Yellowstone National Park
Yellowstone Wolf Project 2019
Wyoming, Montana, Idaho

Yellowstone Center for Resources
National Park Service
Department of the Interior

Yellowstone Wolf Project Annual Report

2019

Summary

There were at least 94 wolves in 8 packs (7 breeding pairs) living primarily in Yellowstone National Park (YNP) at the end of December 2019. Overall, wolf numbers have been relatively stable from 2009 to 2018 (80-108 wolves.) After dropping to 80 in 2018, numbers rebounded this year with high adult survival and several packs producing multiple litters. Seven breeding pairs (defined as an adult male and an adult female with at least two pups that survive through the end of the year) was the same as the average over the last decade. Pack size in 2019 ranged from 4 to 19, averaging 11.5 in size. Parkwide, 61 pups were produced and 42 survived (68.9%) to year end, with more in northern Yellowstone (27) than the interior (15) of the park. At the end of 2019, pups comprised 44.7% of the park population, higher than the average percentage (32.4%) over the last 10 years.

Wolf-Prey Relationships

Project staff detected 186 kills that were definitely, probably, or possibly made by wolves in 2019: 111 elk (59.7%), 38 bison (20.4%), 11 mule deer (5.9%), 2 deer of unknown species (1.1%), 3 coyotes (1.6%), 2 pronghorn (1.1%), 2 ravens (1.1%), one red fox (0.5%), one moose (0.5%), one golden eagle (0.5%), one bald eagle (0.5%), one mountain lion (0.5%), one domestic dog (0.5%), and 11 unidentified animals (5.9%). The domestic dog death was outside Yellowstone in a residential, gateway community and occurred at night. The composition of wolf-killed elk was: 31.5% calves, 7.2% yearlings, 21.6% adult females, 23.4% adult males, 7.2% adults of unknown sex, and 9.0% of unknown sex and age. The composition of wolf-killed bison was: 42.1% calves, 21.1% adult females, 28.9% adult males, and 7.9% of unknown sex and age. Wolf predation was monitored intensively for nearly five months of the year – one month in early winter (mid-November to mid-December), one month in late winter (March), and several months in the summer (May-late July). The type of prey killed by wolves varies by time period, but consists primarily of elk and bison.

Winter Studies

During the March 2019 late winter study period, air, ground, and GPS cluster search teams discovered 69 ungulate carcasses fed on by wolves. The GPS cluster crew searched 176 GPS clusters (locations in which a GPS-collared wolf spent ≥ 1hr) for two wolf packs (8 Mile and Junction Butte) through hiking or skiing over 930 kilometers (580 miles). Fifty-one (74.0%) of these ungulates were killed by wolves, including 29 (57.0%) elk, 9 (18.0%) bison, 10 (20.0%) deer, one (2.0%) moose, and 2 (4.0%) unknown species. Nine of the elk (31.0%) were calves, three (10.0%) were yearlings, four (14.0%) were adult females, nine (31.0%) were adult males, and four (14.0%) were adults of unknown sex. The wolves also fed on ten bison and eight elk that they did not kill.

During the November-December 2019 early winter study period, we discovered 31 ungulate carcasses fed on by wolves. The GPS cluster crew hiked over 747 kilometers (465 miles) while searching 71 GPS wolf clusters for the Junction Butte pack. Twenty-five (81.0%) of these ungulates were killed by wolves, which included 16 (64.0%) elk, 7 (28.0%) bison, one (4.0%) deer, and one (4.0%) unknown species. Three of the elk (19.0%) were calves, four (25.0%) were adult females, six (38.0%) were adult males, two (13.0%) were adults of unknown sex, and one (6.0%) was of unknown age and sex. The wolves also fed on four bison, one elk, and one deer that they did not kill.

Summer Predation

We also assessed wolf predation from May through late July by searching for prey remains at clusters (a location other than a home site where a wolf spent 30 minutes or more) generated from GPS collars. In 2019, we searched 147 clusters for wolf 907F of the Junction Butte pack. Crews hiked over 1,263 kilometers (785 miles) to detect 41 suspected kills or fresh carcasses of ungulate prey, which included 26 (63.0%) elk, 13 (32.0%) bison, and 2 (5.0%) unknown species.

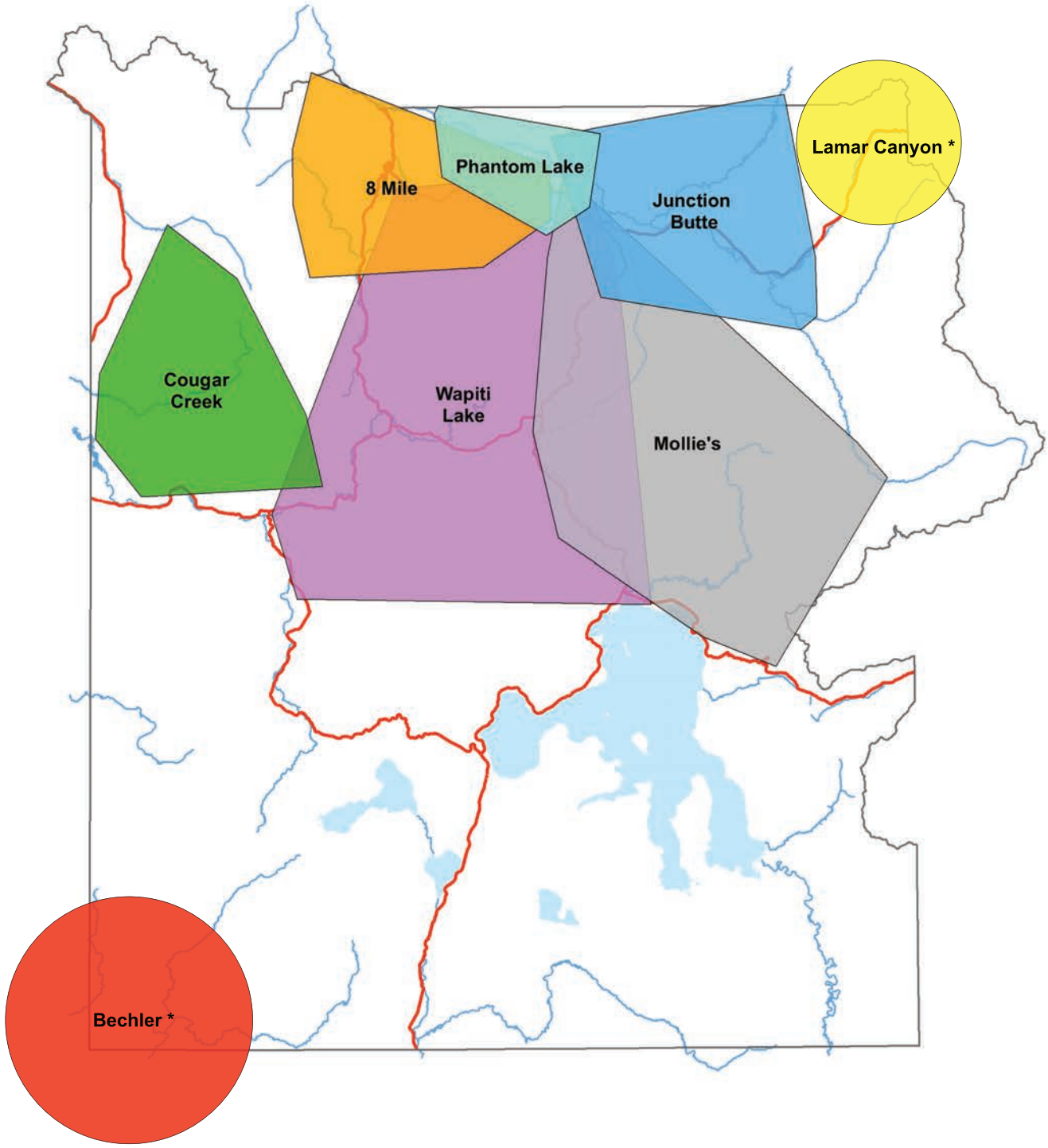
Mortalities

Only two radio-collared wolves died in 2019. After being injured by other wolves, the dominant male of 8 Mile, 962M, could not keep up with the rest of the pack and became a lone wolf. He traveled out of Yellowstone and was harvested in Montana in January. Wolf 1118F's GPS collar sent a mortality signal in September 2019, indicating she had not moved for at least four hours. We will attempt to recover the collar in summer 2020, but any remains will be scavenged or decomposed. In addition, staff recorded five uncollared wolf deaths. Two seven-month old pups from Junction Butte were hit by a vehicle in late November. Both pups died immediately. Three wolves were harvested in state hunting seasons: two Phantom Lake pups in Montana, and one Mollie's wolf in Wyoming. For the second year in a row we recorded no intraspecific-caused mortality, which is usually the leading cause of natural mortality in the park. However, deaths of uncollared wolves from natural causes are rarely found and recorded.

COVER: The Junction Butte pack takes time out to howl. NPS Photo - D. Stahler.

2019 Yellowstone Wolf Pack Territories

(95% minimum convex polygons of aerial locations)



*** No radio collars present, unable to estimate territory size.**

Disease

There was no evidence of any major disease mortality in 2019. The wolf density in northern Yellowstone is the highest it has been in over 10 years (approximately 50-70 wolves/1000km^2, depending on movements of the Wapiti Lake and Mollie's packs), which may facilitate disease transmission over the next year. Ellen Brandell, a graduate student at Penn State, is investigating the prevalence and abundance of canine parasites and has collected scat samples from most packs in northern Yellowstone.

Reproduction

Each year staff attempt to establish early pup counts at dens by either observing from the ground through spotting scopes or, more often, taking photos of the den area during tracking flights. Since wolf pups normally stay underground for their first three to five weeks, the earliest counts for each pack are often of two to three month old pups. For some packs whose den sites are unknown or hidden, we do not get pup counts until the pups are moved to a rendezvous site in the early fall. This year the Wolf Project documented at least 61 pups born to seven different packs. Four packs produced multiple litters: Junction Butte (17 pups from four litters), 8 Mile (11 pups from two litters), Phantom Lake (at least 13 pups from at least three litters), and Wapiti Lake (9 pups from two litters). Many of these packs, however, lost some pups by the end of the year and pup survival for those packs with multiple litters was 64.0%. Of the minimum 61 pups produced in all packs, 42 (68.9%) pups survived to the end of the year.

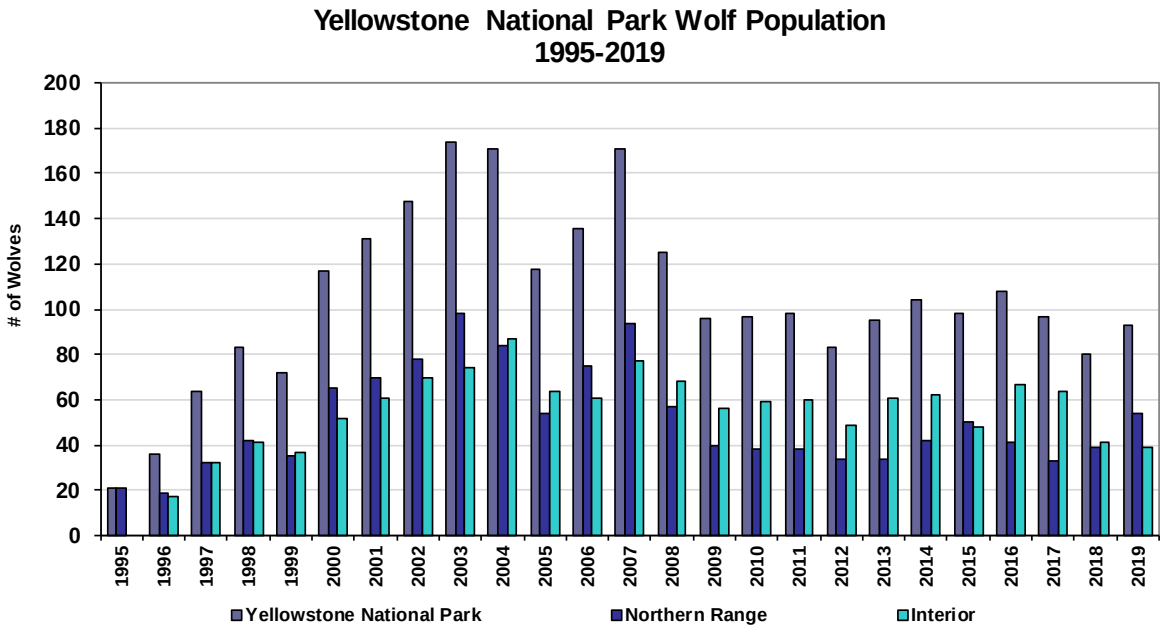
Wolf Capture

Twenty-four wolves from six packs were captured and collared in 2019. Six of these replaced old or malfunctioned transmitters. A number of measurements and biological samples were also taken while the wolf was sedated. Twelve females and twelve males were captured; three were old adults (≥6 years old), six were adults (2-5 years old), three were yearlings, and twelve were pups. A female from the Cougar Creek pack was collared and her genetic markers indicate she is actually 953F from Cougar Creek, whose collar was chewed off in 2017.

Wolf Management and Outreach

Wolf management activities included den site closures and several hazing events. Staff continued to manage wolf viewing areas in Slough Creek, Lamar Valley, and other areas where wolves were frequently observed. Wolf Project staff observe wolves through spotting scopes and, during 2019, at an average distance of 2.4 km. This distance facilitates data collection on completely natural wolf behavior uninfluenced by human presence. In January, biological technician Jeremy SunderRaj spotted the Junction Butte pack from a distance of 11.4 km (over 7 miles) away! Hayden Valley, a common place to view wolves in the past, was rarely used by the Wapiti Lake pack in 2019. Public outreach included giving 119 formal talks (six at scientific conferences), 76 interviews, educating at least 10,000 people while viewing wolves, making at least 15,000 visitor contacts, and giving 158 informal talks in the field.

Wolves often travel single file when in snow - unless of course, you are a pup (first wolf in line and flanking white female.) Wapiti Lake pack in Hayden Valley in late 2019. NPS photo - D. Smith.



2019 Wolf Population

YELLOWSTONE WOLF POPULATION (as of 12-31-2019)	Adults	Pups	Total
NORTHERN RANGE			
8 Mile	9	8	17
Phantom Lake	4	7	11
Junction Butte	10	8	18
Lamar Canyon (no collars)	3	4	7
Other (1154F & 1200M)	2		2
Northern Range Totals	28	27	55
NON-NORTHERN RANGE			
Bechler (no collars)	2	2	4
Cougar Creek	6		6
Mollie's	6	4	10
Wapiti Lake	10	9	19
Non-Northern Range Totals	24	15	39
YNP Total	52	42	94

2019 Wolf Capture

Wolf #/Sex	Date of Capture	Age	Color	Pack
1104F	2/19/2019	Yearling	Black	Wapiti Lake
1198F	2/19/2019	Pup	Black	Cougar Creek
1199F	2/19/2019	Pup	Black	Cougar Creek
1200M	2/19/2019	Adult	Black	Cougar Creek
1201F	2/19/2019	Pup	Black	Wapiti Lake
1203F	2/21/2019	Yearling	Gray	Wapiti Lake
1117M	2/22/2019	Adult	Black	Cougar Creek
1204F/953F	2/22/2019	Adult	Gray	Cougar Creek
1047M	12/14/2019	Adult	Black	Junction Butte
1048M	12/14/2019	Adult	Black	Junction Butte
1228F	12/14/2019	Pup	Gray	Junction Butte
1229F	12/14/2019	Pup	Black	Junction Butte
907F	12/14/2019	Adult	Gray	Junction Butte
1230M	12/15/2019	Pup	Black	8 Mile
1231M	12/15/2019	Pup	Gray	8 Mile
1232M	12/15/2019	Pup	Black	8 Mile
1233M	12/15/2019	Pup	Black	8 Mile
1234M	12/15/2019	Yearling	Black	Wapiti Lake
1235F	12/15/2019	Pup	Black	Wapiti Lake
1236M	12/15/2019	Pup	Black	Wapiti Lake
1005F	12/16/2019	Adult	Black	Phantom Lake
1237M	12/16/2019	Adult	Gray	Mollie's
1238M	12/16/2019	Pup	Black	Mollie's
1239F	12/16/2019	Adult	Gray	Mollie's

2019 Wolf Mortality

Wolf #/Sex	Date of Death	Age	Color	Pack	Cause of Death
962M	1/22/2019	Old adult	Black	Alone	Harvest
1118F	9/12/2019	Adult	Gray	Alone	Unknown, likely due to complications after being shot and injured in late 2018
uncollared	10/29/2019	Yearling	Gray	Mollie's	Harvest
uncollared	11/19/2019	Pup	Black	Junction Butte	Vehicle
uncollared	11/19/2019	Pup	Black	Junction Butte	Vehicle
uncollared	12/10/2019	Pup	Gray	Phantom Lake	Harvest
uncollared	12/10/2019	Pup	Gray	Phantom Lake	Harvest

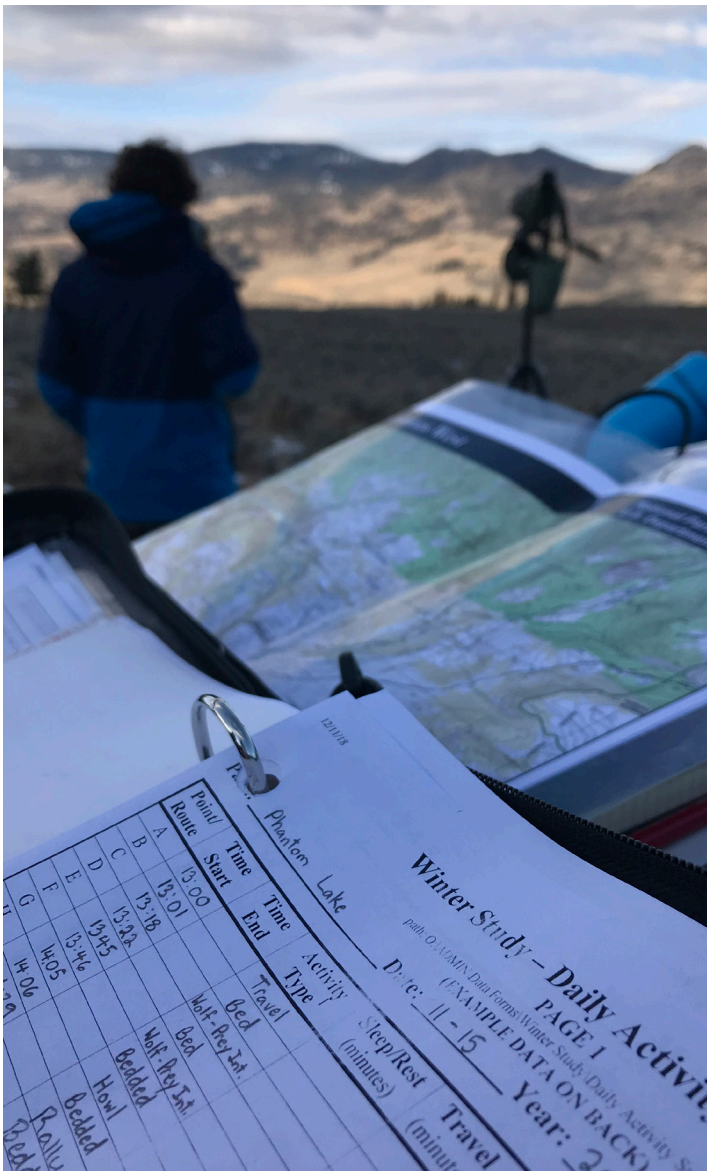
Wolf Project Leader Doug Smith was invited to give a TEDx talk in Big Sky, MT, in January 2019. His talk examined human perceptions of wildlife and our place in this shared world. It was titled: "Should Humans Rule the World? Using Wolves to Connect with Nature" and can be viewed on YouTube (https://www.youtube.com/watch?v=kCu34aAyBFc). Doug also gave formal presentations and interviews with BBC, PBS, Yellowstone Public Radio, *National Geographic*, *Science Magazine*, WY Public Radio, *Men's Journal*, NOAA, The Meateater, and many others.

Wolf Project Research Associate Kira Cassidy taught a three-day field course through Yellowstone Forever called "Animal Families: Lessons on Growing Up Wild." The course took place at the Lamar Valley Buffalo Ranch and will be offered again in spring 2020.

Since 2014, Yellowstone Wolf Project staff and over 80 collaborators have been working on a book about wolf research in Yellowstone which will be released in 2020. Titled *Yellowstone Wolves: Science and Discovery in the World's First National Park*, the book will feature an in-depth look at wolf research, results, stories, graphics, and photos from the last 25 years. Hardcover release is expected in October 2020.

Other Programs

Wolf Project Leader Doug Smith, along with other researchers, advised the gray wolf relocation program at Isle Royale National Park. The project relocated 13 wolves to the island during early 2019. Most of the wolves are still alive and being monitored through GPS collars. The project will continue in 2020.



Field work is not what you think...notes, notes, and more notes. NPS Photo - M. Jackson.

Wolf Pack Summaries

8 Mile (17 wolves: 9 adults, 8 pups)

The 8 Mile pack experienced an interesting restructuring in early 2019 when the dominant male was injured and the females started to travel with six new males from the Wapiti Lake pack. One low-ranking male returned to Wapiti Lake but the rest stayed with 8 Mile in their stable territory and the pack denned in two separate locations. Eleven pups were produced and eight lived to the end of the year. The pack continues to be led by an uncollared five-year-old female recognized by her graying, brindle-colored coat. She is only the second lead female the pack has had since their formation in 2011.

Phantom Lake (11 wolves: ~4 adults, ~7 pups)

This new pack (previously known as 1005F group) formed in the Hellroaring to Oxbow and Crevice Creek areas left vacant after the disintegration of the Crevice Lake pack in late 2018 and the Prospect Peak pack in late 2017. At least three adult females produced a total of at least 13 pups and all survived until early winter when two gray pups disappeared and two others were harvested during the Montana hunting season outside of Yellowstone. After the harvests, one of the radio-collared females appeared injured and alone and the other might be dispersing by the end of the year. Sporadic sightings suggest at least 11 pack members are still alive but are difficult to track without consistent radio-collars.

Junction Butte (18 wolves: 10 adults, 8 pups)

For the second year in a row all four adult females in the Junction Butte pack denned and produced pups. In a strange series of events never before recorded in wild wolves, six -year-old subordinate female, 969F, killed all seven of the three-week old pups from the two most dominant females' den, consuming at least three of them. The event occurred when the mothers were gone from the den and the pups were being tended by two male yearlings. The pack then helped 969F raise her seven pups. The fourth female, 1109F, kept her den and pups separate from the rest of the pack and was occasionally helped by beta male 1048M until they merged with 969F's litter at a rendezvous site in Lamar Valley in mid-September. The litter of seven produced by 969F were exposed to humans at a young age because their den and rendezvous were close to a popular hiking trail and several people violated the closure in place to keep the wolves from becoming habituated. By winter, several of the pups were exhibiting severe habituation and were aversively conditioned before two were hit by a vehicle and died. The black yearling male disappeared around this same time and the pack ended the year with 10 adults and eight pups. Given the number of breeding adults, the previous tension between the females, and the expansion of their territory, it will be interesting to see if the pack remains cohesive or if they split into two or more groups in 2020.

Lamar Canyon (7 wolves: 3 adults, 4 pups)

Without a radio collar, any information about this pack is gathered through chance sightings and trail cameras placed in their traditional territory. A reliable sighting in the fall found the pack with the same adult male and female as last winter, with one yearling and four pups. The Lamar Canyon pack began in 2010 and was a dominant force in northern Yellowstone for several years. Since then they have struggled due to a combination of mange and canine distemper outbreaks, wolf hunting outside the park, and pressure from larger neighboring packs, all resulting in losses of pack leaders over the years.

Mollie's (10 wolves: 6 adults, 4 pups)

Starting with a smaller pack size compared to recent years, the Mollie's pack rebounded by producing five pups with four living through the end of the year. Once again the pack anchored their territory in Pelican Valley but made occasional trips to northern Yellowstone, going as far west as Lava Creek. The pack killed several winter-weakened bison despite only having two large males (one of them is the second-oldest wolf in the park, eight-year-old 890M) and two adult females. In early 2020 Mollie's pack will reach 25 years old (they were released as the Crystal Creek pack in 1995), and we can trace the females' genetic line back through their mother to original Crystal Creek wolves 5F, 6M, and 8M; original Nez Perce wolves 27F, 28M, and 72M; and original Rose Creek wolves 9F and 10M.

Wapiti Lake (19 wolves: 10 adults, 9 pups)

In a rare split the dominant male and female of Wapiti Lake, after two and a half years together, went separate ways. The change was likely precipitated by an inter-pack fight with the 8 Mile pack after which six of the Wapiti males remained with the 8 Mile females. During the next three months the dominant female (the oldest wolf in the park at nine years old) led the pack's adult females and all the pups through their traditional territory. Near the peak of the breeding season, third-ranking male 1014M returned to Wapiti and was accepted as the new dominant male. The pack produced two litters totaling nine pups, all of which lived through the end of the year.

Cougar Creek (6 wolves: 6 adults)

The Cougar Creek pack split during the denning season with the old dominant male and an adult female shifting west and the other six pack members remaining in the traditional territory. One or two females may have localized at a den

Wolf Habituation and Personality: An Interaction of Nature, Nurture, and Human Presence

by Kira Cassidy

For much of the last few hundred years in North America, gray wolves were persecuted and eventually eradicated from the entire lower 48 states except for a tiny corner of Minnesota bordering Canada. After reaching their smallest range contraction in the 1940s, natural recolonization and reintroduction programs (including Yellowstone) saw the gray wolf slowly, tentatively begin to thrive in areas they'd been absent for decades. No one knows exactly what wolf behavior was shaped by those years of hatred and removal. Were wolves always scared of humans? A written account by William Clark during the 1804 Corps of Discovery Expedition described wolves as "*fat and extreemly* [sic] *gentle*" and he was able to approach them, even killing one with a bayonet. The simple existence of domestic dogs, the descendants of wild wolves some 10,000 to 40,000 years ago, suggest that at least some wolves throughout history grew close to humans, eventually becoming part of the human family. But for wild wolves, those years of persecution seem to still echo in their DNA and, being an intelligent creature, they are usually extremely wary of humans.

It's dangerous to speak in absolutes regarding wildlife, especially for an intelligent species where individuals can have a wide range of personalities. The visibility of wolves in Yellowstone, combined with research based on following marked wolves throughout their entire lives, has afforded us intimate views not only of important patterns in wolf life history, but also those anomalies that don't really fit in scientific papers. While most wolves are afraid of people, or at the very least avoid them whenever possible, once in a while a combination of personality (nature) and environment (nurture) interact to result in an individual who doesn't fit the general pattern.

The Junction Butte pack started in 2019 as a stable, dominant force consisting of eight adults and three pups in their first winter. It had been almost two years since an adult wolf died (elderly sw763M in April 2017), so the adults knew each other well, a fact evidenced by their prowess fighting other packs and taking down large prey like adult bison. When spring arrived, the three pups turned to yearlings and their personality differences became more apparent. The gray male diligently attended the den of the two dominant females, brought them food, and even babysat the tiny pups when their mothers left the den for the first time.

The other two yearlings were less interested in the pups and the den, instead cruising roadways and pullouts. It's possible they found some treat along the road (either roadkill or litter) and kept searching for similar tidbits. In a short time, the male became quite comfortable around people and would casually walk through a crowd of visitors, watching them curiously. Because this behavior can slip quickly towards confidence and the chances of being fed by a person increase due to proximity, we decided to aversively condition him with cracker shells. The yearling female also displayed a nonchalance around the road and vehicles; however, after her own aversive conditioning event, both yearlings seemed to decide the road was not a good place to linger. They still crossed the road in view of people but did so quickly and moved well away from the roadway before relaxing. Since 1995 we have recorded habituated behavior in 55 individuals and almost half of them were aversively conditioned. Only six times did the aversive conditioning fail to correct the wolf's behavior, a testament to their mental flexibility, intelligence and sometimes, determination.

Wolves in Yellowstone den in mid-April, often just a day or two before whelping. Junction Butte subordinate female 969F chose a den site in a quiet, dense forest. Unfortunately, a popular hiking trail goes through the forest in the summer. Her den was secluded and safe for the first month or so and then traffic started to increase. We assumed she would move her pups because of the human presence near the trail but as the weeks went on, the pack continued to secretly raise their pups in the same area, likely watching and hearing humans through the trees. Maybe she didn't want to move the pups and cross a snow-melt swollen Slough Creek when the pups were so small and could easily drown. Maybe she worried about their safety as a few weeks earlier she had killed the pups of the two dominant females in the pack (see pack summary). Maybe she ran into a grizzly sow with two yearlings in western Lamar Valley and decided against leaving the safety of a den hole. Maybe she tried to move the pups but they were reluctant and ran back to the den when they heard a bison or a group of people coming down the trail. Whatever the reason, we couldn't force her or the pups to move and so instead we worked with YNP Law Enforcement to set up a "No Off-Trail Travel" zone. We hoped this would prevent people from accidentally stumbling onto the den or sneaking in to see the pups up close.

We didn't realize it at the time but several visitors had heard or seen the pups on or right next to the trail. Some of these people even made the exact wrong choice to hide

Wolf decision-making at its best: what to do now? The lead female (white wolf) brings up the rear, leaving the decision-making up to others. Wapiti Lake pack in Yancey's Hole, late December 2019. NPS photo - D. Stahler.

themselves or tried to be nonthreatening, and allowed the pups to get very close for photos. Some people may have purposely snuck into the forest near the den closure hoping for a close encounter with the pups. That early contact with humans probably influenced the pups' views of humans as benign or interesting and may have led to long-term negative consequences.

Eventually the pack did move the pups into Lamar Valley; away from people, away from the road, and the autumn months passed without incident. At least, all incidents were of the wild variety: bull bison snorting and fighting during the rut, some of them dying and providing food for the pack. Grizzly bears, hungry during a poor seed production year for whitebark pine, congregated in Lamar to feed on the dead bison, but the Junction Butte adults taught the pups how to navigate around them.

In late October the pups started to travel full-time with the adults, which meant leaving the rendezvous and occasionally crossing the park road. This time of year is a steep learning curve for wolf pups and instead of being nervous, several of them were curious, interested in the road and the smelly metal boxes that roll on it, and even those loud, two-legged animals coming out of the boxes. Over several weeks two or three of the pups were deemed "trouble-makers." One even walked between visitors and grabbed a tripod left on the roadside. Of the ten pups from two litters, seven of them unfortunately exposed to human sounds and smells since they were very young, only two of the pups were regularly causing issues by curiously and boldly approaching human-related items like cars and road signs. We were very concerned about this behavior. When a wolf is close to a human (or developed area or road) and unafraid, the story always ends poorly for the wolf. Over the weeks we attempted to aversively condition the pups, succeeding only once in scaring one away from the road.

Why weren't all of them confident around people? Or at least all seven raised near the busy trail? This seems to be a classic interaction between nature and nurture where even though seven were raised in the same place under the same circumstances, only a few had the personality to take those experiences and become a human definition of "trouble." This behavior probably contributed to ending the lives of two of the pups when they were hit by a vehicle on the night of November 19th and died immediately. Wolves often cross the park road, especially at night when traffic is minimal, but a few of the Junction pups had been known to confidently stand in the road with vehicles approaching during the daytime. The two dead pups, one male and one female, did not exactly match the descriptions of the bold ones (black with a large white chest blaze) but because the road-curious behavior seemed to abate somewhat after the deaths, it is possible even the curious ones adjusted their behavior after the aversive conditioning and maybe even witnessing the deaths of their litter-mates.

We live in a world where wild animals are rarely allowed to be bold, even when it is a natural case on one end of the personality spectrum. However, we have a responsibility to help keep them safe from us, too. An encounter with a wild wolf is incredible, and for many people, will etch itself into a lifelong memory; but keeping them safe from humans means keeping them cautious of us and never approaching a wolf and never allowing a wolf to approach, even curiously. Park regulations prohibit people from getting within 100 yards of a wolf. That rule isn't only for the safety of humans but also to keep these intelligent animals safe from us and, sometimes, their own natural curiosity. Wolves and humans have lived alongside each other for millennia and along every level of comfort: wolves as a part of the family to wolves hated and persecuted. Today, even in a protected, wild place like Yellowstone, wolves are better off afraid of humans.

briefly but no pups were ever observed. By the end of the year sightings were even more sporadic and one of the two collared yearlings traveled to northern Yellowstone while the other ranged widely but was not seen often and it is unknown how many wolves remain in the pack.

Bechler (4 wolves: 2 adults, 2 pups)

In collaboration with Utah State University, graduate student Aaron Bott took on an intensive project attempting to document wolf and other wildlife movement in the Bechler region. Bott hiked 485 kilometers (301 miles) and spent 25 nights in Bechler between July and November 2019 gathering data. Trail cameras in Bechler recorded at least four wolves, one of them a recognizable gray male seen in previous years, with another gray adult and two gray pups. The Bechler pack, which began in 2002, has waxed and waned in numbers, possibly due to varying winter prey use in the southwest corner of Yellowstone and wolf hunting in the state of Idaho.

Other wolves

1200M, loner

Collared as part of the Cougar Creek pack, 1200M dispersed from the pack in February but spent March through May traveling back and forth between his natal pack's territory and northern Yellowstone, seemingly alone. Over the summer his movements sometimes overlapped with the Phantom Lake pack but not enough to be considered a part of the pack.

1154F, loner

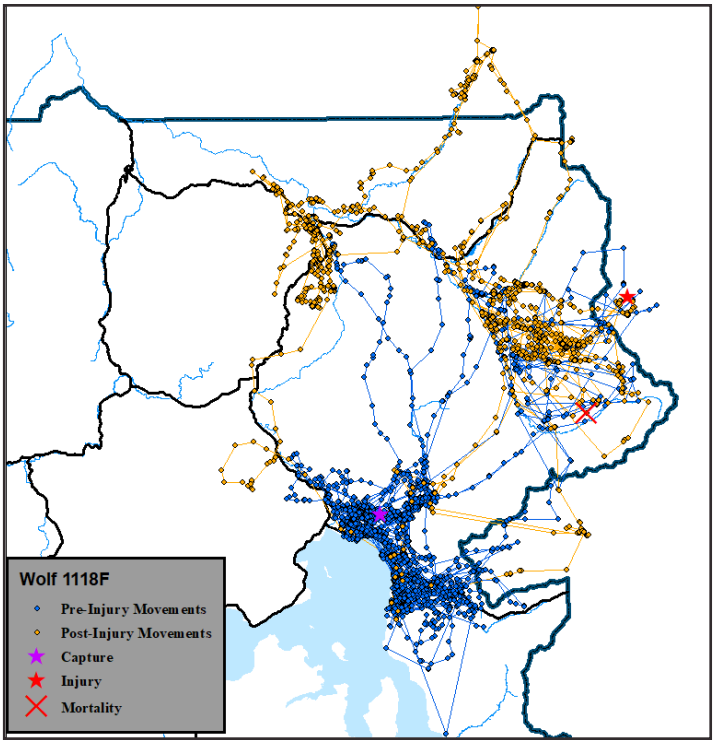
Born in the 8 Mile pack, 1154F dispersed over the summer and all sightings found her alone through the end of the year. She continued to travel throughout traditional 8 Mile territory but seemed to avoid the main pack.

Crevice Lake

In a surprisingly quick disintegration from December 2018 to January 2019, the Crevice Lake pack was not located in Yellowstone at all in 2019. Several pack members joined a pack north of Yellowstone monitored by Montana Fish, Wildlife and Parks, and the pack's former territory was quickly filled in by the new Phantom Lake pack.

1104F

Originally born in the Wapiti Lake pack, 1104F dispersed in March but returned to her natal pack for a short time over the spring before leaving for good in the summer. Sightings were rare until winter when 1104F was spotted with a large uncollared male. The pair moved south towards Grand Teton National Park by the end of the year.



Collared as an adult female in Mollie's pack, 1118F started her own group in May 2018 before being shot in late October 2018 outside of Yellowstone. Her rate of travel before the injury was approximately 10.6 km per day. In the two months after the injury, she traveled only 1.9 km per day but that was concentrated on just a handful of travel days between feeding for weeks on old carcasses she found far up the Lamar drainage on her way back into the park. As the injury healed somewhat and a crust formed on the snow in late winter, she was able to travel further - for the last 8 months of her life she traveled an average of 6.2 km per day. As a lone wolf this is a very slow average but, considering her injury, 1118F is an exceptional example of tenacity, determination, and grit.

1118F

After being shot just below the elbow during the 2018 wolf hunting season in Wyoming, wolf 1118F never joined back up with the remnants of her pack: her mate and two pups. She survived by chewing on old carcasses for several weeks at a time. Once in 2019 she was seen with another gray wolf, possibly her sister from Mollie's pack. 1118F's collar switched into mortality mode in September in a difficult-to-access area deep in Yellowstone's backcountry. Crews attempting to retrieve the collar and samples were thwarted by grizzly bears in the area and later attempts were abandoned due to accumulating snow.

Publications

Cusack, J.J., M.T. Kohl, M.C. Metz, T.Coulson, D.R. Stahler, D.W. Smith, and D.R. MacNulty. 2019. Weak spatiotemporal response of prey to predation risk in a freely interacting system. Journal of Animal Ecology 89: 1-12.

Hoy, S.R., D.R. MacNulty, D.W. Smith, D.R. Stahler, X. Lambin, R.O. Peterson, J.S. Ruprecht, and J.A. Vucetich. 2019. Fluctuations in age structure and their variable influence on population growth. Functional Ecology 34:203-16.

Koch, E.M., R. M. Schweizer, T.M. Schweizer, D.R. Stahler, D.W. Smith, R.K. Wayne, and J. Novembre. 2019. De novo mutation rate estimation in wolves of known pedigree. Molecular biology and evolution 36: 2536-2547.

Kohl, M.T., T.K. Ruth, M.C. Metz, D.R. Stahler, D.W. Smith, P.J. White, and D.R. MacNulty. 2019. Do prey select for vacant hunting domains to minimize a multi-predator threat?. Ecology letters 22: 1724-1733.

Carter, N.H., J.O. Bruskotter, J.A. Vucetich, R. Crabtree, H. Jaicks, G. Karns, M.P. Nelson. D.W. Smith, and J.D.C. Linnell. Towards human-wildlife coexistence through the integration of human and natural systems: a case of grey wolves in the Rocky Mountains, USA. Pages 384-413 ***in*** B. Frank, J.A. Glikman, and S. Marchini, editors. Human wildlife interactions: turning conflict into coexistence. Cambridge University Press, Cambridge, England.

Van Valkenburgh, B., R.O. Peterson, D.W. Smith, D.R. Stahler, and J.A. Vucetich. 2019. Tooth fracture frequency in gray wolves reflects prey availability. eLife 2019;8:e48628

2019 Wolf Project Volunteers

Name	Hours
Adam Fahnestock	320
Annie Stevens	960
Ben Breslau	288
Carly Segal	584
Celestina Davidson	288
Charlie Southwick	288
Gregor Woodruff	296
Hannah Booth	288
Hunter Stier	288
Jeremy SunderRaj	320
Logan Route	640
Maddy Jackson	960
Micah Jaffe	288
Nels Christensen	296
Penelope Haas	296
Taylor Bland	160
Zach Fogel	640
TOTAL	7,200

BACK COVER: Female wolf 1049F of the Phantom Lake pack tends to her pups in early July. This pack had two litters in 2019 totaling 13 pups. NPS Photo - D. Stahler.

Wolf Project Technician Madeline (Maddy) Jackson processes a bison kill likely made by the Junction Butte pack. Later Maddy found evidence that a grizzly bear chased the wolves off their kill. NPS Photo - A. Stevens.

For a complete list of our publications, please visit: go.nps.gov/yellwolves

Suggested citation: Smith, D.W., D.R. Stahler, K.A. Cassidy, E. Stahler, M. Metz, C. Meyer, J. Rabe, N. Tatton, J. SunderRaj, L. Carroll, M. Jackson, B. Cassidy, E. Loggers. 2020. Yellowstone National Park Wolf Project Annual Report 2019. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, WY, USA, YCR-2020-01.