cows, two bulls, and one adult of unknown sex.

Other research involving wolves during 2013 included population genetics, population regulation, disease, hunting behavior, spatial analyses of territory use, pack leadership, multi-carnivore-scavenger interactions, breeding behavior, dispersal, and observations of wolf, grizzly bear, and bison interactions in Pelican Valley. Nine wolves in four packs were fitted with radio collars during February and early March. Seven wolves in three packs were radio-collared during December. At year's end, 24% (21 wolves) of the wolf population was collared.

Wolf management activities included den site closures and several hazing events. Staff continued to manage wolf viewing areas in Slough Creek, the Lamar Valley, and other hot spots where wolves were frequently sighted. Public outreach included giving 265 formal talks, participating in 82 interviews, helping 18,000 people view wolves, making 18,822 visitor contacts, and giving hundreds of informal talks in the field.

8-Mile pups on the move in the tracks of the adults.

Background

Gray wolves (Canis lupus) once roamed from the Arctic tundra to Mexico, but they were regarded as dangerous predators and extermination programs led to their demise throughout most of the United States. There were no wolf packs left in Yellowstone National Park by 1926. 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.

National Park Service policy calls for restoring 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 was identified as an area where the recovery of wolf populations had a good chance of succeeding. Wolf restoration to the Yellowstone area began in 1995, when 14 wolves were brought to the northern portion of Yellowstone National Park from Alberta, Canada, held in acclimation pens for 10 weeks, and released. In 1996, an additional 17 wolves were transplanted from British Columbia and released in more widespread locations throughout the park. A companion effort to restore wolves to central Idaho occurred during 1995-1996.

The U.S. Fish and Wildlife Service supervised these recovery efforts because they are responsible for ensuring compliance with the Endangered Species Act. Wolves reintroduced into Yellowstone were classified as "nonessential experimental" under section 10(j) of the Endangered Species Act, while wolves outside the park were managed under special rules that provided flexibility in addressing wolf conflicts with livestock and other wildlife management goals.

The goal for wolf recovery was 30 breeding pairs of wolves for at least three successive years in the greater Yellowstone, central Idaho, and northwest Montana areas. This goal was met in 2002. Gray wolves were delisted in Idaho and Montana during 2011 and in Wyoming during 2012. These states now manage wolf harvest seasons, with trapping also occurring in Idaho and Montana.

Each year, personnel in Yellowstone National Park monitor the population dynamics, life history, dispersal, distribution, disease, genetics, predator-prey dynamics, and ecosystem impacts of wolves. Monitoring and management activities for the first two years were documented in The Yellowstone Wolf Project, Biennial Report 1995–96. Subsequent project activities are presented in annual reports.

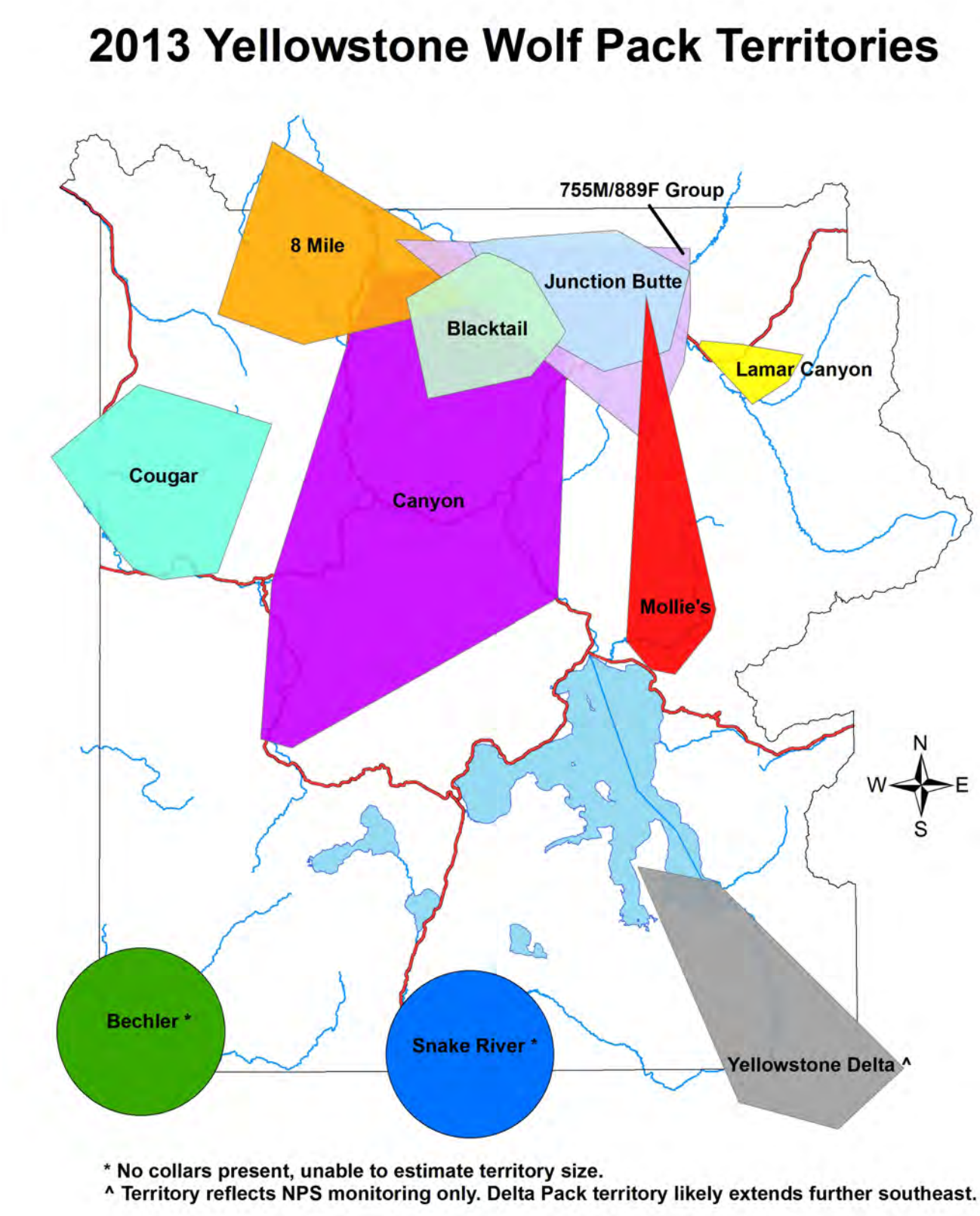

Figure 1. Wolf packs with some or all of their territory within Yellowstone National Park in 2013.

NUMBERS & TERRITORY STATUS

There were at least 95 wolves in 10 packs and one group (eight breeding pairs) living primarily in Yellowstone National Park during December 2013. These totals are higher than the 83 wolves and six breeding pairs observed during December 2012, but similar to the previous three years when about 100 wolves were counted. Wolf numbers in the park have decreased by about 50% since 2007, likely due to fewer elk which are their primary prey. Wolf numbers decreased less in the interior of the park than in northern Yellowstone, probably because wolves in the interior supplement their diets with bison.

State-managed wolf hunts during 2013 did not significantly affect wolves primarily living in the park. The severity of mange continued to decrease in 2013, although some individuals still showed signs of the mite. There was no evidence of distemper being a mortality factor as it was in 1999, 2005 and 2008. Pack size ranged from two (Lamar Canyon and 755M/889F group) to 18 (8-Mile) and averaged nine wolves, which is slightly smaller than the long-term average of 10 wolves.

For the fifth consecutive year, there were slightly less than 100 wolves living in Yellowstone National Park at the end of December. This number is substantially less than the 174 wolves counted in 2003. Wolf numbers in northern Yellowstone have decreased by 60% since 2007, compared to 23% for wolves living in the interior of the park during the same period. Wolves in northern Yellowstone are more dependent on elk as a food source, which have decreased 60% since 2007, than interior wolves that also prey on bison that are widely available.

REPRODUCTION

Nine of 10 packs monitored by the park or the Wyoming Game & Fish Department had pups. The average number of pups in packs with pups during early winter was 4.6, which is higher than 2012 (2.5) and 2011 (4.1). At least 41 pups survived to the end of the year, which was double the number that survived in 2012. Only the Blacktail Plateau pack did not produce pups this year.

Table 1. Estimated number of wolves in Yellowstone National Park on December 31, 2013. Underlined packs successfully reproduced during 2013.[1]

Location	Adults	Pups	Total
Northern Range			
8-Mile	9	9	18
Blacktail	3		3
Junction Butte	5	4	9
Lamar Canyon[2]	2		2
755M/889F group	2		2
Northern Range Totals	**21**	**13**	**34**
Non-Northern Range			
Bechler (no collars)	7	4	11
Canyon	5	3	8
Cougar Creek	7	6	13
Mollie's	2	5	7
Snake River (no collars)	5	4	9
Yellowstone Delta	7	6	13
Non-Northern Range Totals	**33**	**28**	**61**
YNP Total	**54**	**41**	**95**

[1] Table does not list Pahaska pack that dens outside of the park.
[2] The Lamar Canyon pack produced 2 pups that did not survive.

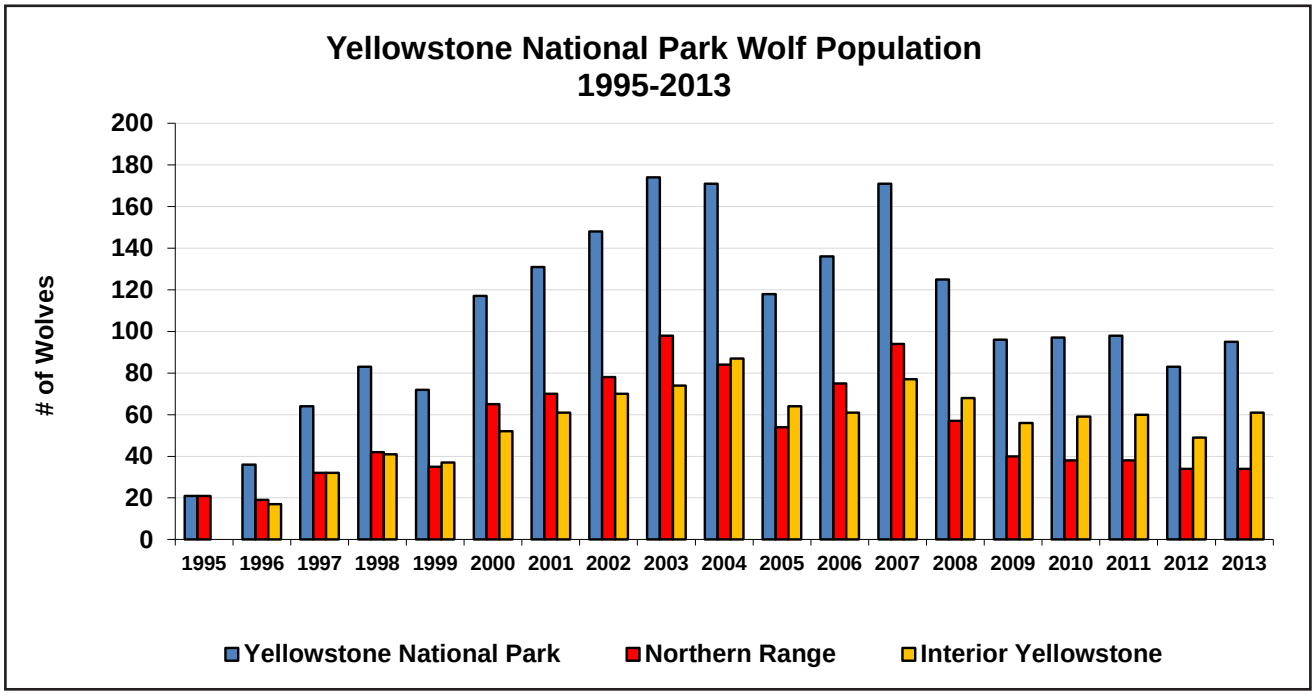

Figure 2. Yellowstone National Park early winter wolf numbers, 1995-2013.

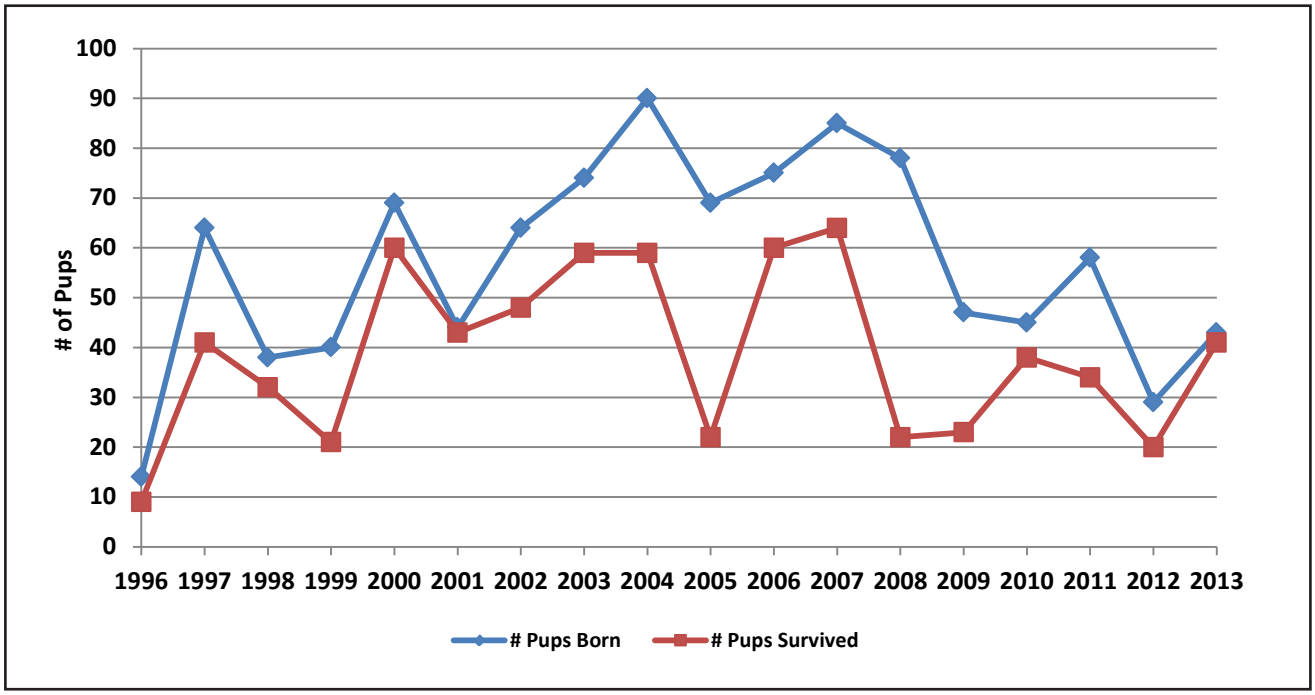

Figure 3. Yellowstone National Park pups born and survived until year end, 1996-2013.

MORTALITIES

Seven radio-collared wolves died in 2013, with intraspecific aggression being the leading cause (three deaths). One wolf dispersed from the Yellowstone Delta pack and was hit by a vehicle on Highway 191 northwest of Yellowstone National Park. Two wolves were removed in control actions outside the park due to livestock depredations. The alpha female of the Blacktail pack (693F) was found dead near the end of the year, but decomposition and scavenger activity made it impossible to determine the cause. Wolf Project staff also recorded two uncollared wolf deaths; one from intraspecific strife and the other hit by a car on Highway 191. No wolves that primarily lived in Yellowstone National Park were harvested during the hunting or trapping seasons in adjacent states.

WOLF CAPTURE & COLLARING

Nine wolves in four packs were fitted with either a GPS or VHF radio collar during February and early March. Seven wolves in three packs were radio-collared during December. These 16 wolves (seven females, nine males) included nine adults, four yearlings, and three pups. At year's end, 24% (21 wolves) of the wolf population was collared.

Table 2. Confirmed mortalities of collared Yellowstone National Park wolves, 2013.

Wolf #/Sex	Age Class	Pack	Date of Death	Cause of Death
759F	Adult	755M/759F Group	3/14/2013	Intraspecific
758M	Adult	758M Group	3/21/2013	Intraspecific
831F	Adult	Canyon	5/5/2013	Control action (shoot-on-site permit)
820F	Adult	Unknown	8/24/2013	Control action
828M	Adult	Unknown, formerly Yellowstone Delta	9/8/2013	Vehicle
686F	Old adult	Loner, formerly Mollie's	9/15/2013	Intraspecific
693F	Old adult	Blacktail	10/31/2013	Unknown

Table 3. Wolves captured and handled in 2013.

Capture Date	Wolf #/Sex	Age	Color	Pack
2/2/2013	759F	Adult	Gray	755M/759F Group
2/2/2013	869M	Pup	Gray	Junction Butte
2/2/2013	870F	Adult	Gray	Junction Butte
2/3/2013	661M	Adult	Black	Yellowstone Delta
2/3/2013	871M	Adult	Black	8-Mile
2/3/2013	872F	Yearling	Gray	Yellowstone Delta
2/3/2013	SW763M	Adult	Black	8-Mile
3/7/2013	889F	Yearling	Black	Junction Butte
3/7/2013	890M	Yearling	Black	Junction Butte
12/12/2013	906M	Yearling	Black	Junction Butte
12/12/2013	907F	Pup	Gray	Junction Butte
12/13/2013	778M	Adult	Gray	Blacktail
12/13/2013	908F	Pup	Black	8-Mile
12/13/2013	909F	Adult	Gray	8-Mile
12/13/2013	910M	Adult	Black	8-Mile
12/13/2013	911M	Adult	Gray	Blacktail

Current Elk Research in Yellowstone

In the late 1930s, pioneering field biologist Adolf Murie was tasked by the National Park Service to assess the relationship between predators and their prey. After a study on Yellowstone's coyotes in 1937, which challenged the Service's predator eradication programs, Murie went on to conduct the first ever scientific study of wild wolves in Alaska's Mount McKinley region (now Denali National Park). In Alaska, Murie's questions on wolf ecology were straightforward:

"What, for instance, is the total effect of the wolf preying on the big game species in this national park? How do such predators as the golden eagle, fox, grizzly bear, and lynx affect the hoofed animals, and how does the wolf affect these predators? In short, what is the ecological picture centering about the wolf . . .?"

Similar questions persist today wherever wolves inhabit the landscape, and the foundation of most carnivore research focuses the dynamics between predator and prey. Chief among the Wolf Project's diverse science objectives is investigation on the very same questions Murie asked over 75 years ago - particularly, what are wolves' influence on their main prey, Yellowstone's elk? Not only are elk the preferred prey for wolves in the Greater Yellowstone Ecosystem, but also favored by the region's other meat eaters, namely cougars, grizzly and black bears, and humans. For elk today, living among one of the greatest concentrations of large carnivores in the nation undoubtedly has behavioral, survival, and reproductive consequences. Additionally, elk population dynamics are also influenced by other environmental challenges brought on by climate, seasonal changes, and habitat quality. Given the complexity of these ecological components, uncertainty and controversy exists over what drives elk population dynamics in Yellowstone, particularly for the northern Yellowstone elk herd, which is one of the most studied herds in North America.

Much of the controversy emanates from disagreement over herd size, how large it should be, the relative influence of large carnivores, humans and environmental conditions, and the policy and management decisions surrounding elk. After decades of what was perceived as too many elk and efforts directed at reducing them – both in and out of the park – the concern now expressed by some is declining elk numbers. With the reintroduction of wolves, natural recolonization of cougars, increasing numbers of bears, and influence of human harvests, the elk debate has taken on new intensity, but now over too few elk. Critical to resolving such debates are scientific data, giving past and current Yellowstone elk research a prominent role in our understanding of this ecological, economical, and intrinsically valuable species. In the effort to fill the current gaps in knowledge of Yellowstone elk ecology, Yellowstone Wolf

Adult female #821 pursuing an elk. Female wolves often lead hunts on prey.

Project, along with other NPS staff and university collaborators have incorporated elk research as part of the long-term monitoring of this ecosystem.

Current research focused on the northern range is assessing elk demography, movements, and ecosystem effects of elk populations. In addition to annual interagency aerial counts and classification surveys, 161 elk were collared from 2000-2006 to study elk demography post wolf reintroduction – 13 of these elk are still being monitored. Beginning again in 2010 and continuing to the present, another 83 elk were collared to further understand elk demography and movements post-wolf and Gardiner Late Hunt cessation in 2009. Through the deployment of both VHF and GPS collars, and collection of data evaluating pregnancy rates, age, nutritional condition, and calf survival, multiple research objectives can be achieved. Collaring another 20 elk is planned for the 2014-2015 winter; combined with the proposal to conduct a sightability study which aims to improve the accuracy of the annual counts by determining what factors influence the probability of detection of elk on the landscape.

By following collared known-aged cow elk through time, we are able to monitor age-specific survival rates, cause-specific mortality, reproductive success, migration patterns, and habitat selection. Ultimately, this information will help determine 1) the influence of wolf predation on the survival, recruitment, and age structure of the Northern Range elk herd relative to other factors, and 2) the relative influence of top down (i.e., predation) and bottom-up (i.e., plant productivity) factors on the movement of elk in Northern Yellowstone, and to evaluate the influence of these movement patterns on elk survival and reproduction. By comparing spatial and temporal movements of GPS collared elk and wolves, we hope to better understand the strength of elk response to predation risk and the degree to which this supports various hypotheses on community ecology and trophic interactions on the Northern Range ecosystem. Through these efforts, combined with knowledge gained from other past and present research investigating Northern Range ecological dynamics, we aim to converge on a more accurate understanding of the forces influencing predator-prey dynamics and ecosystem processes.

While our methods for studying wolf-ungulate dynamics (e.g., technologically-advanced collars, large complex data sets, sophisticated statistical analyses) lie in stark contrast to those first employed by Murie, equipped with little more than field optics and a field journal, our objectives do not. We are asking the similar questions about how wolves are shaping the ecological picture of this national park. We share the same goals of letting the scientific process inform diverse stakeholder interests in our national parks' resources. And even though the National Park Service's mission to preserve and restore natural ecological processes had not yet been formulated during Murie's early years in Yellowstone, his pioneering studies provided early insight into the relationships between predators, prey, and other environmental challenges these species face. An appreciation of this ecological complexity guides our current research on Yellowstone elk.

Wolf Pack Summaries

NORTHERN YELLOWSTONE

8-Mile Pack (18 wolves: 9 adults; 9 pups): The 8-Mile wolves became a well-established pack in northern Yellowstone during 2012. Prior to denning, the pack was rarely observed from the ground, spending time away from the viewing corridor of the park roads in the northern reaches of their territory. They denned inside the park and had nine pups in spring, all of which survived to year's end. The pack spent most of its time in Gardner's Hole, the Fawn Creek drainage, and on Quadrant Mountain during summer and autumn. Thereafter, they shifted to the east and began using Mount Everts, the Blacktail Deer Plateau, and Oxbow Creek area, taking over much of the territory traditionally used by the former Leopold and current Blacktail packs.

In December, the pack consisted of five black-colored adults, four gray adults, seven black pups, and two gray pups. As the largest pack in Yellowstone during 2013, these wolves were able to expand and shift their territory deeper into the northern portion of the park. This year the two alphas, a large black male (871M) and a reddish-gray female (909F), were fitted with radio collars. Two other collars were put on a black male adult (910M) and a black female pup (908F). An old graying black male (SW763M) that was a founding member of the pack had his VHF radio collar replaced with a GPS collar. During this handling event, a healed broken front right leg was discovered, leaving him with a chronic limp. Despite this adversity, he has had few problems keeping up with the pack when traveling or hunting.

Blacktail Deer Plateau Pack (3 wolves: 3 adults; 0 pups): For most of 2013, the Blacktail pack consisted solely of its alpha pair: 778M and 693F. Though they continued to use their pack's historical territory, the increased presence of the larger 8-Mile pack kept them from spending time in the Mt. Everts, Blacktail Deer Plateau, and Oxbow Creek areas. These wolves did not produce a litter for the second consecutive year. At 6- or 7-years-old, both wolves were beyond prime age. However, they appeared in good condition throughout the year. In early November, 693F's collar emitted a mortality signal and her body was later found just inside the park boundary. The cause of death could not be determined because the body was heavily scavenged with no obvious signs of trauma.

Thereafter, 778M was observed with several uncollared wolves. He was re-fitted with a radio collar in December, as was a 2- or 3-year-old gray male (911M) that was with him. By the end of the year, their group also included an uncollared gray female, possibly a disperser from the Canyon pack.

Junction Butte Pack (9 wolves: 5 adults; 4 pups): The Junction Butte pack formed in May 2012 and is one of the dominant packs in northern Yellowstone. This ascendency was aided by the dispersal of five males from the Blacktail pack and six females from the Mollie's pack that increased their competitive strength. During 2013, four females bred but only one—an uncollared gray female—had four surviving pups. While breeding with the alpha male, alpha female 870F was injured—likely a neck or back injury—as she was mobbed by excited pack members. She had difficulty travelling with the pack for about two months and subsequently lost her alpha status until October when she seemed to be fully healed. Pack members 889F and 890M dispersed in April and apparently denned, but no surviving pups were discovered. In autumn, 890M rejoined the Junction Butte pack and 889F joined 755M, the former alpha male of the Lamar Canyon pack (see 755M/889F group below). After the disappearance of the first alpha male in November, and the death of the next during a skirmish with the 8-Mile pack in December, 890M—the only remaining adult male—became the new leader. Most of the pack had mild to severe cases of mange, but by the end of the year only two members had mild cases.

Lamar Canyon Pack (2 wolves: 2 adults; 0 pups): During 2013, the Lamar Canyon pack maintained the same territory in Lamar Valley despite the loss of their alpha female, 832F, the previous year. The long-time alpha male, 755M, left the pack during the breeding season because he was related to the remaining females. The pack then split into two groups. One group dispersed outside the park and became part of the Hoodoo pack monitored by the Wyoming Game & Fish Department. The other group, consisting of a 2-year-old black female, a 3-year-old gray female, and a gray male remained in the park on their historic territory. They had two black pups that apparently did not survive. In addition, the 3-year-old gray female disappeared in autumn and her whereabouts are unknown.

755M/889F Group: These two wolves were first seen together in October, but it is suspected that they joined up earlier that fall. 755M is the former Lamar Canyon alpha male that dispersed early in 2013. Also a disperser, 889F left the Junction Butte pack in the spring, one month after being fitted with a GPS collar. She was one of three wolves with GPS collars whose datapoints were used in a summer predation study. Their general territory included Amethyst Creek, Specimen Ridge, and Tower. In late December 889F was observed with an injured front right leg.

INTERIOR YELLOWSTONE

Mollie's Pack (7 wolves: 2 adults; 5 pups): There were only three wolves in Mollie's pack at the beginning of 2013, including alpha female 686F, 779F, and a gray alpha male that joined the pack in 2012. Both females may have produced pups this year, but only 779F's five pups survived. Wolf 686F dispersed during the summer and was found dead in late September. The Mollie's pack spent most of their time in or near their long-standing home in the Pelican Valley and only made one trip to northern Yellowstone. No mange was documented in the pack during 2013.

Canyon Pack (8 wolves: 5 adults; 3 pups): The Canyon pack spent more time in the Old Faithful region than in previous years hunting winter-weakened bison and bull elk. One black female disappeared near the breeding season and 2-year-old 831F was shot by a rancher north of Gardiner, Montana in May. The alpha male (712M) and an uncollared white female bred and produced three pups in the Hayden Valley. On June 2nd, the alpha female made three trips to carry the pups from the natal den to the pack's traditional rendezvous site—a total of 12 miles. The pups lived through the end of the year. Several wolves had moderate to severe cases of mange early in the year, but appeared free of the mite by year's end.

Yellowstone Delta Pack (13 wolves: 7 adults; 6 pups): The Yellowstone Delta pack continues to live in the southeastern corner of Yellowstone National Park. Six-year old alpha 633F denned and produced six pups. Beta male 661M and yearling female 872F were fitted with radio collars in early 2013. The collar on 872F was a prototype which recorded and sent satellite locations by email every day. The first few weeks after deployment provided a great deal of information regarding the pack's travel routes, trans-boundary movement patterns, and likely predation sites. Unfortunately, the collar malfunctioned soon after. Two-year old male 828M disappeared in April and was hit by a car northwest of the park in September. The pack was free of mange during 2013.

Snake River Pack (8 wolves: some adults with at least 4 pups): No radio-collars were fitted on wolves in this pack during 2013, but sporadic observations indicated the pack was still functioning. Several radio-collars will be deployed by staff from Grand Teton National Park in early 2014. Early observations indicate the pack may contain about eight members, including at least four pups.

Bechler Pack (8 wolves: 4 adults; 4 pups): There were no radio-collars on wolves in this pack for the fourth year in a row. However, at least some of the pack was spotted in the traditional den area in June. The observed group included four small pups, a white adult, two black adults, and a black adult that had turned silver with a radio-collar (may be 8-year old Bechler female 545F whose collar malfunctioned in 2007).

Cougar Creek Pack (13 wolves: 7 adults; 6 pups): By the end of 2013, the Cougar Creek pack was among the largest packs in Yellowstone National Park. The pack was led by alphas 478F and 689M, who have been the alpha pair for about five years. Wolf 478F was one of the oldest wolves in the park at 10-years-old. By year's end, they were the only collared wolves in the pack because 757F has not been located since July. We observed six pups this year and it is possible that there were two litters. Aerial locations during autumn and winter indicate that the Cougar Creek pack may be expanding their territory, although they are most often found within their territory core. No mange was documented in the Cougar Creek pack during 2013.

OTHER WOLVES

Pahaska Pack (Clear Creek Group) (10 wolves: 6 adults; 4 pups): Non-invasive camera traps and two radio collars deployed by the Wyoming Game & Fish Department greatly improved knowledge of this pack's composition. The pack dens outside Yellowstone National Park, but occasionally moves along the east side of Yellowstone Lake during late summer and autumn. The pack is officially counted toward the Wyoming wolf population.

Major Wolf Project Programs

WOLF-PREY RELATIONSHIPS

Wolf–prey relationships were documented by observing predation attempts and recording prey characteristics at kill sites. Wolf packs were monitored for two winter-study sessions in 2013. Wolves were intensively radio-tracked and observed for 30-day periods in March and from mid-November to mid-December. The Blacktail, Junction Butte, and 8-Mile packs were monitored by three-person ground teams and aircraft during the March session. Other park packs (Canyon, Cougar Creek, Mollie's, Yellowstone Delta, and 755M's group) were monitored only from aircraft. The Bechler pack (no radio collars) could not be located. Data from downloadable GPS collars was used to detect predation events for wolves from the Junction Butte and 8-Mile packs during the 30-day winter studies. During May through July, GPS collar predation data was gathered from the 8-Mile pack and 889F/890M group (who dispersed from the Junction Butte pack for the summer). During these established predation studies, and opportunistically throughout the year, project staff recorded behavioral interactions between wolves and prey, kill rates, total time wolves fed on carcasses, percent consumption of kills by scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites.

Composition of Wolf Kills

Project staff detected 269 kills that were definitely, probably, or possibly made by wolves during 2013, including 193 elk (72%), 16 bison (6%), 13 mule deer (5%), seven deer of unknown species (3%), five coyotes (2%), four pronghorn (1%), four wolves (1%), three bighorn sheep (1%), two moose (<1%), two badgers (<1%), one red fox (<1%), one porcupine (<1%), one muskrat (<1%), one long-tailed weasel (<1%), one fish (<1%), and 15 unidentified animals (6%). The composition of elk kills was 39% calves, 4% yearlings, 33% cows, 14% bulls, 4% adults of unknown sex, and 6% of unknown sex and age. Bison kills included nine calves, two yearlings, two cows, two bulls, and one adult of unknown sex.

Winter Studies

During March 2013, study packs (8-Mile, Blacktail, Junction Butte) were observed for a total of 205 hours from the ground. Poor weather conditions limited wolf pack monitoring from the air to 11 days, compared to the long-term average of 17 days during March winter studies. We were unable to locate the Yellowstone Delta pack. Groups 755M/759F and 758M were located only for two and five days before the deaths of 759F on March 14 and 758M on March 21. The other wolf packs were located on four (Lamar Canyon) to 11 (8-Mile, 869M/870F group, Blacktail, Junction Butte, and Mollie's) days. A total of 34 ungulate carcasses fed on by wolves were discovered by air and ground teams. Thirty (88%) of these ungulates were killed by wolves, including 21 elk, five bison, two deer, and two bighorn sheep. Four of the elk (19%) were calves, one (5%) was a yearling, 12 (57%) were cows, and four (19%) were bulls. Wolves also fed on four bison they did not kill. Compared to other late winter studies, the proportion of wolf-killed elk that were cows was relatively high. In addition, one badger and one red fox were killed by wolves.

During mid-November to mid-December, study packs (8-Mile, Blacktail, Junction Butte) were ob-served for a total of 146 hours from the ground. Wolf packs were located from the air on 10 days, which was less than the long-term average of 13 days during November-December winter studies. The number of days wolf packs were located ranged from six (Canyon) to 10 (755M/889F group, 8-Mile, Blacktail, and Junction Butte). A total of 23 ungulate carcasses fed on by wolves were discovered by air and ground teams. Twenty (87%) of these ungulates were killed by wolves, which included 18 elk, one bison, and one deer. Four of the elk (22%) were calves, eight (44%) were cows, five (28%) were bulls, and one (6%) was of unknown age and sex. The wolves also fed on two bison and one bull elk that they did not kill. Wolf predation patterns on elk during this early winter period were similar to other early winter periods. In addition, one wolf was killed by wolves.

GPS Collars and Winter Predation

During March, we searched clusters of GPS radio locations from wolf SW763M of the 8-Mile pack and wolves 889F and 890M of the Junction Butte pack. We began searching clusters of the Junction Butte pack after the wolves were fitted with collars on March 7. For the 8-Mile pack, all carcasses were detected by GPS clusters. Conversely, traditional monitoring methods using air and ground crews only found 30% of all carcasses. For the Junction Butte pack, about 90% of carcasses were detected through GPS clusters, while traditional monitoring methods found about 70% of carcasses.

In November-December, GPS clusters were again

searched for SW763M of the 8-Mile pack and 890M of the Junction Butte pack. For the 8-Mile pack, about 85% of all carcasses were detected through GPS clusters, while traditional monitoring methods found only about 45% of carcasses. For the Junction Butte pack, all carcasses were detected through GPS clusters, while traditional monitoring methods found 80% of carcasses.

Given that the number of flights during winter studies has generally declined in recent years, locating kills via GPS clusters has become an increasingly important tool for our understanding of winter wolf predation. However, the combined efforts of air crews, ground crews, and GPS cluster searches allows for our most complete assessment of wolf predation. We plan to continue these monitoring methods in 2014.

Summer Predation

The Wolf Project continued to assess the predation patterns of wolves from May through July by searching the GPS clusters of wolf SW763M of the 8-Mile pack and wolves 889F and 890M, who largely functioned as just a pair of wolves during the summer of 2013. Wolf 889F's GPS locations were only searched through mid-June, at which time her GPS collar quit functioning. We found 95 suspected kills or fresh carcasses of ungulate prey, which included 74 elk, 10 bison, eight deer, one bighorn sheep, and two unidentified species. Bison comprised a larger percentage of carcasses than in most previous years during which we searched wolf GPS clusters in summer. However, elk were still the primary prey, with carcasses comprised of about 65% neonate calves, 25% cows, and 10% of bulls, adults of unknown sex, or yearlings 11- to 14-months old.

POPULATION GENETICS

Collaborative efforts between the Yellowstone Wolf Project and the University of California, Los Angeles (UCLA) continued in 2013 working with genetic samples from wolves in Yellowstone National Park. Drs. Stahler and Smith continued to collaborate on a National Science Foundation grant awarded to co-principal investigators Dr. Robert Wayne and Dr. John Novembre at UCLA that aims to further understand the evolutionary and ecological dynamics of coat color in wolves. Separately, Drs. Smith and Stahler remained co-principal investigators on a Natural Environment Research Council grant with Dr. Tim Coulson (Oxford College) and Dr. Daniel MacNulty (Utah State University) integrating the genetic data on wolves in Yellowstone with ecological, population dynamics, and life history datasets.

The Wolf Project continued partnership with UCLA on the wolf genome sequencing project, which involves samples from wolves from around the world. Genetic material from Yellowstone's 302M is being used for whole genome sequencing that will create the entire genetic map of wild wolves, allowing us to better understand how genes may impact wolf behavior, health, life history, and canid evolution. Additionally, blood and skin biopsies collected from captured wolves are used for research on gene expression and live stem cells to better understand immunological, behavioral, and evolutionary profiles of wild wolves.

Additionally, the Wolf Project cooperated with doctoral student Dave Ausband from the University of Montana collecting scat at den and rendezvous sites to genotype unique individuals. This will improve the knowledge of pack composition of lesser-known wolf packs in Yellowstone National Park.

DISEASES

Our most active area of disease research this past year continued to be on sarcoptic mange, an infection caused by the mite Sarcoptes scabiei, which reached epidemic proportions in northern Yellowstone during 2009. The mite is primarily transmitted through direct contact and burrows into a wolf's skin where it feeds and lays its eggs. This process can initiate an extreme allergic reaction causing the wolf to scratch infected areas, resulting in hair loss and secondary infections. In 2013, two of eleven monitored packs were infected, with prevalence ranging between 22-33% of the wolves in infected packs. Uninfected packs tended to be those in the interior of Yellowstone National Park. Although S. scabiei has been isolated from wolves in the past, attempted skin scrapings were not successful in isolating the mite. Those efforts will continue. Despite our difficulty in isolating the mite, the hair-loss patterns are highly consistent with sarcoptic mange as opposed to other parasites that result in hair-loss.

In 2008, the Wolf Project began a partnership with the U.S. Geological Survey to rigorously address questions about how mange is affecting individual wolves and their overall population in the Yellowstone region. This team effort includes Dr. Paul Cross of the U.S. Geological Survey, Cheyenne Burnett of the Wolf Project, Emily Almberg and Peter Hudson of Pennsylvania State

A camera set up at Clear Creek to document wolf activity and reproduction picks up other species as well. The wolf is probably female #879 from the Pahaska pack.

University, and Dr. Andy Dobson of Princeton University. Ongoing analyses will assess the individual and pack-level risk factors for infection and explore the impacts of mange on individual survival and reproduction.

Disease surveillance and pup and adult survival suggested no other disease outbreaks had circulated in Yellowstone National Park during 2013. Exposure to canine parvovirus, canine adenovirus type-1, canine herpes virus, and canine distemper in 2013 is unknown at the end of the year due to pending test results.

YELLOWSTONE WOLF PROJECT ONGOING RESEARCH

Elk Research

As part of a National Science Foundation Long Term Research in Environmental Biology grant awarded to the Wolf Project in 2012, a long-term study of wolf impacts on the northern Yellowstone elk population continues in collaboration with Dr. Daniel MacNulty (Utah State University), Dr. John Vucetich (Michigan Technological University), and Dr. Tim Coulson (University of Oxford). This work has developed into a large-scale project consisting of three objectives: 1) determine the influence of wolf predation on the survival, recruitment, and age structure of the elk population; 2) determine the relative influence of top-down and bottom-up factors on the movement of elk; and 3) evaluate the influence of these movement patterns on elk survival and reproduction. We are now tracking over 75 elk fitted with both satellite GPS and VHF radio-collars. Radio-collared elk are monitored for survival and calf recruitment throughout the year.

Hunting Behavior

Studies centered around hunting behavior have been a research focus in Yellowstone largely through the efforts of long-term collaborator Dr. Dan MacNulty. With the availability of longitudinal data from repeated observations of individually-known wolves hunting prey, behavioral, ecological, and evolutionary dynamics of predation have been uniquely studied. New research has focused on the predatory performance of wolves when hunting bison. New research with Dr. L. David Mech (University of Minnesota) will look at prey encounter rates and daily activity patterns through time.

Pelican Valley Wolf, Grizzly Bear, and Bison

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

Population Dynamics

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

Dispersal

The ecological, demographic, and genetic implications of dispersal is an important research focus for Yellowstone wolf biologists. Using radio-collar tracking information and genetic techniques, current research aims to understand basic demographic patterns of dispersal (i.e., age, sex, distance, seasonal influences, etc.), along with the influence of wolf density, pack structure and size, kinship, and breeder loss in a naturally regulated system. Additionally, migrant detection analysis using molecular techniques will assess gene flow and genetic connectivity to other regional wolf populations.

Survival

Radio-collar information is used to monitor annual survival rates and cause-specific mortality for wolves living in and outside Yellowstone National Park. The Wolf Project led an effort analyzing annual survival/mortality data for every wolf collared in Idaho, Montana, and Wyoming during 1982-2004. With collaborators from University of Oxford, that analysis is being updated for 2005-2010 with data from about 1,500 individual wolves. In addition, a more intensive analysis of data from Yellowstone National Park is being

examined to understand why survival varies from year-to-year or between the interior and northern portions of the park. A paper scheduled for publication in 2014, found that wolf survival in northern Yellowstone was affected more by density dependent factors rather than food (elk), which is a unique finding for North American wolf populations.

Breeding Behavior

During January and February each year, Wolf Project staff monitor packs for courtship and breeding behaviors. The opportunity to study breeding behavior in wild wolves is unprecedented, and this study investigates the role of social and ecological factors influencing breeding attempts and their relative fitness consequences.

Wolf Pack Leadership

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

Wolf Capture and Handling

Each year, approximately 10-20 wolves are darted with immobilizing drugs from helicopters and radio-collared. Handling of individuals provides body measurements and information on disease, genetics, age, sex, breeding status, and condition. Both VHF and GPS collars are fitted on captured wolves.

Multi-carnivore and Scavenger Interactions

Research is ongoing to understand the degree to which exploitative and interference competition is occurring among carnivores in Yellowstone National Park. Data is collected on all observed wolf-bear, wolf-cougar, and wolf-coyote interactions. Scavenger species diversity, abundance, and carcass utilization at wolf kills is assembled to understand how these interactions influence structure and function of the ecosystem.

Wolf Spatial Dynamics

Thousands of wolf locations from VHF and GPS radio collars have been gathered since wolves were reintroduced in 1995. Rigorous analyses using these locations examine many questions concerning habitat use and territoriality. Year-to-year changes in territory use are being related to variables such as elk density and distribution, intraspecific strife, pack size, and reproduction. Other analyses underway are habitat use, travel and territory size, summer versus winter, and night versus day, as well as comparisons between GPS and VHF collars.

WOLVES & CAMERAS

Remote cameras have become a valuable tool for monitoring lesser known packs, particularly those without radio collars or with remote territories. This non-invasive monitoring tool allows for an alternate method to discern pack size and pup production in different areas of the park. Cameras placed near well-traveled game trails leading to traditional den and rendezvous sites have been especially informative. In addition, we also learned that protecting cameras with metal cases is a necessity for packs with curious pups. In 2013, members of the Pahaska pack damaged and/or stole cameras from trees as seen in this photo.

Pahaska pack pup chewing the remote camera. Initially staff were concerned that the wolves might avoid the camera.

Wolf & Human Management

Top photo: Erin Stahler caught on film setting up the Clear Creek camera. Bottom photo: A pup in fall looks on (after Erin's departure).

AREA CLOSURES

Visitor entry was closed to areas surrounding the dens and rendezvous sites of the Canyon and Lamar Canyon packs at various times during summer 2013 to prevent human disturbance of denning wolves during the sensitive period of pup rearing. Other packs' den sites were not closed because historically low visitor use made it unlikely these dens would be disturbed.

WOLF ROAD MANAGEMENT PROGRAM

Since wolf reintroduction began in Yellowstone, the Lamar Valley has become the premier location world-wide to observe free-ranging wolves. From 1996-2009, the main pack of interest was the Druid Peak pack, which denned in or near Lamar Valley. Since 2011, focus has been on the Lamar Canyon pack, which dens at the same sites historically used by the Druid pack.

Yellowstone staff established the Wolf Road Management Program 14 years ago to cope with the opportunities and problems that accompany increasing park visitors. The objectives for this program are: 1) human safety; 2) wolf safety; 3) visitor enjoyment; and 4) wolf monitoring and research. A record number of visitor contacts were made by staff in the 2013 season (18,822 people) even though the summer season was characterized by only moderate wolf-viewing opportunities.

HABITUATED WOLVES

There were very few cases of habituated wolves in 2013. The Canyon and Lamar Canyon packs exhibited some habituated behavior, with most of the behavior occurring during the summer. Both packs den relatively close to park roads and must maneuver around park visitors and vehicles more often than packs in the backcountry. Much of the decrease in reports of habituated wolves may be due to the Lamar Canyon pack decreasing from nine adults in 2012 to three or four adults in 2013.

Staff & Volunteers

Table 4. Our dedicated staff and volunteers.

Name	Period of Involvement	Hours Worked
Charly Arney	11/12/13-12/19/13	**120**
Aidan Beers	5/30/13-6/23/13	200
Cheyenne Burnett	2/27/13-4/3/13	288
Brenna Cassidy	2/27/13-4/3/13	592
	11/12/13-12/19/13	
Lizzie Cato	11/12/13-12/19/13	304
Sara Eno	11/12/13-12/19/13	304
Cayley Faurot-Daniels	2/27/13-4/3/13	288
Elizabeth Flesch	11/12/13-12/19/13	304
Shannon Forshee	2/27/13-4/3/13	592
	11/12/13-12/19/13	
Dane Horowski	11/12/13-12/19/13	304
Lisa Koitzsch	2/27/13-4/3/13	288
Ky Koitzsch	2/27/13-4/3/13	288
Molly McDevitt	1/1/13-4/3/13	624
Brandon Navratil	11/12/13-12/19/13	304
Kameron Perensovich	2/27/13-4/3/13	288
Daniel Perret	6/19/13-12/19/13	1180
Kersten Schnurle	11/12/13-12/19/13	304
Yasaman Shakeri	2/27/13-4/3/13	288
Eric Torvinen	2/27/13-4/3/13	288
Ryan Wilbur	2/27/13-4/3/13	288
Total Volunteer Hours		**7436**

Four full-time employees from the National Park Service worked for the Yellowstone Wolf Project in 2013: Project Leader Douglas Smith, Project Biologist Daniel Stahler, and biological science technicians Erin Stahler and Rick McIntyre. Year-round technicians were Matt Metz, Kira Quimby, and Caitlin Ruhl. Seasonal and volunteer staff included Charley Arney, Aidan Beers, Cheyenne Burnett, Brenna Cassidy, Lizzie Cato, Sara Eno, Cayley Faurot-Daniels, Elizabeth Flesch, Shannon Forshee, Dane Horowski, Lisa Koitzsch, Ky Koitzsch, Molly McDevitt, Peter Mumford, Brandon Navratil, Kameron Perensovich, Daniel Perret, Kersten Schnurle, Yasaman Shakeri, Aimee Tallian, Eric Torvinen, Jamie Walton, Ryan Wilber, and Travis Wyman. Technicians and volunteers were supported by funds and assistance from the Yellowstone Park Foundation and the Yellowstone Association.

OUTREACH

Yellowstone Wolf Project staff gave 265 formal talks and 82 interviews. Talks were given at scientific conferences and to general audiences. Interviews were to all forms of media. Staff assisted visitors in the field helping an estimated 18,000 people view wolves, connecting with 18,822 visitors, and giving over 600 informal talks in the field.

Dan Stahler and Matt Metz on fall elk duty.

Acknowledgements

We thank the many interested people who come forward every year to work with and help Yellowstone wolves. First and foremost, we thank the Wolf Project staff, especially the volunteers, whom without we would not complete as much research. The Yellowstone wolf watching community over the years has always helped when they can and to them we are appreciative. We also thank the many generous individuals, foundations, and organizations that have provided approximately $5 million in grants through the Yellowstone Park Foundation to the Wolf Project since 1996. Continued support from the Yellowstone Association, Canon U.S.A, Inc., an anonymous donor, The Tapeats Fund, the Perkin-Prothro Foundation, individuals donating to specially targeted projects, and the National Science Foundation grants DEB-0613730 and DEB-1245373 are also critical to our success and we thank all of those mentioned.

We also appreciate safe piloting from Roger Stradley of Gallatin Flying Service, Steve Ard of Tracker Aviation, Bob Hawkins of Sky Aviation, and Jim Pope of Leading Edge. Without all of the above support our knowledge of wolves would be far less and we would be unable to preserve the wolves of Yellowstone.

Special thanks
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INSPIRE. EDUCATE. PRESERVE.

Matt Metz packs up after another search on Mirror Plateau. Only an old bison skull this time...

Publications

Cassidy, K. 2013. Group composition effects on interpack aggressive interactions of gray wolves in Yellowstone National Park. Thesis. University of Minnesota, Minneapolis, Minnesota, USA.

McIntyre, R. 2013. The 06 Female. In "Wild Wolves We Have Known: Stories of Wolf Biologists' Favorite Wolves" (ed. R.P. Thiel, A.C. Thiel, and M. Strozewski), International Wolf Center, pp. 123-130.

Smith, D.W. 2013. Connection with a Wolf in Yellowstone's Most Remote Region. In "Wild Wolves We Have Known: Stories of Wolf Biologists' Favorite Wolves" (ed. R.P. Thiel, A.C. Thiel, and M. Strozewski), International Wolf Center, pp. 141-148.

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Stahler, D.R., D.R. MacNulty, R.K. Wayne, B. vonHoldt, and D.W. Smith. 2013. The adaptive value of morphological, behavioural and life-history traits in reproductive female wolves. Journal of Animal Ecology 82, 222-234.

The only two gray wolves, seen here, in the Cougar Creek pack.

Collaborative Research

Wolf Project Students: Direct Assistance

Wolf habitat selection at the territory level: Seasonal and interannual variation and influence on reproductive success.
Graduate Student: Alessia Uboni, completed dissertation in Forestry.
Committee Chair and University: Dr. John Vucetich, School of Forest Resources and Environmental Science, Michigan Technological University.

Elucidating evolutionary processes in North American gray wolves: demographic history, coat coloration, and ecotype-specific selection.
Graduate Student: Rena Schweizer, doctoral candidate.
Committee Chair and University: Dr. Robert Wayne, Department of Ecology and Evolutionary Biology, University of California, Los Angeles.

Modeling the effects of environmental change on wolf population dynamics.
Graduate Student: Dr. Sarah Cubaynes, post-doctoral research associate.
Committee Chair and University: Dr. Tim Coulson, Department of Zoology, University of Oxford.

Survival of northern Rocky Mountain wolves: Phase II.
Graduate Student: Jack Massey, doctoral candidate.
Committee Chair and University: Dr. Tim Coulson, Department of Zoology, University of Oxford.

Groups and mortality: Their effects on cooperative behavior and population growth in a social carnivore.
Graduate student: David Ausband, doctoral candidate.
Committee Chair and University: Dr. Michael Mitchell, Wildlife Biology Program, University of Montana.
Title: Influence of top-down and bottom-up forces on movement and habitat use of northern Yellowstone elk.
Graduate Student: Michel Kohl, doctoral candidate.
Committee Chair and University: Dr. Daniel MacNulty, Department of Wildland Resources, Utah State University.

Assessing the impact of wolf predation on the demography and age structure of northern Yellowstone elk.
Graduate Student: Ryan Kindermann, doctoral candidate.
Committee Chair and University: Dr. Daniel MacNulty, Department of Wildland Resources, Utah State University.

Dynamics of predator-prey space use in a wolf-bison system.
Graduate Student: Aimee Tallian, doctoral candidate.
Committee Chair and University: Dr. Daniel MacNulty, Department of Wildland Resources, Utah State University.

Group composition effects on interpack aggressive interactions in Yellowstone wolves.
Graduate Student: Kira A. Quimby, M.S. student.
Committee Chair and University: Dr. L. David Mech, Department of Natural Resources, Science, and Management, University of Minnesota.

The dynamics and impacts of sarcoptic mange in Yellowstone's wolves.
Graduate Student: Emily Almberg, doctoral candidate.
Committee Chair and University: Dr. Peter Hudson, Department of Biology, Pennsylvania State University.

Factors affecting elk encounter rate by gray wolves on the northern range of Yellowstone National Park, Wyoming.
Graduate Student: Hans Martin: M.S. student
Committee Chair and University: Dr. L. David Mech, Department of Natural Resources, Science, and Management, University of Minnesota.

To stay informed about science in Yellowstone National Park, visit our website - www.nps.gov/ycr