WYOMING WOLF RECOVERY
2009 ANNUAL REPORT

A cooperative effort by the U.S. Fish and Wildlife Service, National Park Service, and USDA Wildlife Services

Photo: USFWS

This cooperative report presents information on the status, distribution, and management of wolves in Wyoming, including Yellowstone National Park, from January 1, 2009 through December 31, 2009.

Suggested Citation: Jimenez, M.D., D.W. Smith, D.R. Stahler, Erin Albers, and R.F. Krischke, 2010. Wyoming Wolf Recovery 2009 Annual Report. Pages WY-1 to WY-28 *in* U.S. Fish and Wildlife Service Rocky Mountain Wolf Recovery 2009 Annual Report. USFWS, Ecological Services, 585 Shepard Way, Helena, Montana, 59601.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

SUMMARY

In 2009, ≥320 wolves (*Canis lupus*) in ≥44 packs (≥27 breeding pairs) inhabited Wyoming (WY), including Yellowstone National Park (YNP). The wolf population increased statewide by approximately 6%, making 2009 the seventh consecutive year that the wolf population in WY has exceeded the numerical, distributional, and temporal recovery goals established by the U.S. Fish and Wildlife Service (USFWS). The wolf population in WY (outside YNP) increased by approximately 26%, consisting of ≥224 wolves in ≥30 packs of which ≥21 breeding pairs produced ≥89 pups that survived through 31 December 2009. Average pack size was 7 wolves per pack and average litter size was 4.1 pups per litter. Wolf numbers in YNP declined by approximately 23% with 96 wolves living in 14 packs of which 6 breeding pairs produced 23 pups that survived through the end of the year. Average pack size in YNP was 7.1 wolves per pack. We recorded 40 dead wolves in WY (outside YNP). Causes of mortality included: agency control = 31; under investigation and unknown = 7; and natural = 2. YNP recorded 10 dead radio collared wolves. Causes of mortality included: harvest or control outside YNP =3; control inside YNP =1; intraspecific pack strife =3; disease/unknown =2; and malnutrition = 1. Mortality numbers for YNP did not include pups born in spring 2009 that did not survive through 31 December 2009.

We managed wolf population growth and wolf distribution in WY (outside YNP) to minimize chronic loss of livestock from wolves and promote wolf conservation by maintaining the WY wolf population well above recovery objectives. In 2009, wolves killed ≥215 livestock (20 cattle and 195 sheep). Agency control efforts removed 31 depredating wolves (approximately 12% of the WY wolf population outside YNP) to reduce livestock losses due to wolves.

Numerous ongoing research projects investigated predator-prey interactions, wolf population dynamics, elk habitat selection, disease, genetics, interactions between wolves and other predators, and livestock depredations.

GREATER YELLOWSTONE RECOVERY AREA - WYOMING

PERSONNEL

Personnel in Wyoming outside Yellowstone National Park

In 2009, the USFWS monitored and managed wolves in WY outside YNP with the assistance from the U.S. Department of Agriculture APHIS Wildlife Services (WS), the National Park Service (NPS), and the Wyoming Game and Fish Department (WGFD). USFWS personnel were Project Leader Mike Jimenez, law enforcement agents Dominic Domenici (Resident Agent-in-Charge, Casper), Tim Eicher (Special Agent, Cody), Roy Brown (Special Agent, Lander), biologist Susannah Woodruff, and volunteer Kellie Antrobus.

WS personnel involved with wolf management in WY during 2009 were: State Director Rod Krischke, Grant Belden, Dan Braig, Chuck Bunch, Arnold DeBock, Jed Edwards, Dave Fowler, Tracy Frye, Miles Hausner, Kelly Huseby, Gerald Hyatt, Ted Jensen, David Johnson, Paul Kokes, Rod Merrell, Monty Nicholson, Brandon O'Brien, Kent Officer, Jamie Olson, Jim Pehringer, Michael Peterson, Nordell Putnam, Steve Richins, Brad Seaman, Luke Spanbauer, Lester Swanson, Melvin Utter, and Bob Wells.

NPS biologists involved in monitoring wolves in WY included Sarah Dewey and John Stephenson from Grand Teton National Park (GTNP).

Personnel in Yellowstone National Park

Three full-time employees worked for the Yellowstone Wolf Project in 2009: Project Leader Douglas Smith and Biological Science technicians Erin Albers and Rick McIntyre. Daniel Stahler split time between graduate work at UCLA and working in the park as the project biologist. Other paid and volunteer staff: Colby Anton, Nate Bowersock, Nick Bromen, Cheyenne Burnett, Carrie Byron, Brenna Cassidy, Grace Hammond, Sarah Hardee, Ted Jensen, Ky Koitzsch, Lisa Koitzsch, Bonnie McDonald, Meghan O'Reilly, Mike Peterson, Rebecca Raymond, Aaron Snyder, Dave Unger, Trina Wade, and Hilary Zaranek. Some of these staff members were paid technicians with funding provided by the Yellowstone Park Foundation and other contributions from other sources through them.

MONITORING

Monitoring wolves in Wyoming outside Yellowstone National Park

Population Status: As of 31 December 2009, we estimated that $\geq$224 wolves in $\geq$30 packs ($\geq$21 breeding pairs) inhabited western WY. Another $\geq$16 single wolves were located throughout the western portion of the state (Figure 1 and Table 1). Pack size ranged from 2 to 22 and averaged 7 wolves per pack.

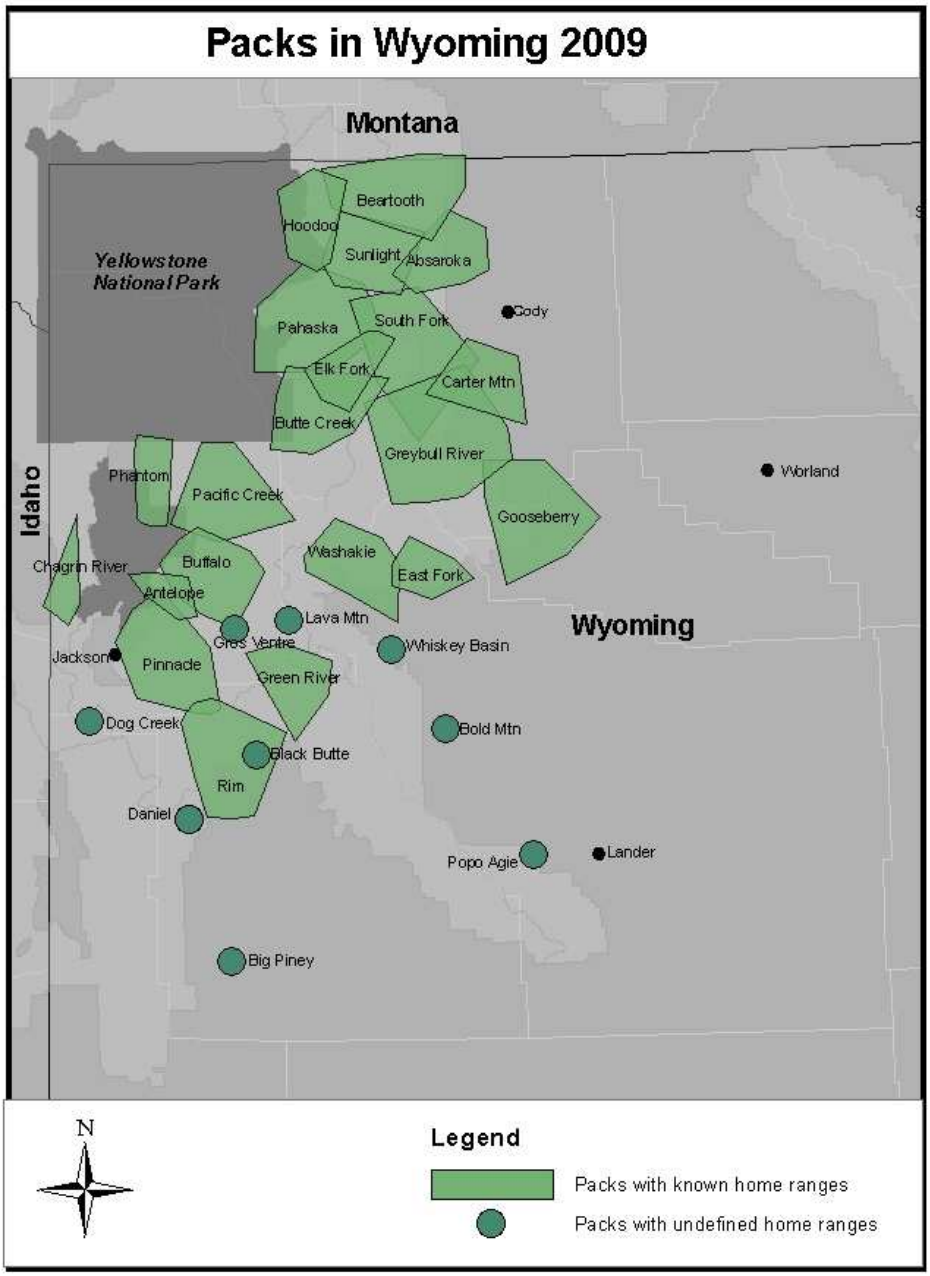

Figure 1. Home ranges of confirmed wolf packs in WY - 2009.

REF #	WOLF PACK	RECOV AREA	STATE	MINIMUM ESTIMATED PACK SIZE DEC 2009 ADULT	PUP	TOT	CONTROL	CONFIRMED LOSSES CATTLE	SHEEP	DOGS	OTHER
	Wyoming Outside Yellowstone National Park										
1	Absaroka	GYA	WY	2	2	4	4	4	0	0	
2	Antelope	GYA	WY	5	0	5	0	0	0	0	
3	Beartooth	GYA	WY	2	3	5	0	0	0	0	
4	Big Piney	GYA	WY	5	?	5	0	1	0	0	
5	Black Butte	GYA	WY	1	2	3	6	1	37	0	
6	Bold Mtn	GYA	WY	2	0	2	0	0	0	0	
7	Buffalo	GYA	WY	8	14	22	0	0	0	3	
8	Butte Creek	GYA	WY	4	4	8	1	0	0	0	
9	Carter Mtn.	GYA	WY	2	2	4	3	1	0	0	
10	Chagrin River	GYA	WY	4	3	7	0	0	0	0	
11	Daniel	GYA	WY	4	?	4	0	1	0	0	
12	Dog Creek	GYA	WY	1	5	6	5	0	45	3	
13	East Fork	GYA	WY	4	4	8	2	2	0	0	
14	Elk Fork Creek	GYA	WY	3	2	5	0	0	0	0	
15	Gooseberry	GYA	WY	4	4	8	0	0	0	0	
16	Green River	GYA	WY	3	5	8	4	7	0	0	
17	Greybull River	GYA	WY	4	3	7	0	0	0	0	
18	Gros Ventre	GYA	WY	3	0	3	0	0	0	0	
19	Hoodoo	GYA	WY	6	4	10	0	0	0	0	
20	Lava Mtn	GYA	WY	3	4	7	0	0	0	0	
21	Pacific Creek	GYA	WY	10	4	14	0	0	0	0	
22	Pahaska	GYA	WY	5	4	9	0	0	0	1	
23	Phantom Springs	GYA	WY	5	4	9	0	0	0	0	
24	Pinnacle Peak	GYA	WY	8	6	14	0	0	0	0	
25	Popo Agie	GYA	WY	2	0	2	0	0	0	0	
26	Rim	GYA	WY	4	2	6	0	0	0	0	
27	South Fork	GYA	WY	4	2	6	1	0	0	0	
28	Sunlight	GYA	WY	2	2	4	0	0	0	0	
29	Washakie	GYA	WY	6	4	10	0	0	0	0	
30	Whiskey Basin	GYA	WY	3	0	3	0	0	0	0	
	Sub-total			**119**	**89**	**208**	**26**	**17**	**82**	**7**	**0**
	Packs no longer existing										
1	~~Deer Creek~~	GYA	WY	0	0	0	ukn	1	0	0	
2	~~Huckleberry~~	GYA	WY	0	0	0	0	0	0	0	
3	~~Prospect~~	GYA	WY	0	0	0	2	1	0	0	
4	~~Snake River~~	GYA	WY	0	0	0	0	0	0	0	
5	~~Big Horn~~	GYA	WY	0	0	0	3	0	101	0	
	Misc. wolves										
	Misc./Lone wolves	GYA	WY	16	0	16	0	1	0	0	
	WY Total (outside YNP)		WY	**135**	**89**	**224**	**31**	**20**	**195**	**7**	**0**

Underlined packs are counted as breeding pairs toward recovery goals.

Strike through indicates pack no longer exists.

Table 1. Composition of confirmed wolf packs in Wyoming in 2009.

We combined 3 techniques to estimate the minimum total number of wolves in WY: 1) direct observations of wolves; 2) winter track counts of wolves traveling in snow; and 3) confirmed reports of wolf sightings from other agencies. We defined a pack as ≥2 wolves traveling together using a defined home range. A breeding pair was defined as ≥1 adult male and ≥1 adult female in a pack producing ≥2 pups that survived through 31 December of that year. We counted the number of wolves in packs containing radio collared wolves using visual observations from the ground and aerial telemetry flights. We tracked wolves in winter and counted the different sets of wolf tracks in snow. In areas where repeated sightings were confirmed by state and federal agencies, we incorporated those observations into our estimates. Visual observations from telemetry flights in early January 2010 were also used to improve our year-end estimates. Our final population count was a minimum estimate and not a precise census.

Population Growth: The WY (outside YNP) wolf population in 2009 increased approximately 26% from ≥178 wolves in 2008 to ≥224 wolves in 2009 (Figure 2). From 2000 through 2009, the wolf population has grown each year, with the exception on 2008. Average increase has been approximately 19% per year.

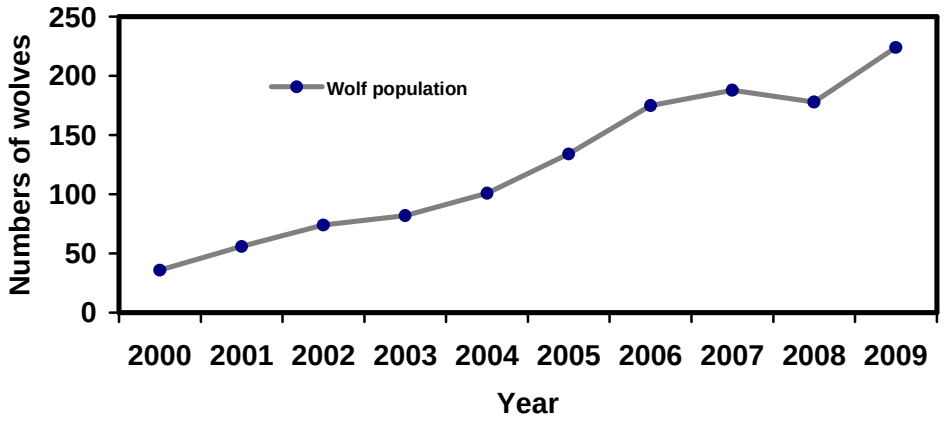

Figure 2. Wolf population growth in WY: 2000 - 2009.

Reproduction: A total of 21 packs produced ≥89 pups and met the USFWS breeding pair definition. Breeding pairs in 2009 included: Absaroka, Beartooth, Buffalo (2 litters), Butte Creek, Carter Mtn., Chagrin River, East Fork, Elk Fork Creek, Gooseberry, Green River, Greybull River, Hoodoo, Lava Mtn., Pacific Creek, Pahaska, Phantom Springs, Pinnacle Peak, Rim, South Fork, Sunlight, and Washakie (Figure 3). Mean litter size of pups surviving to 31 December 2009 was 4.1 pups per litter and ranged from 2-14 pups (14 pups were a double litter) (Figures 4). We were not able to confirm pup production in: Big Piney, Bold Mtn., Daniel, Gros Ventre, Popo Agie, and Whiskey Basin Packs. The Dog Creek, Antelope, and Black Butte Packs did not contain ≥2 adults and ≥2 pups on 31 December 2009.

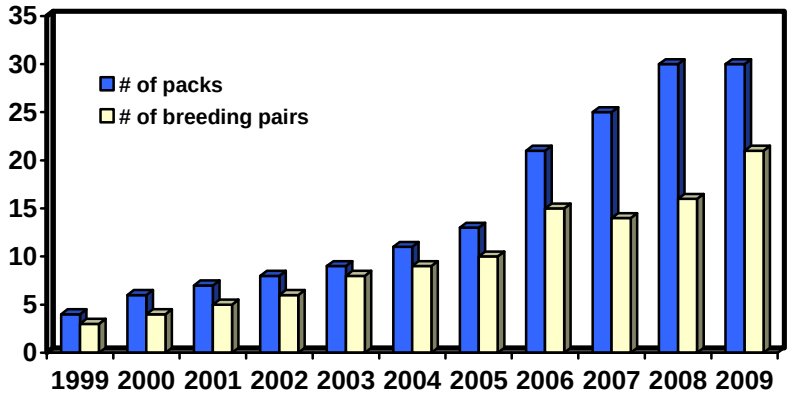

Figure 3. Number of wolf packs and breeding pairs in WY: 1999 – 2009.

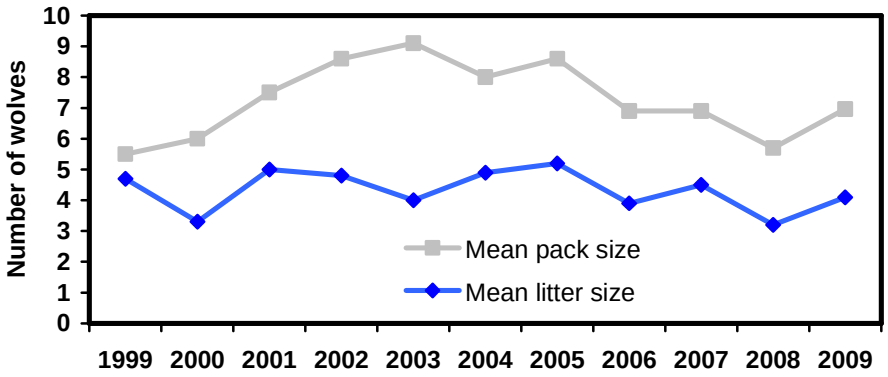

Figure 4. Mean pack size and mean litter size for wolves in WY: 1999 - 2009.

Mortalities: In 2009, 40 wolves (15% of the total population) were known to have died in WY. Causes of mortality included: agency control = 31 (77% of all documented mortality); unknown or under law enforcement investigation = 7 (18%); and natural = 2 (5%).

Radio Collars: A total of 38 wolves were radio collared in 2009 (VHF and ARGOS collars) and we monitored a total of 50 radio collared wolves (22% of the population) in 20 packs (67% of all packs). From 1999 through 2009, we maintained radio collars on 20-25% of the wolf population each year to monitor their movements, locate den and rendezvous sites, document breeding success, locate wolves to mitigate livestock conflicts, and aid in law enforcement. We used VHF radio collars for general monitoring purposes and used various types of GPS and ARGOS collars for specific research projects.

Pack assignment to states and national parks: Wolf packs were defined as ≥2 wolves traveling together in a defined home range. Packs were assigned to specific states or national parks based on which area contained the majority of the packs annual home range. Breeding pairs were defined as ≥1 adult male and ≥1 adult female with ≥2 pups surviving through 31 December of that year. Breeding pairs were assigned to the state or park where wolves denned and raised pups. However, if wolves denned in one state or park, but the majority of their home range was located outside that state or park, those wolves were assigned to the area that included the majority of their home range.

WY contains 2 national parks (YNP and GTNP). In 2009, YNP had 14 wolf packs, including 6 breeding pairs that denned within the boundaries of YNP. The home range Bechler Pack (YNP) straddled the WY-Idaho (ID) state border; however, the majority of the pack's home range was in YNP. GTNP had 2 wolf packs (Phantom Springs and Buffalo Packs) that denned within the park boundary; however, the Buffalo Pack's home range was mostly outside the park. The Antelope Pack denned outside of GTNP, but the majority of its home range was inside the park boundary. On 31 December 2009, no pups had survived in the Antelope Pack.

The home range of the Chagrin River Pack straddled the WY-ID state border. The pack denned in WY and spent most of the year within the state of WY.

Disease Surveillance:

Mange

Sarcoptic mange is a highly contagious skin disease caused by mites (*Sarcoptes scabiei*) that burrow into the epidermis of the host animal and create tunnels where females lay eggs. Larvae hatch from eggs, which molt through 2 nymph stages and continue to burrow new tunnels in the epidermis. The 2-week life cycle is completed after the second nymph stage molts to adults. Each stage can add to the tunnel system but most tunneling is done by adult females. Burrowing in the epidermis and allergic responses by the hosts to excretions from the mites causes pruritis (severe itching) which leads to progressive skin damage as the host animal bites, scratches, and rubs the affected area. Infested animals generally suffer from alopecia (loss of hair), hyperkeratosis (thickening of the skin), seborrhea (excessive discharge from sebaceous glands causing an oily coat, scales, and surface crust on the skin), scabs, ulcerations, and lesions. Severe cases can affect the animal's entire body and can lead to emaciation, poor body condition, and death from secondary infections or hypothermia in winter due to hair loss. Sarcoptic mange is spread from infested animals to new hosts by direct contact, contact with areas contaminated with mites (ie: bedding sites or dens), or contact with common rubs used by infested animals.

Sarcoptic mange is fairly common in wolf populations through out the world, including wolves in Canada, Alaska, Wisconsin, Minnesota, and Michigan. Based on other areas that have experienced epizootic mange infestations, sarcoptic mange in the northern

Rocky Mountain (NRM) wolf population will most likely be localized in specific areas and not threaten regional wolf population viability.

From 1995 through 2008, we identified wolves infested with *Sarcoptes scabiei* in WY and MT; however, sarcoptic mange was not confirmed in any wolves in ID (Jimenez et al. 2010). We also confirmed wolves infested with *Sarcoptes scabiei* and displaying signs of alopecia, hyperkeratosis, and seborrhea; however, in the following year those wolves appeared to recover from the previous infestation and body hair had re-grown (Jimenez et al. 2010). Pups have been vulnerable to *Sarcoptes scabiei* infestation. We suspected sarcoptic mange in the Antelope Pack in February 2009 when we captured and radio collared 5 wolves displaying signs of alopecia and seborrhea. The pack produced $\geq$2 pups, but during summer 2009, 2 pups were seen with severe alopecia. By 31 December 2009, it appeared that no pups survived in the Antelope Pack. Wolves displaying signs of sarcoptic mange were seen in the Absaroka and Antelope Packs in 2009, but the overall occurrence of mange in WY (outside YNP) may be declining.

Canine Distemper and Canine Parvovirus

Canine distemper (CDV) and canine parvovirus (CPV) are highly contagious diseases that infect domestic dogs, coyotes, fox, raccoons, skunks, and wolves. In 2009, 35 wolves were tested for CDV and CPV. Test results for CDV were: 80% (n=28) positive and 20% (n=7) negative. Test results for CPV were: 94% (n=33) positive and 6% (n=2) negative. Based on other areas of the world that have experienced epizootic CDV and CPV infections, these diseases in the NRM wolf population will most likely occasionally cause some mortality, particularly among pups, but will be localized in specific areas/years, and not threaten regional wolf population viability.

Brucellosis

Blood taken from 35 wolves captured in WY during 2009 were tested for *Brucella canis* and all samples tested negative. Nineteen wolves were tested for *Brucella abortus*, 89% (n=17) of the samples tested negative and 11% (n=2) tested positive. "A positive serology titer for *Brucella abortus* in a wolf means that the wolf has been infected with the bacteria sometime in the past (probably in the last 12 months) and developed an immune response reflected in the antibodies measured by the diagnostic tests. A positive test does not mean that the wolf is currently infected with living bacteria, although it can be. How a wolf becomes infected by *Brucella abortus* is speculative. Possible ways of becoming infected include: 1) consumption of a fetus aborted by an infected elk or bison; 2) consumption of an adult, pregnant, infected elk or bison (particularly consumption of the reproductive tract); 3) consumption of an adult, infected, but not pregnant elk or bison (unlikely source); or 4) contact with the environmental site of an aborted fetus (also unlikely). Wolves can become infected with *Brucella abortus* and transiently shed the bacteria in the feces, although the amount of shed bacteria is thought to be insufficient to infect cattle, elk, or bison" (Terry Kreeger, DVM, PhD).

Wolf Packs in Wyoming outside YNP in 2009

Nineteen confirmed wolf packs had their territories in northwest WY with relatively high native ungulate densities and relatively low seasonal exposure to domestic livestock. Livestock depredations in these areas were relatively few and sporadic in 2009. Pack size and composition were based on our best estimates as of 31 December 2009.

1) *Antelope Pack:* (5 wolves: 5 adults/0 pups) The Antelope Pack formed in 2008 when wolves split off from the adjacent Huckleberry Pack. The pack denned in 2009 and produced ≥2 pups, but the entire pack became infested with *Sarcoptes scabiei* (mange). By December, 2 adult wolves died of unknown causes and it appeared that no pups survived.

2) *Beartooth Pack:* (5 wolves: 2 adults/3 pups) The Beartooth Pack was involved in numerous livestock depredations in 2008 and 2007; however, in 2009 no depredations were reported in the pack's home range. A radio collared adult male wolf dispersed from the Steel Mountain Pack in central Idaho in 2007 and paired with a female wolf from the Beartooth Pack in 2008. The pair produced pups in 2009.

3) *Bold Mountain Pack:* (2 wolves) Agency reports led to the documentation of this pack in late summer 2008. Numerous photos taken from remote sensing cameras have consistently shown 2 wolves traveling together in the area. Reproduction was not confirmed and little is known about this pack. USFWS biologists and personnel from the Wind River Indian Reservation attempted to identify movement patterns of these wolves, but were unsuccessful. Sporadic reports of wolves in the area will be monitored.

4) *Buffalo Pack:* (22 wolves: 8 adults/14 pups) The Buffalo Pack formed in 2006 and usurped the Teton Pack from their territory the same winter. The pack normally produced large litters, but only 2 pups survived in 2008. The pack produced a double litter of 14 pups in spring 2009 and their home range continued to include GTNP and the adjacent national forest. The pack killed 3 lion hounds in the Gros Ventre drainage in November 2009.

5) *Elk Fork Creek Pack:* (5 wolves: 3 adults/2 pups) This pack was documented in 2008 when a radio collared wolf dispersed from the Pahaska Pack. The pack was occasionally exposed to livestock, but no livestock depredations were reported in 2009

6) *Gooseberry Pack:* (8 wolves: 4 adults/4 pups) The Gooseberry Pack formed in 2006 when the lone remaining wolf from the Owl Creek Pack paired with another wolf. The new pack was implicated in numerous depredations in 2006 and 2007. The entire pack of 6 wolves was removed in control actions in 2008 after they repeatedly killed cattle. A new pack formed in 2009 but was not involved in any livestock depredations that year.

7) *Greybull River Pack:* (7 wolves: 4 adults/3 pups) The home range of the Greybull River Pack includes areas where large numbers of cattle graze. The pack has been involved in chronic depredations since 2003. In 2007, 8 wolves were controlled for confirmed depredations of 2 cattle. At least 1 cow was killed in 2008 and 2 wolves were removed. No depredations were reported in 2009.

8) *Gros Ventre Pack:* (3 wolves: 3 adults/0 pups) This small pack has persisted for several years in the Gros Ventre drainage. Given the several large adjacent packs in the area and the many potential young dispersers within these packs, it is likely that the Gros Pack will increase next year.

9) *Hoodoo Pack:* (10 wolves: 6 adults/4 pups) The Hoodoo Pack formed in 2009 after repeated livestock depredations in the Sunlight Basin led to the removal of the entire Crandall Pack and most of the Sunlight Pack in 2008. The Hoodoo Pack produced pups in 2009 and was not involved in any livestock depredations. Two radio collared wolves from the pack dispersed to the Lamar Valley in YNP.

10) *Lava Mountain Pack:* (7 wolves: 3 adults/4 pup) USFWS has received reports of wolves in this area since 2006. In summer 2009, USFWS biologists found a rendezvous site and confirmed 3 adults and 4 pups.

11) *Pacific Creek Pack:* (14 wolves: 10 adults/4pups) The Pacific Creek Pack was first documented in 2004. Mange was found on two members of this pack in winter 2006 during capture efforts, but mange was not found on Pacific Creek wolves in 2008 or 2009.

12) *Pahaska Pack:* (9 wolves: 5 adults/4 pups) The Pahaska Pack was first documented in 2007. Radio contact with the Pahaska Pack was lost when the only radio collared wolf in the pack dispersed >150 miles to southern WY. The Pahaska Pack was not involved in any livestock conflicts in 2007, 2008, or 2009, but they killed a hiker's dog in 2009.

13) *Phantom Springs Pack:* (9 wolves: 5 adults/4 pups) Numerous agency and citizen reports led to the documentation of this pack in 2008. This pack possibly formed from members of the Huckleberry Pack. The pack's home range is mostly in GTNP; however, the pack makes occasional long distance movements in the winter to southern YNP.

14) *Pinnacle Peak Pack:* (14 wolves: 8 adults/6 pups) The Pinnacle Peak Pack was documented in fall 2007 when a 2-year old radio collared female dispersed from the Buffalo Pack. The pack's home range includes the National Elk Refuge and the Granite Creek drainage near Bondurant, WY.

15) *Popo Agie Pack:* (2 wolves/0 pups) Wolves were confirmed in the Sinks Canyon area in 2008, with reports of at least 2 wolves. We continuously received reports of these wolves, but we have not been able to confirm pack size or pack composition.

16) *Rim Pack:* (6 wolves: 4 adults/2 pups) This pack was first discovered in April 2008 when a 3-year old radio collared male dispersed from the Pinnacle Peak Pack. The pack produced pups in 2008 and 2009.

17) *Sunlight Pack:* (4 wolves: 2 adults/2 pups) The Sunlight Pack has occasionally killed livestock in the past, but during summer 2008 the pack repeatedly killed cattle on private

property and public grazing allotments. All but 4 wolves were removed from this pack in 2008 in an effort to stop depredations. Mange has been documented in this pack since 2003. The pack persisted in 2009 and no depredations were reported within their home range.

18) *Washakie Pack:* (10 wolves: 6 adults/4 pups) The Washakie Pack has existed since 1997 and has been implicated in numerous depredations. A public grazing allotment that overlapped the pack's home range was retired in 2008, and no depredations were reported in 2009.

19) *Whiskey Basin Pack:* (3 wolves) This pack was first documented in winter 2008. Numerous photos consistently show 3 wolves. Despite considerable field efforts, we have not been able to document reproduction or pack composition.

Home ranges of 14 wolf packs in WY whose home ranges overlapped areas where large numbers of domestic livestock grazed on private and public lands were involved in at least 1 depredation in 2009.

1) *Absaroka Pack:* (4 wolves: 2 adults/2 pups) Due to chronic depredations, all but 2 wolves were removed from the Absaroka Pack in control actions in 2007. The pack reformed in 2008, and 2 more wolves were removed after 2 confirmed depredations. This pack continues to persist in spite of chronic mange infestations and repeated cattle depredations. In 2009, 4 wolves were removed after the pack killed 4 cattle.

2) *Big Piney Pack:* (5 wolves) Multiple wolves were found near Big Piney region in fall 2008 and in 2009. Depredations have been chronic in this area in the past, but no depredations were confirmed in 2007 or 2008. One calf was killed in 2009. We could not confirm reproduction or pack composition.

3) *Black Butte Pack: (*3 wolves: 1 adult/2 pups) This pack formed and reproduced in 2006, but chronic depredations have led to numerous control actions. A dispersing radio collared male from the Jackson area was located here in late summer 2008 with 1 other wolf. The pair produced 6 pups in 2009. After the pack killed 37 sheep and 1 yearling steer, both adults and 4 pups were removed. The 2 remaining pups survived and were later joined by a dispersing, radio collared, male wolf from the Phantom Springs Pack near Jackson, WY.

4) *Butte Creek Pack:* (8 wolves: 4 adults/4 pups) This pack was first documented in summer 2008 when 2 radio collared wolves dispersed from the South Fork Pack. In the following year, the pack produced 4 pups. One wolf was removed in 2009 after the pack severely injured 1 cow**.** No further depredations were reported after the control action.

5) *Carter Mountain Pack:* (4 wolves: 2 adults/2 pups) In past years, chronic depredations have been documented in the Carter Mountain Pack. In 2007, all but one wolf were removed in control actions. The pack reformed in 2008 and killed 1 cow. Two wolves were removed in a control action and no additional depredations were recorded. In 2009,

the pack killed 1 calf. Given the pack's history of chronic depredations, 3 wolves were removed and no further depredations occurred.

6) *Chagrin River Pack:* (7 wolves: 4 adults/3 pups) Wolves were first documented in the Driggs area in 2005 when a radio collared male dispersed from the Teton Pack. Contact was lost in 2006 when this collar was chewed off. In summer 2008, USFWS followed up on reports from a hunter leading to the discovery of a missing radio collared wolf from the Huckleberry Pack with 5 other wolves. The pack killed 1 calf near Victor, ID in 2009. ID WS attempted to trap and remove a wolf near the depredation site, but were unsuccessful. No other depredations occurred and control effort ended.

7) *Daniel Pack*: (4 wolves) There were 4 wolves in the Daniel Pack at the end of 2007. In early 2008, this entire pack was killed by private individuals when wolves were delisted and WGFD designated wolves as predators in this area. There was no evidence of wolves in this pack at the end of 2008. The pack reformed in 2009 and killed 1 calf. No additional depredations occurred.

8) *Dog Creek Pack:* (6 wolves: 1 adult/5 pups) This pack was discovered in summer 2008 when at least 12 sheep were killed on a public grazing allotment. One wolf was removed in a control action and no additional depredations were reported. The pack produced 6 pups in 2009 and quickly began killing sheep once the grazing season began. Five adult wolves were removed after the pack had killed 45 sheep and 3 guard dogs. At the end of 2009, $\geq$1 adult and $\geq$5 pups remained in the Dog Creek drainage.

9) *East Fork Pack:* (8 wolves: 4 adults/4 pups) The East Fork Pack was first documented in 2005, but is suspected to have been around since at least 2004. In 2006, a radio collared wolf dispersed from the adjacent Washakie Pack and joined the East Fork Pack. The East Fork Pack killed 2 cattle in 2005, 2 cattle in 2006, 6 cattle in 2007, and 2 cattle in 2008. Three wolves were removed in control actions in 2008. In 2009, 2 calves were killed. Depredations stopped after 2 wolves were removed.

10) *Green River Pack:* (8 wolves: 3 adults/5pups) With several thousand cattle grazing in the Upper Green River drainage, the Green River Pack has been removed several times since 2002 due to chronic depredations, but new packs continue to recolonize the area. The pack killed >10 cattle in 2002, >9 cattle and 1 sheep in 2003, >20 cattle in 2004, >10 cattle in 2005, >27 cattle in 2006, >12 cattle in 2007, and >11 cattle and 14 sheep in 2008. Control actions were ongoing in 2008; however, no wolves were removed. The pack reproduced in 2009 and began killing cattle early in the summer. By the end of the grazing season 4 wolves were removed and there were a total 7 confirmed cattle depredations.

11) *South Fork Pack:* (6 wolves: 4 adults/2 pups) The South Fork Pack formed in 2005 and have since been implicated in chronic depredations killing >3 cattle in 2005, >19 cattle in 2006, >1 cattle in 2007, and at least 4 cattle in 2008. The South Fork and the Absaroka Packs were both in the vicinity of a livestock depredation in 2009. One wolf from the South Fork Pack was removed and no further depredations occurred.

Packs no longer existing or missing

1) *Deer Creek Pack:* A pair of wolves was repeatedly seen during winter 2009 in Converse County. WS unsuccessfully attempted to trap and radio collar these wolves in the spring after they killed a calf. We did not receive any other reports of wolves in the area for the rest of the year and we suspect that the wolves no longer exist.

2) *Prospect Pack:* Since 2005, the Prospect Pack has been implicated in multiple depredations: 33 sheep in 2005, and 22 cattle in 2006. No depredations were reported in 2007 or 2008. At the end of 2007, at least 3 wolves were confirmed in the Prospect Pack. Two wolves were killed while wolves were delisted and were classified by WGFD as predators in this area. Two wolves were repeatedly seen in the same area in 2009. Both wolves were removed after they killed a calf.

3) *Big Horn Pack:* Wolves have dispersed to the Big Horn Mountains on numerous occasions over the last several years; however, no packs and no reproduction have been confirmed. In 2007, 4 sheep were killed by wolves. Two wolves have been inadvertently killed by M-44's used for coyote control. In 2009, 2-3 wolves began killing sheep on private land in the southern Big Horn Mountains. Shoot-on-site permits were issued to the wool growers who lost sheep and WS repeatedly tried to remove the offending wolves in very difficult terrain. Three male wolves were finally removed, but not until the wolves killed ≥113 sheep. After the wolves were killed, we discovered that one of the wolves was radio collared and had dispersed from Montana.

4) *Snake River Pack:* (4 wolves: 4 adults/? pups) Reproduction in the Snake River Pack was not documented in 2008. Their remote location did not allow confirmation of reproduction or pack composition. By 2009, we suspected the pack no longer existed.

5) *Huckleberry Pack:* (3 wolves: 3 adults/? pups) The Huckleberry Pack formed in 2006 and possibly combined with the Sage Pack in 2007. Members of this pack split and formed the Antelope Pack and possibly the Phantom Springs Pack. During winter 2009, a remote camera took a photo of ≥6 uncollared wolves within the old home range of the Huckleberry Pack. It's unclear if these wolves are remnants of the old Huckleberry Pack or possibly wolves from the Bechler Pack in YNP. This winter we will attempt to radio collar these wolves and unravel the mystery.

Monitoring in Yellowstone National Park

Population and Territory Status

At the end of 2009, at least 96-98 wolves in 14 packs (6 breeding pairs), 1 non-pack grouping, and 2 loners occupied Yellowstone National Park (YNP; Fig. 3, Table 2b). This represents a 23% decline from 124 in 2008. Despite the decline the number of breeding pairs did not change (6 in both 2008 & 2009). Both the northern range and

interior populations declined, but the decline was greater for the northern range (-29%) than for the interior (-18%). For the second consecutive year the interior wolf population was larger than the northern range. This is also the first population decline (there were three other years the YNP wolf population declined: 1999, 2005, 2008) without evidence of the disease distemper, and also the first consecutive year decline since wolf reintroduction in 1995. Intraspecific strife, food stress, and mange are all likely reasons for fewer wolves in YNP.

Despite the downward trend, two new packs formed in 2009: Lava Creek on the northern range and Grayling Creek in the interior. Lava Creek was comprised of 3 wolves at year end, 2 of which had been together (#471F & SWMT#147) without successfully reproducing for over a year. Grayling Creek formed from dispersers from the Cougar Creek (#632F) and Gibbon Meadows packs (#647M) joined with one other uncollared adult. They had at least 2 pups making them a breeding pair. Wolf #632F (a three-legged wolf) died late in the year, probably killed by other wolves. No packs were lost in 2009, each pack just ended the year with fewer wolves.

Pack size ranged from 3 (Lava Creek & Canyon) to 17 (Gibbon Meadows) and averaged 7.1, down from the long-term average of about 10. The average number of pups/pack in early winter was 1.8 for all packs, but 3.8 for packs that had pups (5 of 13 packs had either no pups or no surviving pups; Cottonwood Creek pack not included), both counts were down from long-term averages.

Both of the notably old wolves, 12 years old (#126F Delta pack and #192M Bechler pack), died in 2009 as did 9 year old wolf #302M. #302 was killed by other wolves, probably the Quadrant Mountain pack. Other old wolves that survived the year were #472F of Agate Creek (8-9 years), #586M of Mollie's (7-8 years), #482 of Gibbon Meadows (8-9 years). Wolf #480M, the long-time alpha male from Druid Peak, at 7-8 years and with a bad case of mange, appeared unlikely to survive.

Northern Range: After an almost complete reorganization of the packs on the northern range in 2009, wolf territories were relatively stable, but a significant number of wolves/pack were lost a second consecutive year: from 94 wolves at the end of 2007 to 40 (-57%) at the end of 2009. Disease, both distemper and mange, intraspecific strife, and food stress all contributed to the decline. Distemper at the time of this writing had not been documented in 2009, but mange was still prevalent among many wolves, especially Druid Peak, and was likely a contributing factor for some wolf mortalities. Likely fewer vulnerable elk, because the elk count indicated a stable population in 2008, were present leading to less food consumption and mortality as at least one wolf died from malnutrition, a rare cause of death for YNP wolves thus far. Fewer vulnerable elk was also probably an underlying cause of intraspecific strife.

No packs were lost on the northern range and one new one formed (Lava Creek). The Mount Everts packs by year end was much reduced with no surviving pups as was Druid Peak and Agate Creek. Blacktail and Quadrant Mountain fared the best each with surviving pups, and Cottonwood Creek also had pups, but 4 of 10 wolves, including both

alphas and radio-collared wolves, were harvested during the Montana wolf hunting season, so the pack could no longer be tracked and was not counted as a breeding pair. Other than one sighting of one wolf (#383M), Slough Creek was not present in YNP in 2009. Mange in Druid Peak was extensive and likely contributed to pup mortality as well as adult mortality. Several wolves were observed sleeping standing up, probably because they did not want to lie in the snow. Mange was also present in other packs on the NR, but no cases were as severe as in Druid Peak.

Interior: Wolf numbers declined only slightly for wolves living in the interior of YNP. Lower density, possibly leading to less exposure to disease including mange, and greater reliance on bison likely reducing food stress, kept the interior population from declining as much as the northern range. No pack was lost, and one pack formed (Grayling Creek). The Canyon pack for the second year had young, but none of them survived and they spent time both in the interior and on the northern range. Mollie's, Gibbon Meadows, and Cougar Creek were stable. The status of Bechler and especially Yellowstone Delta is less clear than previous years as there were no or few radios. The only radio-collared wolf (#192M) in Bechler died in 2009 making tracking and counts difficult. The Delta pack was equally hard to track and no radio-collared wolf was consistently tracked. One backcountry trip into the Thorofare region recorded multiple areas of wolf sign, therefore wolves were present, but none of the sign indicated pack activity.

Reproduction

Of the 44 known births in 2009, 23 pups (only one more than in 2008) survived the summer. Like 2008, this was one of the lowest years for pup production since wolf reintroduction. Although the survival rate was not as low (52%) as in previous years when distemper was documented, pups likely died before they were observed. So far, and unlike other years when pup production was poor, distemper does not appear to be the cause of the poor recruitment. Lack of food over the summertime was a probable cause of poor pup production, although other causes cannot be ruled out. The Druid Peak pups had especially bad cases of mange, a likely contributing factor to their mortality and none of them survived. At year end, 24% of the park wolf population was pups, slightly higher than the 17% in 2008. Eleven of 13 packs had pups (85%; Delta excluded as pup status was unknown), but by year end only 6 packs had pups (46%; assuming there were surviving pups in the Cottonwood Creek pack). There was no evidence of pups in Lava Creek or Agate Creek. Pups were born, but none survived in the Mt. Everts, Druid Peak, and Canyon packs. Gibbon Meadows for the second year had the most surviving pups (6). Two packs (Druid Peak and Blacktail) had two litters of pups.

Mortalities

Ten collared wolves died in 2009 (Table 2b). These included 3 old adults (>5 years), 6 adults (2-5 years), and one yearling. Two males and 8 females died. Four wolves were harvested or killed in control actions outside YNP that originated in the park (one uncollared food-conditioned wolf was killed in YNP), 3 died from intraspecific strife, one

from malnutrition, and 2 from unknown natural causes (one of these wolves was 12 years old (#192M) and the other was probably intraspecific (#632F).

Yellowstone National Park Wolf Packs in 2009

Quadrant Mountain Pack (7 wolves: 4 adults, 3 pups)

After localizing at a new den site in Reese Creek, spring counts showed three pups for this group and as a result, 2009 represents this pack's first year with surviving young since their formation. Collared individuals still include #469F (original alpha female) and #695M (alpha male) but field evidence has revealed an uncollared black adult female, a possible sister to #469F, as vying for the alpha position. With the pack now numbering seven wolves, their territory has expanded slightly to include Willow Park, Elk Plaza, and the Bunsen Peak/Osprey Falls region. With expanded use out of their core Gardner's Hole territory dominated by bull elk, these other areas offer greater access to cow/calf elk groups. Moreover, they have shown slight overlap in territory, at their eastern boundary, with the Blacktail Deer Plateau pack and the roving Canyon pack. It is likely that Quadrant Mountain wolves are responsible for the death of #302M, former alpha male of the Blacktail pack. Despite more frequent interaction with other packs than in 2008, all individuals in this group have yet to show signs of mange.

Mount Everts Pack (4 adult wolves)

The Everts pack continued to hold their territory atop the namesake mountain near the north entrance of Yellowstone. Although spending the majority of their time in a relatively small area of rolling hills and plateau terrain bordered by the Yellowstone River, the towns of Gardiner and Mammoth Hot Springs, this pack appeared to thrive in the first half of the year in a territory rich in elk, mule deer, bison, bighorn sheep, and pronghorn. In early 2009, downloadable GPS-collars were deployed on wolves #684M (black yearling male) and #685M (gray alpha male), allowing for detailed study of predation patterns, especially in summer. Although numbering seven adults and five pups at mid-summer, the pack declined to just four adults at year end with a seemingly fragmented pack structure. At least two adults died during the summer, including the uncollared alpha female and an old adult female, as well as the entire litter of pups, putting the fate of this pack in question by year's end. All wolves in this pack showed moderate signs of mange, which may have contributed in part to pup mortality. With the alpha female gone, it was suspected that #470F would take the lead along alpha male #685M, but she continues to exhibit her curious independence and occasional solitary existence within the confines of her once natal Leopold territory that is now Everts'.

Lava Creek: (3 adult wolves)

The Lava Creek pack formed in late February when former Agate female #471F and Agate/Blacktail female #692F joined with SW#147M, a black male disperser from the Eight Mile pack in Montana's Paradise Valley. Number 692F soon left and traveled with

the Agate pack before rejoining the Blacktails. A two-year-old gray Agate female joined the pack in March. The pack localized around Lava Creek as if denning, but no pups were discovered. Suspected alpha #471F was seen during denning season with the Blacktail pack temporarily, but returned to the other two Lava Creek wolves in May. The frequent peaceful intermingling between all these Lava, Blacktail, and Agate females is presumably due to their close kinship and natal origin from the Agate Creek pack. The three spent most of the summer ranging from Lava Creek to Grizzly Lake. Despite #SW147M's severe mange in early 2009, and slight mange on #471F, all three wolves appear to be mange-free at year's end.

Blacktail Deer Plateau* Pack *(9 wolves: 5 adults, 4 pups)

The Blacktail pack remained a force on the northern range in 2009. Led by nine-year-old #302M and three-year-old #693F, the Blacktail wolves traveled widely from Little America to Swan Lake area, filling in much of the territory used traditionally by the Leopold pack. Two GPS collars were deployed (#693F and #692F) and used to understand summer and winter predation patterns of wolves on the northern range. Wolf # 692F dispersed in February for a short time, traveling briefly with Lava Creek and her natal Agate pack before rejoining Blacktail in late April. Both alpha female #693F and subordinate #642F denned on Blacktail Plateau in former Leopold den areas, producing a combined total of six pups, with four surviving at the end of the year. Most significant was the death of widely-popular alpha #302M in October due to other wolves, likely the Quadrant Mountain pack (see insert). A two-year-old uncollared gray male relative of #302M assumed the alpha position. An uncollared black male was hit by a car and killed in November. Two of the Blacktail wolves that showed signs of mange earlier in 2009 appeared to have completely recovered from the infection by the year's end.

Cottonwood Creek Pack (? wolves: ? adults, ? pups)

Formerly a group, an unstable association of wolves where membership was fluid, the pack was named in early 2009 when 5 wolves settled in the Cottonwood Creek to Hellroaring region, an area occupied by three other packs before them (Rose Creek, Geode Creek, and Hellroaring Creek) indicating high turnover for this territory. They denned successfully producing 6 pups. During the denning season they attacked a denning trio of wolves near Slough Creek, not yet named as a pack but with collared wolf #694F as the breeding female. They killed #694F and possibly another uncollared wolf and at least two pups were observed killed; the rest of the litter perished and the one surviving uncollared wolf became an un-trackable loner. In late September and early October, four wolves Cottonwood Creek wolves were harvested north of the park line during the Montana hunting season including both alphas and both radio collared wolves, therefore the pack was not tracked for the remainder of 2009. At year-end the estimated pack size was 6 wolves, 3 males and 3 pups; the lack of an adult male and female did not make them a breeding pair. There were no sightings of them for the remainder of 2009.

***Agate Creek Pack* (*3 adult wolves*)**

Despite breeding with at least three different males and localizing around a den, this pack's aging alpha female, #472F, did not produce pups this year. However, two of those males (former Blacktail Pack wolves) remained with the Agate Pack. During the spring a three-year-old subordinate female dispersed to join former Agate #471F's group. Without pups, the pack of four traveled widely, and was located as far as Lamar Valley, south of Canyon, and south of Amethyst Mountain. The uncollared gray beta male either died or dispersed in October. By year's end, the pack consisted of nine-year-old #472F, a black alpha male, and subordinate female #715F. Long-time member and once the alpha, #383M left the Agates and joined the few remaining Slough Creek females to the north of YNP in early 2009, essentially leaving the park population.

694F's Group: (0 wolves)

Started by two dispersing Druid females and an unknown black male, #694F's Group used former Slough and Oxbow pack territories. By April, one of the females returned to her natal Druid Peak pack and had her pups at the Druid's traditional den. Alpha #694F and the black male remained together and denned near Slough Creek. On April 14th the Cottonwood Pack of five, led by alpha #527F, attacked and killed #694F in her den. The days-old pups were observed being carried out and consumed by the Cottonwood females. Upon inspection, it was noted that 694F's den was under boulders and had two entrances, enabling the Cottonwood wolves to attack and overwhelm 694F from all sides. The black alpha male was observed occasionally either alone or with various Druid females throughout the early summer but not after June.

Druid Peak: (11 adult wolves)

This year brought drastic changes to the Druid Peak pack. Two litters were produced this year at the pack's traditional den near Soda Butte Creek, one by alpha #569F and one by a three year old black female who returned to the pack in April after dispersing over the winter. At least nine pups were observed in the early summer. However, members of the pack started to show signs of mange and only four pups were alive by fall. Numerous pack adults went missing over the fall (a three year old black female, a gray yearling male, and #645F); it is unknown if they dispersed or died. Then, after leading the pack for three years, alpha #569F was killed by wolves (suspected to be Wyoming's Hoodoo pack outside YNP) in the Lamar River backcountry. The four remaining pups had severe cases of mange and were not observed alive after October. This left the Druid Pack with 10 adults, all with varying degrees of mange. In early December, an unknown black male joined the pack, causing long-term alpha male #480M to leave and venture out on his own, presumably because the only remaining females in the pack are his daughters which are unlikely to breed with him. By the end of the year, the pack consisted of the new black male, a three year old black female as the new alpha, six other Druid females (including 571F, 690F and 691F), and two yearling males.

682M's Group: (2 adult wolves)

This small, but interesting group of striking-looking black males (#682M, #697M, and an uncollared wolf) first dispersed into YNP in June from the Hoodoo Creek pack. The

Hoodoo Creek pack lives outside of the park east of the Lamar Valley in the Absaroka Wilderness and has direct connection to park wolves through its alpha female, #525F, who was born in the Agate Creek pack. In early October, the group began frequenting the Lamar Valley and drainages flowing into the upper Lamar. This group interacted with the Druid pack throughout the fall, and was implicated in the killing of Druid alpha #569F by GPS collar data. They were also observed attacking Druid #571F and an uncollared Druid male. These three large males seemed poised to take over territory in the Lamar Valley through their repeated challenges of the Druid pack. On the last day of the year, 697M was killed by the Mollie's pack near the Cache Creek/Lamar River confluence. The remaining two males will be followed with great interest as they are poised to become genetically effective migrants into YNP if they are able to find mates and reproduce.

Mollie's: (15 wolves – 10 adults, 5 pups)

The Mollie's Pack, the second largest pack in the park in 2009, were stable both pack size and traditional territory use. With the grizzly and bison-rich Pelican Valley as their core territory, the Mollie's still exhibited their occasional forays into Hayden Valley and the Northern Range. With the successful recollaring of the large #495M (143 lbs), it was confirmed that he held the alpha male position along with mate #486F. The pair produced a litter of 5 pups in the heart of Pelican. Although many of the pack members had mange in 2008, this year brought full recovery to the afflicted individuals, providing valuable data on the ability of wolves to recover from mange. Wolf-bison-grizzly bear studies continued for the twelfth year.

Canyon: (3 adult wolves)

The Canyon wolves, comprised of Mollie's and Hayden dispersers, continued their search for a stable territory, spending time roaming between their core use area of Hayden Valley up to Mammoth Hot Springs. With a tendency to travel the road corridors to move about the park, this pack received special focus for park staff to minimize habituated behaviors. Denning just outside of park headquarters in Mammoth Hot Springs, this pack regularly hunted elk in the developed area. Following several hazing events (see Habituated Wolves section), this pack responded positively, moving their one surviving pup back down to Hayden Valley where they spent the rest of the summer and fall. At year's end, the one pup and the #587M disappeared, leaving just three adults.

Yellowstone Delta Pack (4 wolves: ? adults, ? pups)

Despite collaring 3 wolves in early 2009, and having at least one other wolf collared, tracking of this pack proved difficult and there were very few sightings, so pack size was estimated. They were not considered a breeding pair because neither of their traditional den sites were used. Long-time alpha female, and one of the oldest wolves in the YNP population, #126F, disappeared at 12 years old. She was re-collared in 2008, so although possible, it is unlikely her collar malfunctioned indicating that she left their traditional territory. Occasionally tracking flights would locate #633F and she was often found outside YNP and when sighted had only a few wolves with her, well below typical numbers for the Delta pack, which was historically >10 and sometimes >15 wolves. A

backcountry horse trip into the Delta and Thorofare areas in late August discovered wolf sign in several different places (Trail Creek on the Delta, Mountain Creek) indicating that the region still supported wolves, but none of the sign was more than a couple wolves or a loner. Collaring efforts in 2010 will focus on this pack, but remoteness and size of the area will make success uncertain.

Bechler Pack (6 Wolves: ? adults, ? pups)

Wolf #192M died this summer and was the last radio collared animal in the Bechler pack, therefore the pack was no longer being tracked and year-end pack size was estimated at 6. #192M was 12 years old when he died one of the oldest wolves recorded in YNP. Because tracking was difficult, few observations were made so it was not known if this pack met the criteria of a breeding pair. Early season radio tracking and reports from sightings indicated that they continue to use their traditional area in YNP making future tracking, and possibly collaring, feasible.

Gibbon Meadows: (17 wolves: 11 adults, 6 pups)

For the second straight year the Gibbon pack was the largest pack in the park. Preying on bison and elk, this pack has flourished in the greater Madison-Firehole and western Hayden Valley areas. The pack's long-term alpha female #537F produced six surviving pups this year, but her collar was heard beaconing on mortality mode in the fall in Hayden Valley. Efforts to locate her on the ground failed, likely due to a dead collar battery. But with a distinct, white pelage, this seven year old alpha was not seen with the pack for the remainder of the year and is believed to have died of unknown, natural causes. The success of the Gibbon lineage continued outside of the pack as several Gibbon males dispersed during a territorial foray the entire pack made into Cougar Creek pack territory in February. At least three males (#689M, #687M, and #647M) stayed behind, bonding with two Cougar Creek pack females and forming two new breeding pairs (see Cougar and Grayling pack summaries). Additionally, an uncollared black yearling male believed to be a Gibbon disperser began displaying habituated behaviors near Old Faithful in the spring, prompting focused monitoring and management action that resulted in the first lethal removal of a wolf from the park population (see Wolf Habituation).

Cougar Creek (6 wolves: 3 adults, 3 pups)

Since their formation in 2001, the Cougar Creek pack has maintained a solid presence in the northwest section of the park. With the 2008 loss of long-time alphas pair #151F and #303M, the pack continued on as this pair's daughter, #478F assumed the alpha position after pairing with the Gibbon disperser #689M, a large, black three-year old that showed up just prior to the breeding season. This pair alone represented the new phase of this pack's history until they produced 3 black pups at a traditional den. Interestingly, a previously dispersed male, #636M, returned to his natal territory in May and settled into a role of aiding his sister and the new alpha male raise three black pups for the year,

doubling the pack's size. The only other known surviving Cougar Creek wolf, #632F, dispersed and carved out a new territory adjacent to the north to form the Grayling Creek pack. The Cougar pack continues to inhabit a territory where bull elk are the most abundant prey throughout the year.

Grayling Creek (4 wolves: 2 adults, 2 pups)

The Grayling Creek pack is the only new pack to form in Yellowstone outside of the northern range in 2009. This pack formed when two Gibbon males, #687M, and #647M, joined Cougar female #632F, along with some uncollared Gibbons. Wolf #632F (aka "Tripod"), became the alpha female and successfully bred with one of the Gibbon males, producing two surviving pups. Despite having only three legs (a lower hind leg went missing due to some unknown injury years earlier), this remarkable female successfully established a new territory to the north of her natal Cougar Creek pack with the help of the Gibbon dispersers. Unfortunately, #632F died of natural causes in December, possibly due an elk hunt gone awry. At the end of the year, alpha male #647M continued to lead two pups (unknown paternity) and another uncollared adult in their new territory.

Wolf Capture and Collaring

Twenty-two wolves were captured and collared in 11 packs. One old adult, 12 adults, 5 yearlings, and 4 pups were caught, 8 of which were male and 14 were female. At year's end, 34 of 96 (35%) wolves were collared. Two types of radio collars were deployed: VHF and downloadable GPS. Placement of collars was dependent on monitoring objectives, but VHF radio collars are still the most commonly used collar by the program.

MANAGEMENT

Management in Wyoming outside Yellowstone National Park

Livestock Depredations

Potential livestock depredations in WY were investigated by WS, USFWS and WGFD. Depredations were classified as confirmed, probable, or other based on specific criteria agreed upon by the USFWS and WS. The following livestock depredation statistics were based on reported livestock losses and do not reflect lost or missing livestock. In 2009, wolves in WY were responsible for killing $\geq$215 livestock. Confirmed livestock depredations included 20 cattle (13 calves; 7 cows/yearlings) and 195 sheep (Table 2) (Appendix Tables 2, 5a, and 5b). Two sheep and 2 cattle depredations were recorded as probable wolf-kills. Two cattle and 1 dog were reported injured by wolves. The number of cattle depredations in WY decreased in 2007, 2008, and 2009; however, the number of sheep killed by wolves increased in 2008 and 2009 (Tables 3 and Figure 5).

Confirmed	Probable
13 calves killed	2 calves killed
7 cows killed; 2 cows injured	
195 sheep killed	2 sheep killed
7 dogs killed; 1 dog injured	

Table 2. Confirmed and probable depredations in WY in 2009.

Depredations	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cattle	3	18	23	34	75	54	123	55	41	20
Sheep	25	34	0	7	18	27	38	16	26	195
Dogs	6	2	0	0	2	1	1	2	0	7
Goats	0	0	0	0	10	0	0	0	0	0
Horses	0	0	0	2	0	1	0	1	0	0
Wolves Controlled	1	2	4	6	18	29	41	44	63	31

Table 3. Confirmed livestock depredations in WY: 2000 - 2009

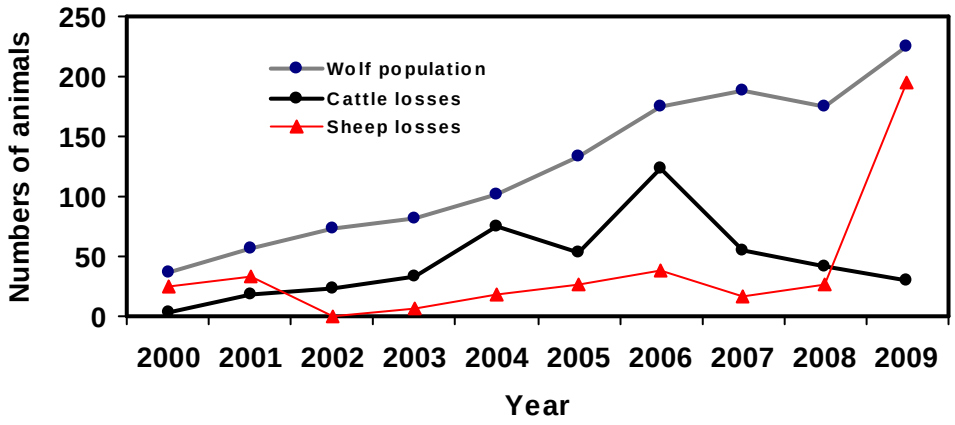

Figure 5. Annual wolf population size and number of confirmed cattle and sheep losses/year in WY: 2000 - 2009.

Number of Packs Involved in Depredations

Fourteen of the 30 known packs in WY were involved in at least 1 depredation in 2009 (Figure 6). Depredating wolf packs averaged 6.6 wolves/pack (range = 2-12) (Figure 7). The average size of chronic depredating packs declined in 2007, 2008, and 2009 (Figure 8). Three wolf packs (Big Horn, Black Butte, and Dog Creek Packs) were responsible for 195 sheep depredations. Since 1999, the WY wolf population has increased annually and wolves have recolonized new areas in northwest WY. Wolves living in areas with

relatively high native ungulate densities and relatively low exposure to domestic livestock caused fewer conflicts with livestock producers. Wolves that recolonized areas where large numbers of livestock grazed on private and public lands were responsible for chronic depredations on domestic livestock.

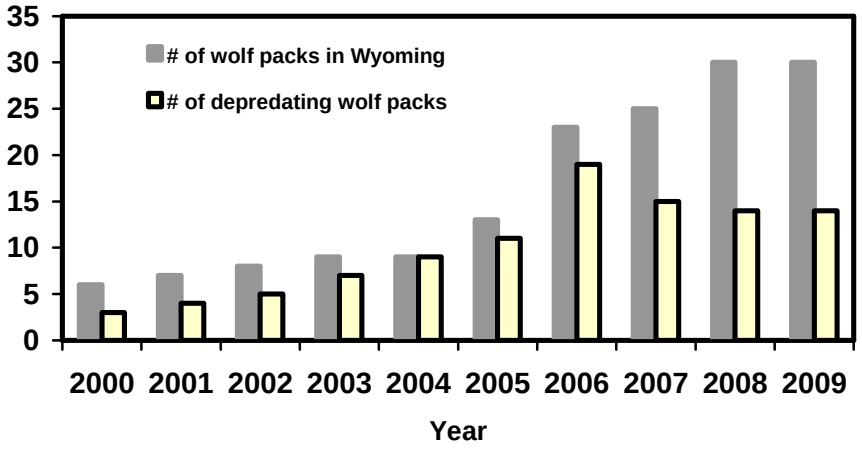

Figure 6. Annual number of wolf packs in WY and number of wolf packs that are involved in at least 1 livestock depredation/given year.

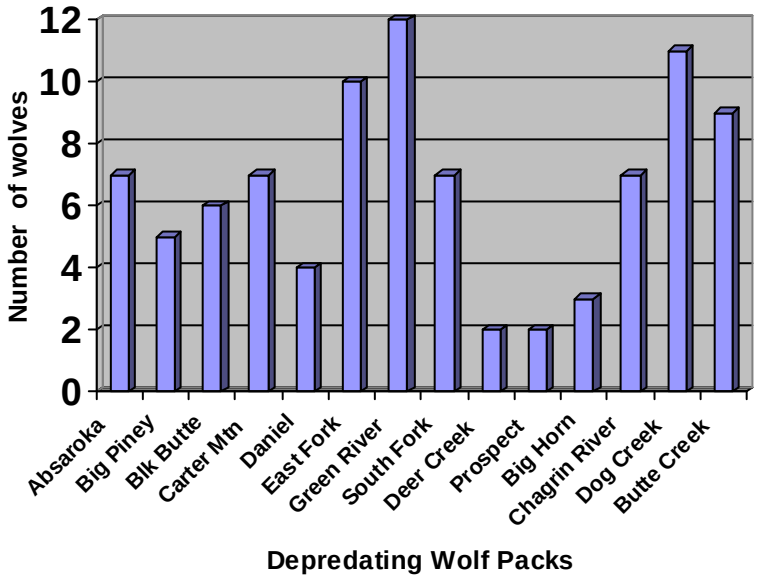

Figure 7. Size of 14 wolf packs involved in depredations in 2009.

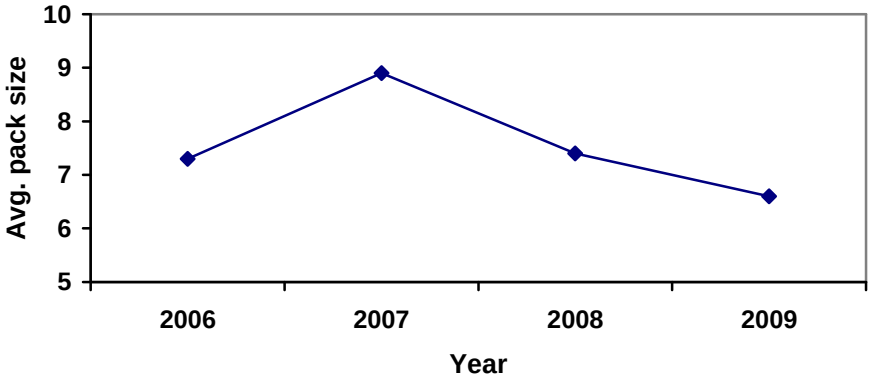

Figure 8. Average size of depredating wolf packs from 2006 – 2009.

Time of Year of Livestock Depredations: Cattle depredations followed a seasonal pattern in 2009 with the highest number of depredations occurring in late summer/fall from July through November (Figure 9). Sheep depredations occurred between June and November (Figure 10).

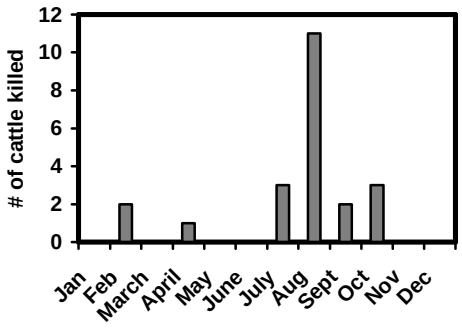

Figure 9. Number of confirmed cattle depredations/month.

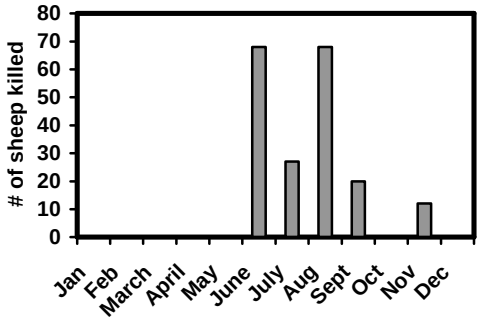

Figure 10. Number of confirmed sheep depredations/month.

Location of Livestock Depredations

Land Status: Forty-five percent (n=97) of all confirmed wolf depredations (20 cattle and 195 sheep) were on public land and 55% (n=118) of all depredations were on private land. Seventy-five percent (n=15) of cattle depredations were on public land and 25% (n=5) of cattle depredations were on private property. Forty-two percent of sheep depredations (n=82) occurred on public land and 58% sheep depredations (n=113) occurred on private land (Figure 11).

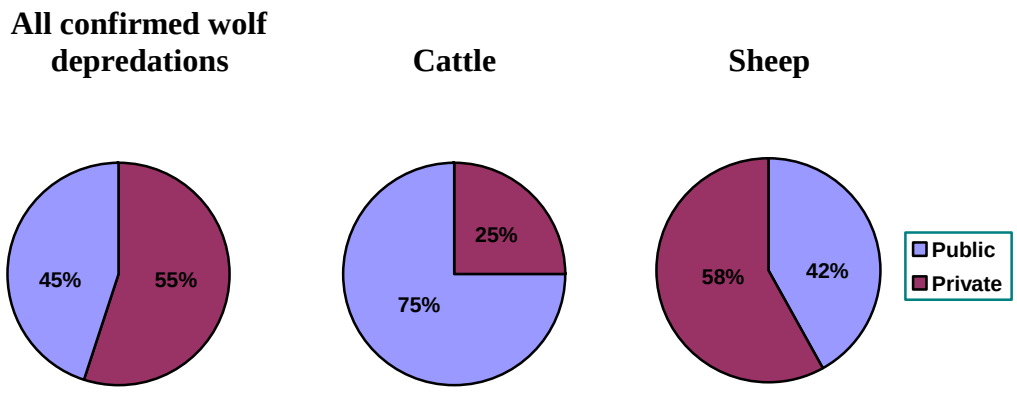

Figure 11. Land status where confirmed wolf depredations occurred in 2009.

Counties: In 2009, confirmed cattle depredations occurred in 5 counties: Sublette 50% (n=10), Park 25% (n=5), Fremont 15% (n=3), Sweetwater 5% (n=1), and Converse 5% (n=1) (Figure 12). Wolves killed sheep in 4 counties: Washakie 30% (n=59), Johnson 28% (n=54), Lincoln 23% (n=45), and Sublette 19% (n=37) (Figure 13).

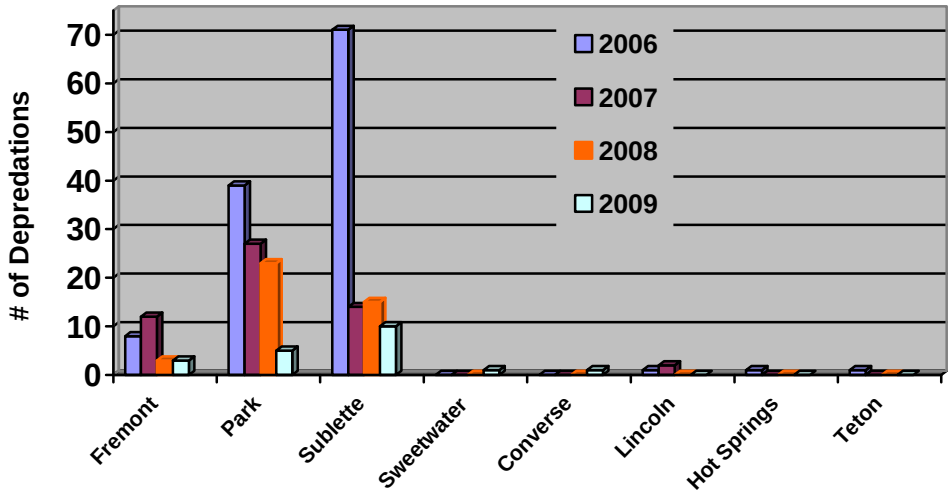

Figure 12. Confirmed cattle depredations by county from 2006 through 2009.

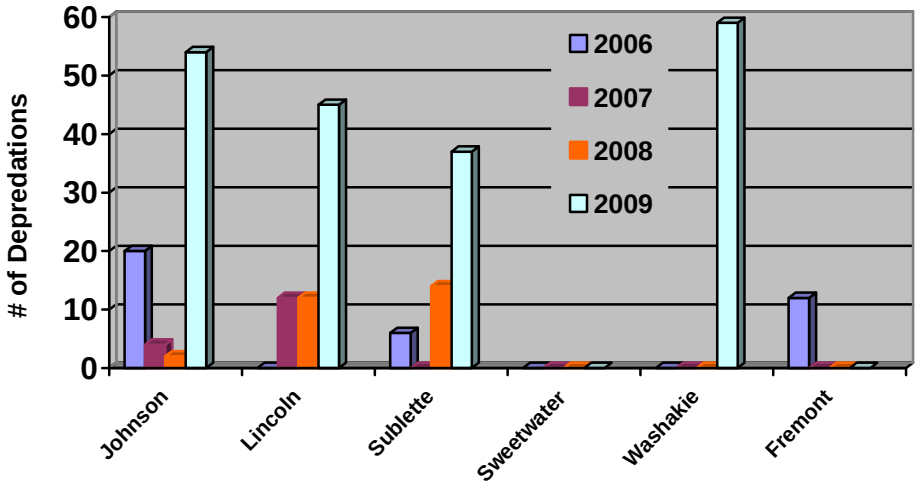

Figure 13. Confirmed sheep depredations by county from 2006 through 2009.

Livestock Depredation Control Actions

We managed wolf population growth and wolf distribution to minimize chronic loss of livestock from wolves and promote wolf conservation by maintaining the WY wolf population (outside YNP) well above recovery objectives. In 2009, 31 depredating wolves (approximately 12% of the WY wolf population outside YNP) were removed to reduced livestock depredation.

Control actions in response to confirmed livestock depredations included trapping and radio collaring wolves; intensive monitoring; issuing 10 Less-than-Lethal Munitions (rubber bullets) to harass wolves; lethally removing wolves through agency control actions; and issuing 7 Shoot-on-Sight (SOS) permits to livestock producers. Non-lethal control was routinely considered but was often not applicable or cost effective in many areas in WY due to: 1) specific wolf packs chronically killing livestock year after year; 2) unpredictable travel patterns and movements by wolves; and 3) very large wolf home ranges that cover vast areas including public grazing allotments. When non-lethal control methods were not effective, wolves were killed through agency control actions in an attempt to prevent further livestock depredations. No wolves were killed in 2009 using SOS permits. Livestock producers attempted to minimize depredations by proactively increasing riders on grazing allotments and moving livestock to different pastures away from wolf activity.

Incidental Takes

One wolf was unintentionally killed by a private county trapper using M-44s for coyote control. USFWS Law Enforcement investigated the incident and determined the M-44s

were legally placed in the area and were being used in compliance with Environmental Protection Agency (EPA) restrictions.

Compensation for Livestock Depredations

A total of $78,352 was paid for wolf damage in WY in 2009. The WGFD paid $67,581 to compensate cattle producers and wool growers who lost livestock to wolves during the 2009 calendar year. Under Chapter 28 of the Wyoming Game and Fish Commission (WGFC) Regulations, compensation for confirmed livestock depredations by wolves was authorized only in the northwest corner (approx. 12% of the state) of WY where the WGFC classified wolves as trophy game animals.

(iii) "Sheep in areas set forth by Commission regulations where gray wolves are classified as trophy game animals. To determine the amount of compensation due to a claimant for sheep believed to be missing as a result of being damaged by gray wolves, in areas occupied by wolves, the Department shall utilize the following formula:

(A) Number of individual sheep confirmed by the Department or its representative killed by gray wolf multiplied by seven (7) multiplied by the value of livestock equals the amount of compensation."

(iv) "Calves in areas set forth by Commission regulations……the Department shall use the following formula:

(A) Number of individual calves confirmed by the Department or its representative killed by gray wolf multiplied by seven (7) multiplied by the value of livestock equals the amount of compensation."

Compensation for livestock lost to wolves was not authorized in the WGFD predator area (approx. 88% of the state); however, Defenders of Wildlife paid $10,771 for wolf-caused losses in the predator area.

Management in Yellowstone National Park

Area Closure

To prevent human disturbance of denning wolves during the sensitive period of pup rearing, visitor entry was closed to some of the areas surrounding dens in the park. Land surrounding the Druid Peak Pack's den area was closed until July 1 in the eastern end of Lamar Valley. Thousands of visitors were still able to observe adults and pups from a safe distance, providing both protection to the pack and enjoyment to visitors. Additionally, the den and rendezvous sites used by the Canyon Pack were closed at different periods in the summer. With the Canyon Pack wolves exhibiting habituated behaviors through their frequent travel on roadways and through developed areas, NPS staff sought to minimize human encounters with these wolves through temporary closure of trails and areas near their den and rendezvous sites throughout the summer. Den sites for the Leopold, Mollie's, and Agate Creek packs were protected from disturbance coincidental to closures for bear management in the park. The areas around the remaining park packs' den sites were not closed because of historically low visitor use.

Druid Road Management

Since wolf reintroduction in YNP, the Lamar Valley has become the premier location worldwide to observe free-ranging wolves. Traditionally, the main pack of interest has been the Druid Peak Pack, which has denned in or near the valley since 1997. In addition to the Druid pack, however, several other packs on the northern range have also been regularly watched by visitors over the years. With large numbers of visitors each year, the National Park Service established the Druid Road Management Program in 2000 to better deal with the opportunities and problems that accompany increasing visitor numbers. 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 2009 season (15,285 people) and the summer season was characterized by high wolf viewing opportunities (see Table 5).

The 2009 season was 124 days (May 12 to September 12) and was staffed primarily by two Wolf Project employees, Rick McIntyre and Kira Cassidy-Quimby.
The Druid pack was the focal pack this season, and they denned in a traditional site used every season between 1997 and 2004. The site is in a forested area one-half mile north of the main road in Lamar Valley. In 2009 there were two litters: one by alpha female 569F and the other by an uncollared three-year old female. Most sightings of the 14 adult wolves occurred when they crossed the road as they traveled to the main den or left the den on a hunt. Pups were first seen on June 15 and at least nine were observed as high count. The pack brought the pups across the road and river at night on July 8 or 9. The entire pack then traveled south-east to a rendezvous site up Cache Creek. Sightings decreased drastically until August 28 when the adults and pups traveled back to Lamar Valley and rendezvoused at Chalcedony Creek, an area highly visible to visitors. The four pups that returned with the adults were extremely small and had a great deal of hair-loss due to mange. The adults varied from minimal hair-loss to being about 50% hair-less. The adults and pups remained in this area through the end of the season.

The Blacktail Pack, formed over the winter of 2008-09, denned in the old Leopold Pack territory. Many visitors greatly desired to see this pack and its leader, nine-year-old 302M, a well-known wolf popularized by televised nature programs. The first den this pack used was well out of view, but in late May the pups were moved to an area visible from an observation point one mile from the road corridor. With the exception of a few weeks, the pups and adults stayed in this area and were highly visible for the rest of the summer season.

Table 4. Visitor contacts in Yellowstone National Park.

Year	Roving Visitor Contacts	# of Talks	# of People at Talks	Total Contacts	# of People Seeing	Time Wolves Visible	Days Wolves Visible

					Wolves		
2000	6,760	83	1,833	8,593	8,145	283.2 hrs	77/82 (94%)
2001	9,375	288	1,552	10,927	11,210	368 hrs	125/125 (100%)
2002	9,450	244	1,952	11,402	12,414	460 hrs	126/126 (100%)
2003	9,375	258	2,064	11,439	9,827	415 hrs	124/124 (100%)
2004	9,450	226	2,260	11,710	8,721	395 hrs	126/126 (100%)
2005	6,200	125	1,250	7,450	11,695	790 hrs	124/124 (100%)
2006	6,500	200	2,000	8,500	13,640	620 hrs	124/124 (100%)
2007	8,775	230	2,300	11,075	32,600	750 hrs	117/117 (100%)
2008	8,660	358	3,925	12,585	35,000	830 hrs	124/124 (100%)
2009	10,040	602	5,245	15,285	31,000	750 hrs	124/124 (100%)

Habituated Wolves

Canyon Wolves Den in Mammoth. In late April, the Canyon pack denned just east (~ 1 km) of Mammoth Hot Springs (Park Headquarters) causing them to hunt elk in the developed area. Several elk were killed within the residential district. As a result, wolves were hazed whenever in the developed area, but protected around their den; the den area and nearby trails were closed. Although the 4 wolves in the pack showed no interest in humans and were not food conditioned, they were still hazed in the developed area and on the road near people. There was no human safety threat, but they did walk near people on several occasions. Wolf Project, Bear Management, and ranger staff patrolled the area daily, especially times when the wolves were most active in an attempt to haze them from the developed area. On May 9, Travis Wyman successfully hazed 3 of the 4 wolves in the pack with non-lethal bean bag rounds and cracker shells. Shortly after this event the wolves left the Mammoth area moving to their summer range in Hayden Valley where they spent the rest of the summer. Surprisingly one pup was with them despite never being observed at the Mammoth den and having been carried the long distance to Hayden Valley, but it did not survive summer. Its mortality was unrelated to the long-distance den relocation. Also interesting, after commonly traveling the road and approaching vehicles in the summer of 2008, they were never observed on the road or near people during the summer of 2009 suggesting that the hazing caused a behavior

change. Considering this pack with other hazing events in YNP, hazing is an effective strategy for habituated wolves and has caused cessation of unwanted behaviors.

Gibbon Meadows Wolf Removed. In early May, a yearling male from the Gibbon Meadows pack chased a woman riding a bicycle near Old Faithful. The chase lasted long enough that the bicyclist waved down a passer-by in a pick-up truck for help. This caused the wolf to move away, but not leave the area. When the gate to the pick-up was opened to load the bicycle, an empty oil can fell out, rolled across the pavement, and the wolf quickly grabbed the can and ran away with it. This behavior suggested food conditioning and a wolf fitting this description had been observed in the Old Faithful area approaching people since March, and it was likely fed. The same wolf later chased two motorcycles and was seen approaching vehicles on the road. The interest in people, different from the Canyon wolves, and the indications of food conditioned behavior made this wolf a human safety threat and the decision was made to kill the wolf. After photographs and other identifying marks were made known to sharpshooting rangers, Wolf Project personnel in conjunction with rangers searched for the target animal and on May 19 was shot away from the road out of visitor view. After the event no other situations were recorded further supporting that the correct wolf was removed.

RESEARCH

Research in Wyoming outside Yellowstone National Park

In 2009, the USFWS continued to provide financial and in-kind support for collaborative research projects in WY. Various projects involved universities, NGOs, and other state and federal agencies.

Topic	Collaborators	Institution
Lead ingestion by scavenging carnivores in the Yellowstone ecosystem	Tom Rogers Kerry Foresman	University of Montana
Summer food habits of wolves in GTNP and YNP determined by scat analysis	Bonnie Trejo Steve Cain Doug Smith	Humboldt State Univ. GTNP YNP
Population genetics of wolves in the GYA	Bridgett vonHoldt Dan Stahler Robert Wayne	University of Calif. Los Angeles
Wolf Movements/Dispersals	Doug McWhirter L.D. Mech Doug Smith	WGFD USGS NPS

Absaroka Elk Project	Arthur Middleton Matt Kauffman	University of Wyoming
Absaroka Wolf-Elk-Livestock	Abby Nelson Matt Kauffman	University of Wyoming
Elk Grouping Patterns and Brucella Transmission in Wyoming	Angela Brennan Paul Cross Scott Creel	Montana State University
Cougar Predation Patterns in the Southern GYA	Travis Bartnick Tim Van Deelen	University of Wisconsin-Madison
Winter Predation Patterns by Wolves	John Stephenson Sarah Dewey	GTNP GTNP

Title: Lead ingestion by scavenging carnivores in the Yellowstone ecosystem
Graduate Student: Tom Rogers
Committee Chair: Kerry Foresman, University of Montana
Cooperators: Beringia South, WGFD, GTNP, and USFWS
Project Summary: Exposure to heavy metals is a potential challenge to the conservation of wildlife. One source of heavy metal exposure known to negatively affect avian wildlife is ingestion of lead rifle bullet fragments found in discarded hunter-harvested ungulate gutpiles. Some large carnivores, such grizzly bears, are also known to target these gutpiles as a food source while others, such as cougars, avoid areas with high levels of human hunting pressure. With the aid of collaborating researchers, we have tested samples of blood, tissue and scat for the presence of lead from black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), wolves (*Canis lupis*), coyotes (*Canis latrans*), and cougars (*Puma concolor*). Grizzly bears (N=82) show higher blood-lead levels (median=4.4 μg/dL; range 1.1-18.6 μg/dL) than black bears (N=44; median=1.6; range 0.5-6.9 μg/dL), but blood-lead levels do not increase during the autumn hunting season when potentially lead-tainted gutpiles are available. Wolves (N=21) and cougars (N=8) show lead concentrations near or below the minimum level of detection in both blood and tissue samples. While lead ammunition fragments are clearly visible by radiograph in the GI tract of affected wildlife, no lead fragments were found in the scat of these target species in samples collected during the summer (N=209) and fall (N=214). Therefore, unlike avian scavengers, large carnivores do not appear to be ingesting lead ammunition fragments.

Title: A Comparison of Two Methods to Assess the Summer Food Habits of Wolves
***Graduate Student*:** Bonnie Trejo
***Committee Chair*:** Richard Golightly, Humboldt State University
Cooperators: USFWS, GTNP, YNP

***Project Summary*:** Scat analysis is commonly used to document the summer diet of wolves. The method is non-invasive and cost efficient; however, biases as well as technical and interpretational difficulties can limit its value. Recent technological advancements in the use of GPS-telemetry and location cluster analysis have been utilized in Yellowstone National Park (YNP) and Grand Teton National Park (GTNP) to improve our knowledge of the summer food habits of wolves. To date, information collected using GPS techniques has not been compared with that gained from the longstanding method of scat analysis. Scat analysis may be particularly useful for detecting small prey items that may be missed by tracking techniques. The objectives of this study are to: (1) analyze wolf scat collected in YNP and GTNP to determine percent frequency of occurrence of prey items, and calculate the relative number of prey consumed, (2) compare the results of scat analysis to that of GPS cluster analysis to evaluate the differential assessment of prey composition and biomass between the two approaches, and (3) compare the summer diet of wolves among years, between packs, seasons (summer and winter), and geographical regions within the greater Yellowstone ecosystem. This project is a collaborative effort between the NPS, USFWS, and Humboldt State University.
***Project Activity in 2009*:** Collection of approximately 500 scats from YNP. Development of lab techniques and beginning analysis of scats collected from GTNP.
Anticipated Completion Date: May 2011

Title: Absaroka Elk Ecology Project
***Graduate Student*:** Arthur Middleton, University of Wyoming, Laramie, Wyoming.
Major advisor: Matt Kauffman, University of Wyoming.
***Cooperators*:** USFWS and WGFD
Project Summary: In collaboration with the U.S. Fish and Wildlife Service, the University of Wyoming and the Wyoming Game and Fish Department are nearing completion of the field work on the Absaroka Elk Ecology Project between Cody, WY and Yellowstone Park. The project's primary objectives have been to determine the proportion of migratory elk in the Clark's Fork herd unit; determine the geography and timing of these migrations; improve understanding of the use of key private lands by Clarks Fork elk; and to understand the relative influence of wolves and habitat conditions on elk habitat selection, movements, and behavior. The project relies on a sample of 70 GPS-collared elk cows in the Clark's Fork herd, and 1-2 GPS-collared wolves in each of three resident wolf packs. Preliminary project data has revealed particularly low pregnancy in the migratory portion of the Clarks Fork herd, suggesting that nutritional stress might be contributing to low migrant productivity. To investigate the potential causes, the project initiated biannual recaptures of collared elk to determine body condition and reproductive status. Four of these five elk recaptures were completed during March and September 2008 and 2009, and the final recapture will take place in March 2010. In winters 2008-10, a Ph.D. student from the University of Wyoming's Cooperative Fish and Wildlife Research Unit has been conducting field observations to quantify the activity budgets of marked elk. Ultimately, this study aims to address applied questions relevant to elk and wolf management, as well as conceptual questions relevant

to our understanding of ungulate-predator interactions more broadly. Field work on this project will be completed in late spring 2010, with analysis and reporting to follow.

Title: Wolf habitat selection in a variety of land-use types: assessing the impact of elk and cattle distribution on wolf habitat use and cattle depredation patterns in the Absaroka Range of Wyoming.
***Graduate Student*:** Abby Nelson, University of Wyoming, Laramie, Wyoming.
Major advisors: Matt Kauffman and Steven Buskirk, University of Wyoming.
***Cooperators*:** USFWS, WS, and WGFD
Project Summary: This project is a collaboration between the University of Wyoming Cooperative Fish and Wildlife Research Unit, the US Fish and Wildlife Service, and the Wyoming Game and Fish Department, conducted in the Absaroka Mountains near Cody, WY. This project investigates the influence of seasonally driven elk and cattle distribution on wolf resource selection and the location of wolf-killed cattle and wild ungulates. Wolf GPS data was collected for this project from collars on 10 wolves in multiple packs throughout 2007- 2009, and fieldwork included collecting attribute data for both cattle and native prey carcasses visited by wolves in 2007 and 2008. The wolf resource selection analysis is being finalized in early 2010 using data collected during 2007-2009, and the wolf kill-site analysis will also conclude in 2010. Ultimately, this project aims to use wolf resource selection, ungulate distribution and other landscape attributes to predict seasonal wolf habitat use patterns and high-risk areas for cattle depredations by wolves.

Title: Land use and predation effects on elk grouping patterns and *Brucella* transmission.
Graduate Student: Angela Brennan
Major Advisor: Paul Cross and Scott Creel, Montana State University
Project Summary: Concern over the potential for transmission of *B. abortus* from elk (*Cervus elaphus*)to cattle is widespread, but it generally focuses in on the Wyoming feed grounds where elk concentrations and brucellosis prevalence are high. Despite the concern and attention given to the disease on the feed grounds, research has explained little about the relationship between transmission of *B. abortus* and elk density. We suspect that the increasing brucellosis prevalence in elk off feed grounds is due to the increasing size of elk groups during the winter and spring, when *B. abortus* transmission is greatest. Although unfed elk groups are generally small relative to fed elk groups, the group size distribution is very right-skewed with a few large groups similar in size to those on the feed grounds. We believe that large wintering elk groups may be a result of changing land use and predation intensity. To estimate the density-transmission relationship in unfed elk groups and to address the potential factors that affect that relationship, we propose to investigate elk aggregation patterns and brucellosis prevalence across regions encompassing wide ranges of predation intensity and environmental conditions.

Title: Investigating trends in cougar predation ecology within the Southern Greater Yellowstone Ecosystem.
Graduate Student: Travis Bartnick
Major Advisor: Tim Van Deelen, University of Wisconsin-Madison.
Cooperators: Beringia South, WGFD, GTNP, and USFWS.
Abstract: We propose to examine the predation ecology of cougars (*Puma concolor*) following the recent recovery of wolves (*Canis lupus*) in the Southern Greater Yellowstone Ecosystem. Cougars were intensively radiotracked, and kill sites (n=608) were examined beginning in winter 2000-2001 and continued through summer 2009. Although wolves were present in the area since the onset of the project, the number of wolf packs in this region markedly increased following winter 2004-2005. We will investigate the relatively recent expansion of the wolf population within our study area to determine potential effects on cougar predation and habitat use. We intend to do this by analyzing prey composition and habitat characteristics of kill sites, to quantify changes in spatial and temporal patterns associated with increasing wolf presence. With the extirpation of wolves in the early 20th century, cougars likely expanded their niche space to include niche space made vacant in the absence of wolves, using more open, less-rugged habitat. We expect to find evidence of cougars demonstrating a niche shift toward hunting in more-rugged, steeper habitat with greater canopy cover as an effect of wolf population recovery. In addition, we expect that cougars will demonstrate changes in predation characteristics, shifting toward prey found in denser habitat, as well as more prime-age and healthy individuals as an effect of increased wolf presence. The expected change in predation characteristics would reflect the difference in predation habits between cougars and wolves, given that wolves are coursing predators, and cougars are ambush predators.

Research in Yellowstone National Park

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 for two winter-study sessions in 2009 during which wolves were intensively radio-tracked for 30-day periods in March and from mid-November to mid-December. The Blacktail (March and Nov-Dec), Druid Peak (March and Nov-Dec), Everts (March), and Quadrant Mountain (Nov-Dec.) packs were the main study packs monitored by three-person ground teams and all packs parkwide were monitored from aircraft. In addition, ground crews opportunistically monitored the Agate Creek, Canyon, Cottonwood Creek, Lava Creek, and Mollie's packs, along with several newly formed groups of wolves, collecting prey selection and kill rate data. The Cougar Creek, Grayling, and Gibbon Meadows packs were monitored from aircraft only. The Yellowstone Delta and Bechler packs were rarely located by ground or air due in part to their absence from the park or poor conditions for aerial monitoring in southern YNP, and lack of radiocollars (Bechler). The summer predation study utilized data from downloadable GPS collars on wolves from the

Everts and Blacktail packs (see below) to understand summer predation patterns. During these established predation studies, and opportunistically throughout the year, project staff recorded behavioral interactions between wolves and prey, predation 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 365 kills (definite, probable, and possible combined) made by wolves in 2009, including 302 elk (83 %), 19 bison (5%), 17 deer (2 %), one moose (<1%), four pronghorn (<1%), one bighorn sheep (< 1%), one Canada goose (<1%), one bald eagle (< 1%), three coyotes (< 1%), two red foxes (<1%), six wolves (2%), and eight unknown prey (2 %). The composition of elk kills was 24 % calves, 36 % cows, 29 % bulls, and 10 % elk of unknown sex and/or age. Bison kills included seven calves, four cows, three bulls, and five unknown sex adults.

Winter predation rates in 2009 continue the recent years' patterns of decreased kill rates compared to earlier years. Changes in prey selection (shift to bull elk), an increase in scavenging on winter-killed ungulates, and a suspected decrease in the number of vulnerable prey available to wolves factor in to this decrease in kill rates. When examined, however, not as elk killed/wolf, but rather biomass consumed (kg/wolf/day), kill rates have been stable since 1995. The wolf-elk interaction continues to be a primary focus of predation studies in YNP. Since wolf reintroduction the elk population has declined approximately 50% with wolves being one factor. Other factors include other predators, management of elk outside YNP, and possibly long-term drought.

Winter Studies

March **-** During the 2009 March winter study (30 days), study packs were observed for 283 hours from the ground. The number of days wolf packs were located from the air ranged from 9 (Canyon) to 13 (Everts, Blacktail, and 471F's group). A total of 80 carcasses utilized by wolves were discovered by air and ground teams, made up mostly of wolf kills, with some winter-killed ungulates scavenged upon. These carcasses included 62 elk, 13 bison, three mule deer, and two unknown species. Among elk, nine (15%) were calves, 20 (32%) were cows, 32 (52%) were bulls, and one (< 1 %) was of unknown sex and age. In addition, 10 bison and two mule deer were killed by wolves. Five of the discovered ungulate carcasses (three bison, one elk, and one deer) were winter-killed and scavenged by wolf packs. Documenting the consumption of biomass from ungulates not killed by wolves is important to explaining variation in kill rates through time. Lower than expected kill rates, particularly for larger wolf packs, can sometimes be explained by increased scavenging of winterkilled ungulates in the spring.

November-December **-** During the 2009 November–December winter study (30 days), wolves were observed for 234 hours from the ground. The number of days wolf packs were located from the air ranged from nine (Grayling) to 11 (Agate, Canyon, Druid Peak, Gibbon, Mollie's, and Quadrant). Aerial monitoring was effected by poor weather

conditions and cold temperatures, with the lowest number of flights for any March winter study. A total of 45 ungulate carcasses utilized by wolves were discovered by air and ground teams. These carcasses were made up mostly of wolf kills, with some other natural and human-caused mortalities that wolves scavenged on. All wolf-killed prey this winter study were elk, comprised of six calves (15%), 17 cows (43%), 15 bulls (38%), and two (< 1 %) of unknown sex and age. Wolves also scavenged five ungulates that died from either non-predation natural causes or from human hunters along the park boundary, including one bison, one mule deer, and three elk. Of interest, the Druid Peak pack had very low kill rates this study period, mostly scavenging other packs' kills. With severe mange affecting the majority of pack members, the Druid wolves showed prolonged periods of inactivity and appeared less fit to hunt. This has implications for predator health and disease impacts on predator-prey dynamics.

In addition to our traditional monitoring (aerial and ground observation) of prey composition and kill rates during winter study, the Yellowstone Wolf Project also began to incorporate GPS clustering methodology during the November-December 2009 winter study. GPS cluster searches are being incorporated into winter study in order to better understand if ungulates killed by wolves are missed via our traditional monitoring methods. If so, we seek to understand what factors (e.g. prey size, time of day kill is made) are most likely to lead to not detecting a kill via ground or aerial observation. Further, our traditional monitoring methods will allow us to better understand if GPS clusters are not formed at some kills observed by either aerial or ground crews. During this pilot study, project staff hiked to GPS clusters created by Blacktail Deer Plateau wolves 692F and 693F. The few kills that were missed by aerial and ground monitoring tended to be elk calf kills made during the night. Additionally, some carcasses visited by Blacktail wolves were not detected by GPS clusters. As initial results proved this to be a valuable component to wolf predation study methodology, the Yellowstone Wolf Project plans to incorporate GPS clustering methodology during winter study in 2010.

Summer Predation

During summer 2009, Wolf Project staff, in collaboration with Michigan Technological University, continued to document summer predation patterns of wolves. Documenting the predatory habits of wolves in summer is problematic due to the lack of snow for tracking, lack of pack cohesiveness, grizzly bear kleptoparasitism of carcasses, and smaller prey packages leading to quick consumption and loss of evidence. Traditionally, the best data concerning wolf summer food habits has come from analysis of scats collected at den and rendezvous sites. However, this technique is limited by a lack of knowledge regarding whether wolves were feeding upon freshly killed prey or scavenging on older carcasses. Although scats were collected at homesites in 2009, GPS collar technology was again used to facilitate a greater understanding of summer predation patterns. Additionally, in collaboration with Humboldt State University, scats were collected at GPS clusters for comparison (see Graduate Students).

During the 2009 capture season, Wolf Project staff deployed five downloadable GPS collars on the northern range to enhance 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. Using GPS collars with downloadable technology, the goal was to perform weekly data gathering downloads from May 1 – July 31 on four collars programmed to collect location data every 30 minutes. This approach has proven successful in prior years for summer predation studies by yielding high-resolution wolf movement data revealing composition of prey killed by wolves, including neonate elk calves.

In 2009, 2 GPS collars used in the summer predation study were placed in each of the Mount Everts pack and Blacktail pack. The GPS collars deployed on the wolves all obtained greater than 95% of possible locations, with the exception of Blacktail wolf #693F when she was in the den after giving birth to a litter of pups. Summer predation staff worked intensively to search clusters, hiking over 1100 miles during the 3+ month field season. While searching clusters, staff recorded the presence of wolf sign, wolf-killed prey, and carcasses scavenged upon by wolves (classified as either fresh or old, meaning carcasses either provided significant biomass (fresh) or did not (old)). During this effort, 108 suspected kills or fresh carcasses were found at identified clusters. Of the kills detected, most were elk, with deer as the other main prey species. Of note, we also found one bighorn sheep ram at a cluster of the Everts pack. Both packs preyed upon mostly elk, but the Everts pack did also often prey upon deer as their territory contains more deer and fewer elk in comparison to other packs. Also, the Blacktail pack preyed upon cow elk more than had the previous resident wolves (the Leopold pack) of the Blacktail Deer Plateau. The estimated number of ungulates consumed by wolves utilizes methodology which accounts for the foraging behavior of wolves in summer. The number of ungulates consumed by wolves declines in late May as prey condition improves. However, kill rates increase shortly thereafter again as neonate elk calves appear on the northern range landscape. Beginning with this time period, much of the variability in summer kill rates is explained by the proportion of kills that are small ungulates, such as deer and neonate ungulates.

Population Genetics

Collaborative efforts between the Yellowstone Wolf Project and the University of California, Los Angeles continued in 2009. Dan Stahler attended UCLA for the spring quarter and continued collecting data in the YNP population throughout 2009 for his dissertation. Stahler and Smith were coauthors on a large collaborative study published in the journal *Science* that incorporated data on Yellowstone pedigrees, coat color, and molecular markers to describe the evolutionary history of melanism (black fur) in North American wolves. This study revealed that black wolves get their dark coat color from a genetic mutation that first occurred in dogs, and was likely introduced and selected in wild wolf populations following successful mating with dogs that came into North America with humans thousands of years ago. Research is underway to investigate the selective advantage that genes associated with black coat color may have on wolves.

An analysis of genetic diversity and gene flow in the Northern Rocky Mountain (NRM) recovery areas was completed in 2009 and submitted for publication by Stahler, Smith, Bangs, Jimenez, Mack, and Niemeyer, in collaboration with UCLA researchers. The

degrees to which subpopulations are genetically structured and connected, along with the preservation of genetic variation, are important conservation concerns. This study analyzed genetic samples of 555 NRM wolves from the three recovery areas (Greater Yellowstone, Northwest Montana, and Central Idaho), including all 66 reintroduced founders, over the initial 10-year recovery period (1995–2004). The NRM population maintained high levels of variation with low levels of inbreeding throughout. Population assignment and migrant detection was difficult due to related founders among different recovery areas, which required a novel approach to determine genetically effective migration and admixture over the first decade of recovery. By combining migrant assignment tests, kinship reconstruction, and field observations, we detected gene flow between all recovery areas inferred by the presence of migrant and admixed (offspring of migrants) individuals. Continued success in the conservation genetics of NRM wolves will rely on management decisions that promote natural dispersal dynamics and minimize anthropogenic factors that reduce genetic connectivity.

Disease

Research on disease in the Yellowstone wolf population is ongoing. In 2009, Emily Almberg finished her M.S. at the University of Minnesota on the diseases affecting Yellowstone wolves and published some of her results (see 2009 publications list). Despite a population decline in 2009, we do not suspect that disease played the same role as was documented in 1999, 2005, and 2008. Most significantly, Sarcoptic mange showed increased prevalence in the population, particularly on the Northern Range.

Sarcoptic mange is a skin disease caused by infection with a mite (*Sarcoptes scabei).* Sarcoptic mange (or "scabies") was intentionally introduced into the western United States in the early 1900's as biological control of wolf and coyote population. Since then, mange has been present in coyote populations in the Greater Yellowstone, and appeared in wolves outside of YNP in the early 2000's. Mange was first suspected in Yellowstone National Park in early 2007, when the alpha male of the Mollies Pack was observed with significant hair loss along his neck and shoulders. Since then, the incidence of mange in the park has increased.

Sarcoptic mange is host-specific and typically spread through direct contact from host to host. Mange mites crawl on and burrow in the skin of its host to reproduce and lay eggs, causing severe itching and an allergic response. The infected animal scratches and chews its skin for relief, causing hair loss, crusted skin, and open sores, which can lead to systemic infection and risk of hypothermia due to exposure. The severity and persistence of mange is often correlated with an individual's health and age, with individuals that are immuno-compromised or malnourished experiencing greater infection.

Perhaps spread through contact with wolves outside the park, an immigrant joining the pack, or contact with an infected coyote, the Mollies seemed to be the first pack to be severely afflicted. During the winter of 2008-2009, at least seven out of the 13 Mollies Pack members had mange and at least three of them were more than 50% hairless. However, evidence for recovery does exist and by July 2009 the same wolves were

observed with full, normal-looking coats. In the span of only four months they had recovered. Similarly, two adults in the Blacktail pack experienced moderate hair loss during spring 2009. Both of those wolves appeared completely furred only three months later. In 2009, the most severe cases of mange have occurred in the Druid Peak pack, with nearly all pack members showing severe stages of mange.

From a biological standpoint, it is invaluable to gain insight into the spread of a disease from its beginning, and its persistence in the population. In other wolf systems where mange has been documented, it does not appear to have significant demographic impacts and often shows epizootic or cyclic patterns. Managing for mange in the wild would require multiple recaptures and treatment of inflicted individuals using veterinarian care. Because this is logistically infeasible, the Wolf Project is closely monitoring patterns and severity of mange to learn about its ecology. Some questions include: Do environmental and ecological conditions, such as climate change and vulnerable prey availability, influence mange severity? Is there interaction with other disease patterns, such as canine distemper, that increase susceptibility to mange? Do certain individuals show resistance or more successful recovery from mange, and if so, does this response have a genetic basis? By establishing a mange monitoring program, the Wolf Project hopes to answer these intriguing and important questions in the future.

Collaborative Research

The Wolf Project and Yellowstone Park Foundation provided financial and in-kind support for collaborative research with scientists at other institutions, including universities, interagency divisions, and non-government research organizations. These investigations required wolf project staff to assist graduate students and outside researchers in their efforts to better understand wolf ecology, ecosystem function, and conservation work, much of which is pioneering research.

Wolf Project Students: Direct Assistance

Five graduate researches and one post-doctoral researcher worked in collaboration with the Wolf Project in 2009: Daniel Stahler, Emily Almberg, Matt Metz, Bonnie Trejo, Alessia Uboni, and Dr. Dan MacNulty. Three are long-time employees on the project that have moved on to work in a new capacity and are partially supported by project funding. Stahler's project focuses on combining behavioral data gathered in the field with genetic data gleaned from DNA samples and overlaying the two techniques to better understand wolf social behavior and life history. Almberg's project focused on wolf diseases both from a current and historical perspective. With severe morality caused by disease in 2008, 2005, and 1999, Almberg's work helped elucidate the role of diseases for wolf population ecology in the Northern Rockies. Metz's project focuses on summer predation patterns in wolves by incorporating downloadable GPS collar technology and modeling techniques. Trejo's project focuses on summer diet analysis of wolves in the Greater Yellowstone using traditional scat analysis technique in comparison with more technological advanced methods such as GPS collar cluster analysis. Uboni's will be studying spatial dynamics of Yellowstone wolves using the extensive location dataset

collected since wolf reintroduction. MacNulty's post-doctoral work involves hunting behavior research.

***Title*:** Behavioral, ecological, and genetic influences on life-history strategies and social dynamics of gray wolves.
***Graduate Student*:** Daniel Stahler, Ph.D. student
***Committee Chair*:** Dr. Robert Wayne, University of California, Los Angeles
***Project Summary*:** The evolution of complex societies, such as seen in wolves, is greatly influenced by how ecological and social constraints impact population structure and mating systems. In combination with the underlying genetic structure of wolf packs, aspects of wolf ecology such as reproduction, dispersal, pack formation, and territoriality is predicted to vary with the abundance and distribution of resources. This research will investigate the link between socioecological conditions and these aspects of wolf ecology in Yellowstone. This project will take advantage of long-term datasets following the 1995 reintroduction: 1) a complete population pedigree of marked individuals resulting from the integration of molecular and field-based behavioral data; and 2) predator-prey and wolf population dynamics. By combining field and laboratory-based data, this study will ask questions concerning life history patterns, territoriality, and pack interactions and how it is associated with kinship and ecological condition. By combining long-term ecological, behavioral, and molecular datasets, this study will enhance our understanding of the evolution of complex, kin-structured societies, as well as provide a better understanding of how social and ecological conditions are related to wolf population dynamics and conservation.
***Project Activity in 2009*:** Fulfilled teaching requirements at UCLA, field data collection and management, analyzed genetic samples, began data analysis, coauthored several YNP wolf genetic related papers.
***Anticipated Completion Date*:** 2011

***Title*:** Infectious Disease in Yellowstone National Park's Canid Community
***Graduate Student*:** Emily Almberg, Master's student
***Committee Chair*:** Dr. L. David Mech, University of Minnesota, St. Paul
***Project Summary*:** Gray wolves were reintroduced into Yellowstone National Park (YNP) after a >70 year absence, and as part of recovery efforts, the population has been closely monitored. We analyzed sympatric wolf, coyote (*Canis latrans*), and red fox (*Vulpes vulpes*) serologic data from YNP, spanning 1991-2007, to identify long-term patterns of pathogen exposure and to examine evidence for disease-induced mortality. We found that canine parvovirus, canine adenovirus-1, canine herpesvirus, and *Neospora caninum* were enzootic within YNP wolves and coyotes. Wolf, coyote, and fox exposure to canine distemper virus (CDV) was temporally variable, with evidence for distinct multi-host outbreaks in 1999 and 2005. The years of high wolf-pup mortality in 1999 and 2005 in the northern region of the park were correlated with peaks in CDV seroprevalence, suggesting that CDV contributed to the observed mortality. Although CDV appears capable of causing short-term population declines, none of the pathogens examined appear to jeopardize the long-term population of canids in YNP. CDV causes acute, highly immunizing infections among its wide range of carnivore hosts. Repeated outbreaks of CDV among YNP's wolves, coyotes, and cougars (*Puma concolor*)

prompted questions as to how, where, and at what scale CDV might be persisting in the regional carnivore community. Using several stochastic, spatially-explicit susceptible-exposed-infectious-recovered (SEIR) simulation models, we determined that (1) current wolf populations in the Greater Yellowstone Ecosystem are too small to support endemic CDV, (2) that under the assumption that coyotes are the primary reservoir host, CDV requires an unrealistically large number of individual hosts (50,000 - 100,000) for long-term persistence, and (3) the inclusion of a second host species, capable of inter-species transmission, can greatly increase the probability of long-term CDV persistence, particularly at relatively small spatial scales. Given the small group sizes of carnivores and their annual reproductive pulses, CDV probably requires multi-host transmission for long-term persistence.
***Project Activity in 2009*:** Successfully defended thesis and published two peer-reviewed papers.
***Completion Date*:** May, 2009

***Title*:** Seasonal predation patterns of gray wolves in Yellowstone.
***Graduate Student*:** Matt Metz, master's student
***Committee Chair*:** Dr. John Vucetich, Michigan Technological University
Project Summary: The summer predation patterns of wolves are mostly unknown, which creates an important gap of knowledge with regards to annual patterns of predation. As a result of methodological difficulties in detecting kills outside of winter months due to changes in both ecological conditions and wolf behavior, wolf kill rates from winter have often been projected throughout the year in order to estimate a wolf's impact on the prey population for the entire year. This likely overestimates kill rates (at least in kg/wolf/day, not necessarily in ungulates/wolf/day) due to the data being gathered only in winter, when adult prey become increasingly vulnerable. Additionally, the need to provide for pups and the utilization of small prey items likely changes the foraging strategy of wolves in the summer. Finally, the presence of both grizzly and black bears in Yellowstone may cause wolves to spend only a short time period at a kill. Due to these challenges, GPS collars deployed on individual wolves will identify location clusters in an attempt to find summer kills and then examine their characteristics (species, sex, age). Results of wolf summer predation patterns will be compared to data collected in winter from Yellowstone in order to compare seasonal patterns of predation.
***Project Activity in 2009*:** Summer fieldwork searching GPS clusters, coursework, and thesis preparation.
***Anticipated Completion Date*:** May, 2010

Title: A comparison of two methods to assess the summer food habits of wolves
***Graduate Student*:** Bonnie Trejo
***Committee Chair*:** Dr. Richard Golightly, Humboldt State University
***Project Summary*:** Scat analysis is commonly used to document the summer diet of wolves. The method is non-invasive and cost efficient; however, biases as well as technical and interpretational difficulties can limit its value. Recent technological advancements in the use of GPS-telemetry and location cluster analysis have been utilized in Yellowstone National Park (YNP) and Grand Teton National Park (GTNP) to improve our knowledge of the summer food habits of wolves. To date, information

collected using GPS techniques has not been compared with that gained from the longstanding method of scat analysis. Scat analysis may be particularly useful for detecting small prey items that may be missed by tracking techniques. The objectives of this study are to: (1) analyze wolf scat collected in YNP and GTNP to determine percent frequency of occurrence of prey items, and calculate the relative number of prey consumed, (2) compare the results of scat analysis to that of GPS cluster analysis to evaluate the differential assessment of prey composition and biomass between the two approaches, and (3) compare the summer diet of wolves among years, between packs, seasons (summer and winter), and geographical regions within the greater Yellowstone ecosystem. This project is a collaborative effort between the NPS, USFWS, and Humboldt State University.
***Project Activity in 2009*:** Collection of approximately 500 scats from YNP. Development of lab techniques and beginning analysis of scats collected from GTNP.
***Anticipated Completion Date*:** May 2011

Title: Effects of wolf age structure and life history on wolf-elk interactions
***Post-Doctoral Researcher*:** Dr. Dan MacNulty
***Post-Doctoral Advisor*:** Dr. John Vucetich, Michigan Technological University
***Project Summary*:** Most wild animal populations are composed of individuals that differ with respect to various traits such as age, sex, and body size. Such heterogeneities in predator populations are thought to have profound effects on predator-prey dynamics. In particular, variation in traits that determine a predator's capture ability may promote dynamic stability. Yet, most predation research has treated predators as abstract, homogeneous sources of risk to which prey respond. The overall goal of this research project is to determine the extent to which heterogeneities in the Yellowstone wolf population influence the outcome of wolf-elk interactions at the individual- and population-level. Results are expected to clarify the effects of wolves on ungulate populations.
***Project Activity in 2009*:** Published research findings detailing how wolf body size and age influence wolf-elk interactions. Results indicate that large body size sometimes limits predatory performance and that individual-level aging impairs hunting ability and reduces prey offtake via fluctuations in population age structure. Because age structure varies independently of population size, results suggest that predatory senescence may cause wolf populations of equal size but different age structure to have different impacts on elk populations. Knowledge of wolf age structure may therefore improve predictions of wolf-dynamics.
***Anticipated Completion Date*:** September, 2010

Title: Wolf spatial analysis: habitat use and territorial patterns.
***Graduate Student*:** Alessia Uboni
***Committee Chair*:** Dr. John Vucetich, Michigan Technological University
***Project Summary*:** This project focuses primarily on spatial analysis of wolf movements using radio telemetry. Territory mapping and determining wolf habitat use via Resource Selection Function (RSF) will be a major part of this project. Relating habitat use to variables like elk distribution and abundance, pack size, kill rate, intraspecific strife, winter vs. summer, day vs. night will be the major emphasis of this project which is just

underway but will use data from 1995 to the present. Data derived from both GPS and VHF collars will be used.
***Project Activity in 2009*:** Attended school at MTU taking classes and working on data analyses.
***Anticipated Completion Date*:** May 2013

The Yellowstone-Abruzzo Wolf Research Exchange Program

In September 2009, Yellowstone Wolf Project members Matt Metz and Rebecca Raymond visited Abruzzo National Park in Italy to observe and participate in a Abruzzo Large Carnivore Research Program led by renowned wolf biologist Luigi Boitani from the University of Rome. The trip was made possible through a donor-sponsored new program designed to exchange professional and cultural ideas about the science and conservation of carnivores through the experiences of young biologists. The Abruzzo research program investigates the ecology of the two large carnivores in the ecosystem: the Marsican brown bear (*Ursus arctos marsicanus*) and the Italian wolf (*Canis lupus italicus*). Primary research objectives for each species include population estimation and diet analysis, as little has been historically known about these large carnivores. An important goal is to estimate annual reproduction. For bears, this is achieved by observing females in open country foraging on the berries of *Rhamnus alpinus*, an important food source for them. Wolf reproduction is documented during summer by conducting howling surveys near homesites. The investigation of these carnivores' diets is primarily accomplished via searching GPS clusters and scat analysis. Prey species available to and utilized by wolves varies between pack territories, with red deer, roe deer, wild boar, and domestic livestock as the primary prey.

During the trip to Abruzzo, Metz and Raymond had a culturally and professionally unique experience with the opportunity to learn from another wolf research program. They assisted with the monitoring of both bears and wolves while in Italy, using methodologies that were both similar and different. As part of the objectives of this program, researchers from both teams exchanged information and ideas on research techniques with the intention of strengthening both teams research programs. Additionally, Metz and Raymond gave presentations on the ecological lessons learned from 15 years of Yellowstone research following wolf restoration. This exchange of ideas and experiences will continue in 2010 as two members of the Abruzzo Large Carnivore Research Program will visit the Yellowstone Wolf Project during March 2010 winter study.

Yellowstone Wolf Project Research

Predator-Prey - A major objective for Yellowstone research is wolf–prey relationships. Biannual 30-day winter studies (November 15-December 14 and March 1-30) ongoing for 15 years are designed to record early and late winter predation patterns. More recently, summer predation patterns are studied using downloadable GPS collar data (May through July), along with scat collection for diet analysis. During these established

predation studies, and opportunistically throughout the year, project staff records behavioral interactions between wolves and prey, predation 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. Graduate students Matt Metz and Bonnie Trejo and post doctoral student Dan MacNulty conducted research associated with this topic.

Hunting Behavior – This aspect of predator-prey has been a research focus in Yellowstone largely through the efforts of long-term graduate and post-doctoral researcher 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. Published research in 2009 focused on predatory performance of wolves with respect to age and body size and their ecological and evolutionary dynamics.

Pelican Valley Wolf, Grizzly Bear, and Bison - Starting in 1999, the Yellowstone Wolf Project has monitored wolves, bison, and grizzly bears from a hilltop observation point in Yellowstone's Pelican Valley for 2-4 weeks during March. The primary goal for this study is to document the behavioral interactions between wolves, bison, and grizzly bears 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 early spring grizzly bears.

Population Dynamics – Using data from a radio-marked population, year-round research focuses on understanding the major components of wolf population dynamics (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, and age structure. Necropsies of all recovered radio-collared individuals and uncollared wolves provide cause-specific mortality data.

Dispersal - The ecological, demographic, and genetic implications of dispersal is an important research focus for Yellowstone wolves. Using radiocollar and genetic techniques under the umbrella of other project objectives, current research aims to understand basic demographic patterns of dispersal (age, sex, distance, season), 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. Graduate work by Dan Stahler at UCLA and Kira Cassidy-Quimby at University of Minnesota is associated with the topic.

Breeding Behavior – During January and February each year, project staff monitor Yellowstone packs for courtship and breeding behaviors. The opportunity to study breeding behavior in wild wolves is unprecedented, and this study is designed to investigate the role of interacting social and ecological factors influencing individuals'

attempts to breed and their relative fitness consequences. Aspects of breeding behavior are included in Dan Stahler's graduate research.

Wolf Pack Leadership - The purpose of this study is to determine the nature of leadership in wild wolf packs. Ultimately, this project will 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 is leadership behavior demonstrated and how it is correlated to breeding status, social status, environmental conditions, and season.

Wolf Capture and Handling – Each year, approximately 25-30 wolves are helicopter darted and radio-collared. Handling of individuals provides data on morphometrics, disease, genetic sampling, age, sex, breeding status, and condition. Both VHF and GPS collars are deployed, and provide the basis for nearly all other aspects of Yellowstone's research program.

Disease - Research on the disease ecology of Yellowstone wolves is ongoing. The majority of disease monitoring comes from extracting and analyzing blood samples. Serum and blood profile analyses record diseases exposure and prevalence. Nasal, rectal, and ocular swabs collected on both live and dead wolves also aide in documenting disease and cause of death. Disease screening includes parvovirus, distemper, and infectious canine hepatitis. Additionally, a population-wide sarcoptic mange monitoring effort has begun using an individual-based monthly documentation of mange occurrence, severity, and recovery in all packs through the use of direct observations, handling, and aerial photographs. Graduate work was completed by Emily Almberg in 2009 in association with this research topic.

Population Genetics – Annual genetic sampling (blood, tissue, and scats) from live and dead wolves is used to study genetic diversity, population structure, parentage and kinship, gene flow, and selection of fitness related traits. In combination with ecological and behavioral datasets, genetic data supports research on both evolutionary and ecological dynamics in the Yellowstone population. Examples of current research questions include evolutionary history and selection for coat color, evolution of life history traits (e.g. reproduction, senescence), effect of kinship on breeding strategies, territoriality and strife. Graduate work was ongoing by Dan Stahler and Bridgett vonHoldt through UCLA in 2009 in association with this research topic.

Multi-carnivore and Scavenger Interactions – Research is ongoing to understand the degree to which exploitative and interference competition is occurring among Yellowstone's carnivores. Data is collected on all observed wolf-bear, wolf-cougar, and wolf-coyote interactions. Additionally, data on scavenger species diversity, abundance, and carcass utilization at wolf kills are collected to understand how these interactions influence structure and function of the ecosystem.

Wolf Spatial Dynamics – Thousands of wolf radio locations, both VHF and GPS, have been gathered since wolves were reintroduced to YNP in 1995. Rigorous analyses using these locations have begun examining many questions concerning habitat use and territoriality. Year-to-year changes in territory use are being related to variables like elk density and distribution, intraspecific strife, pack size, and reproduction. Other analyses underway are habitat use (using Resource Selection Functions; RSF), travel and territory size summer vs. winter and night vs. day, as well as are the answers the same when GPS collars are compared to VHF. Alessia Uboni at Michigan Technological University with Dr. John Vucetich is working on this project as a graduate student.

OUTREACH

Outreach in Yellowstone National Park

Yellowstone Wolf Project staff gave 183 talks and 90 interviews. Talks were at both scientific conferences and to general audiences. Interviews were to all forms of media.

Outreach in Wyoming outside Yellowstone National Park

In 2009, the WY wolf recovery program continued to give numerous formal presentations to public schools, universities, wildlife symposiums, state and federal management agencies, livestock association meetings, state legislature committees, and environmental groups. We were also interviewed for numerous magazine, newspaper, and television feature stories.

USFWS LAW ENFORCEMENT

Enforcement efforts continue in WY. The Office of Law Enforcement continues to use traditional enforcement along with programs designated to prevent illegal killing of wolves. Fast and appropriate response to wolf problems by the USFWS and Wildlife Services has done much to ensure that individuals do not become frustrated and illegally kill wolves. Currently, the State of Wyoming has no laws to protect wolves in $\geq$88% of the state.

WYOMING CONTACT INFORMATION

USFWS Project Leader
Mike Jimenez
P.O. Box 2645
Jackson, WY 83001
(307) 733-7096 (office)
(307) 330-5631 (cell)
mike_jimenez@fws.gov

USDA APHIS WS State Director
Rod Krischke
P.O. Box 59
Casper, WY 82602
(307) 261-5336
rodney.f.krischke@aphis.usda.gov

USFWS Law Enforcement
Tim Eicher
P.O. Box 516
Cody, WY 82414
(307) 527-7607

Roy Brown
P.O. Box 570
Lander, WY 82520
(307) 332-7607

Scott Darrah
P.O. Box 113
Casper, WY 82604
(307) 261-6365

ACKNOWLEDGEMENTS

We thank all of the Wolf Project field technician volunteers, especially winter study volunteers, without whom we could not carry on the vital research and management of wolves. We also thank donations and support from six major institutions and organizations: an anonymous donor, Annie Graham of Tapeats Foundation, Frank and Kay Yeager, Canon, Inc., the Yellowstone Park Foundation, and the National Science Foundation grant DEB -0613730. We recognize the above because our work would not be possible without their support and involvement. These are our major donors, and we also are supported by numerous smaller donors, especially ones through the collar sponsorship program, that add significantly and are also necessary for our research, management, outreach, education and publications.

We thank our pilots Dave Stinson, Roger Stradley, Steve Ard, Neil Cadwell and Bob Hawkins for safe and successful piloting during wolf tracking and helicopter darting, as well as numerous field technicians. Laboratory work was done by Mattson's Laboratory in Milltown, Montana.

Numerous agencies and agency personnel have contributed to the recovery program and we thank Dave Skates, Pat Hnilicka, and Laurie Connel (USFWS Lander); USFS Dale Deiter and Kerry Murphy at Bridger-Teton National Forest; Shoshone National Forest; Steve Cain and Sarah Dewey from Grand Teton National Park; Steve Kallin, Tom Reed, Eric Cole, and Marty Meyer at the National Elk Refuge; Bureau of Land Management; and Wyoming Game and Fish Department. We know that a successful program needs a strong base of support and to all of the above we are indebted.