

# WYOMING WOLF RECOVERY 2010 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, 2010 through December 31, 2010.

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## SUMMARY

The wolf (*Canis lupus*) population increased statewide by approximately 7%, making 2010 the ninth consecutive year that Wyoming (WY) has exceeded the numerical, distributional, and temporal recovery goals established by the U.S. Fish and Wildlife Service (USFWS). At least 343 wolves in  $\geq 45$  packs (including  $\geq 27$  breeding pairs) inhabited WY, including Yellowstone National Park (YNP).

WY (outside YNP): The wolf population increased by approximately 10%, consisting of  $\geq 230$  wolves in  $\geq 34$  packs of which  $\geq 19$  breeding pairs produced  $\geq 77$  pups that survived through 31 December 2010. Another  $\geq 16$  lone wolves were located throughout the western portion of the state. Average pack size was 6.8 wolves per pack and average litter size was 4.1 pups per litter. On average, the WY wolf population has grown approximately 17% per year from 2002-2010. We documented 58 dead wolves (19% of the population). Causes of mortality included: agency control = 40; under investigation and unknown = 13; human caused = 3; and natural = 2.

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 well above recovery objectives. We recorded 59 livestock (26 cattle and 33 sheep) and 1 horse as confirmed wolf-kills. Thirteen packs were involved in at least one livestock depredation in 2010. Agency control efforts removed 40 depredating wolves (13% of the population) to reduce livestock losses due to wolves. The State of Wyoming paid \$73,489.77 to compensate cattle producers and wool growers who lost livestock to wolves in 2010.

YNP: At the end of 2010, at least 97 wolves in 11 packs (8 breeding pairs), with 6 loners occupied Yellowstone National Park (YNP). This is almost exactly the same (96) population size as last year but breeding pairs increased from 6 to 8. Wolves in YNP declined approximately 60% since 2007 mostly because of a smaller elk population, the main food of northern range wolves. The interior wolf population has declined less, probably because they augment their diet with bison. The severity of mange declined in 2010 and there was no evidence of distemper being a mortality factor as it was in 1999, 2005 and 2008. Pack size ranged from 3 (Grayling Creek) to 16 (Mollie's) and averaged 8.3, slightly higher than 2009 (7.1), but lower than the long-term average (10). Eight of 11 (73%) packs reproduced. The average number of pups/pack in early winter for packs that had pups was 4.8, higher than the 3.8/pack average in 2009. A total of 38 pups in YNP survived to year end.

Project staff detected 268 kills (definite, probable, and possible combined) made by wolves in 2010, including 211 elk (79%), 25 bison (9%), 7 deer (3%), two moose (<1%), two pronghorn (<1%), two grizzly bears (<1%), four coyotes (1%), two ravens (<1%), 4 wolves (1%), and ten unknown prey (4%). The composition of elk kills was 25% calves, 43% cows, 18% bulls, and 15% elk of unknown sex and/or age. Bison kills included four calves, six cows, seven bulls, and eight unknown sex adults.

Other research included population genetics, disease, hunting behavior, spatial analyses of territory use, wolf pack leadership, multi-carnivore-scavenger interactions, breeding behavior, dispersal, and observations of wolf, grizzly bear and bison interactions in Pelican Valley.

## **GREATER YELLOWSTONE RECOVERY AREA - WYOMING**

### **PERSONNEL**

#### **Personnel in Wyoming outside Yellowstone National Park**

In 2010, 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 included Project Leader Mike Jimenez; law enforcement agents Terry Thibeault (Resident Agent-in-Charge, Billings, MT), Roy Brown (Special Agent, Lander), and Scott Darrah (Special Agent, Casper); biologists Scott Becker and Susannah Woodruff; and volunteers Ryan Blackadar, Catherine Brown, William Deacy, Callie Domek, Ryan Grindle, Heidi Helling, Leigh McKissick, and Taylor Tully. Law enforcement special agents Dominic Domenici and Tim Eicher retired in mid 2010 after long distinguished careers in state and federal law enforcement. Scott Becker was hired as a full time biologist stationed in Cody, WY.

WS personnel involved with wolf management in WY during 2010 were: State Director Rod Krischke, Rod Merrell, Craig Acres, Jim Pehringer, Grant Belden, Dave Blakeman, Arnie Debock, Jed Edwards, Dave Fowler, Tracy Frye, Miles Hausner, Dave Johnson, Monte Nicholson, Michael Peterson, Steve Richins, Tracy Villwok, Bob Wells, and Dan Braig. NPS biologists John Stephenson and Sarah Dewey monitored wolves in Grand Teton National Park (GTNP) and adjacent areas in WY.

#### **Personnel in Yellowstone National Park**

Three full-time employees worked for the Yellowstone Wolf Project in 2010: 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 were Colby Anton, Nate Bowersock, Cheyenne Burnett, Kira Cassidy-Quimby, Kristen Clover, Caitlin Dodge, Allison Greenleaf, Josh Irving, Ryan Kindermann, Ky Koitzsch, Lisa Koitzsch, Matthew Metz, Regina Mossotti, Brendan Oates, Rebecca Raymond, LaRue Seitz, Dave Unger, Rachel Wheat and Hilary Zaranek.

### **MONITORING**

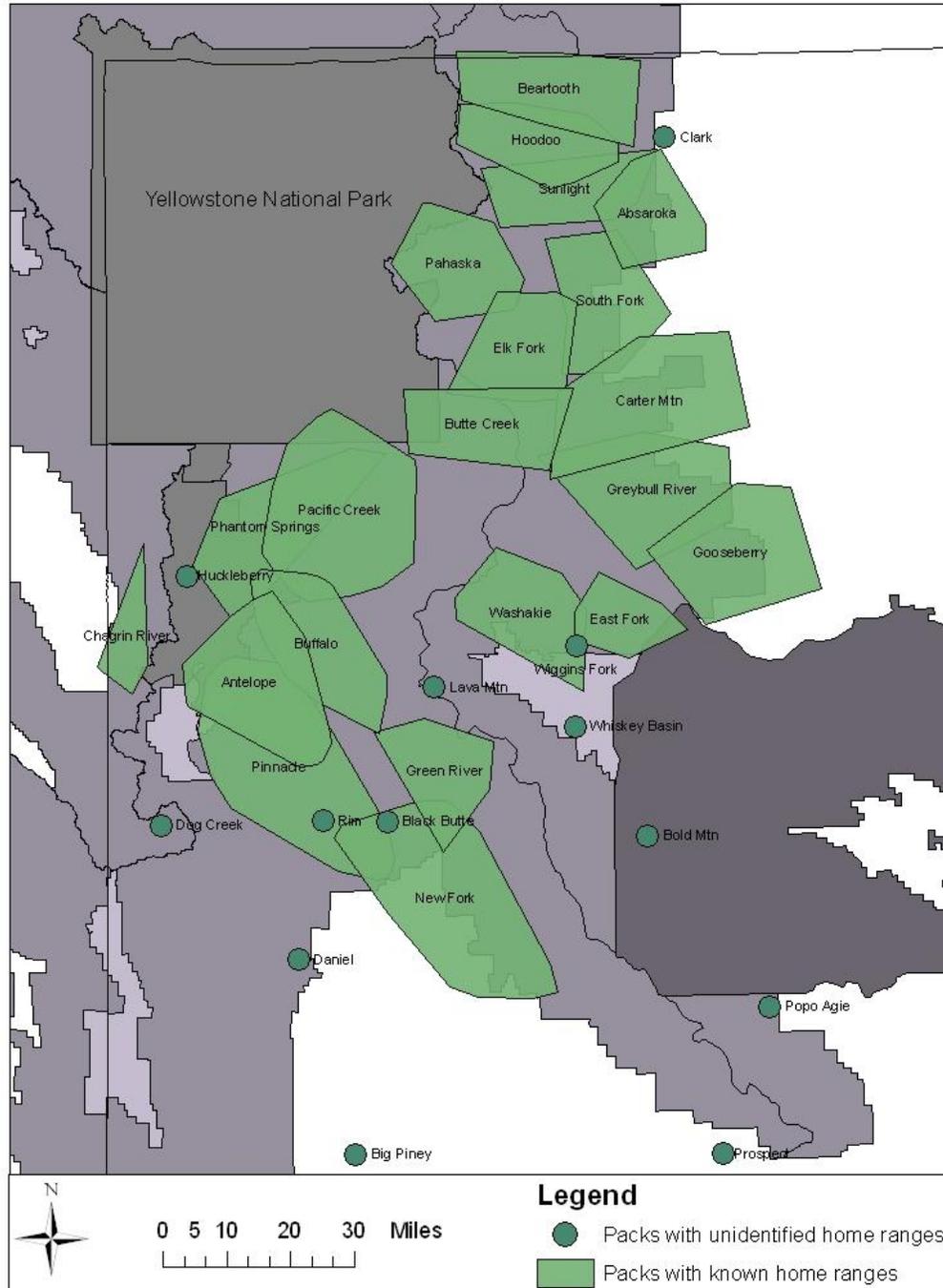
#### **Monitoring wolves in Wyoming outside Yellowstone National Park**

##### ***Population Status***

As of 31 December 2010, we estimated that  $\geq 230$  wolves in  $\geq 34$  packs ( $\geq 19$  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 14 and averaged 6.8 wolves per pack.

### 2010 Wyoming Wolf Packs



**Figure 1.** Home ranges of 34 known wolf packs in WY in 2010.

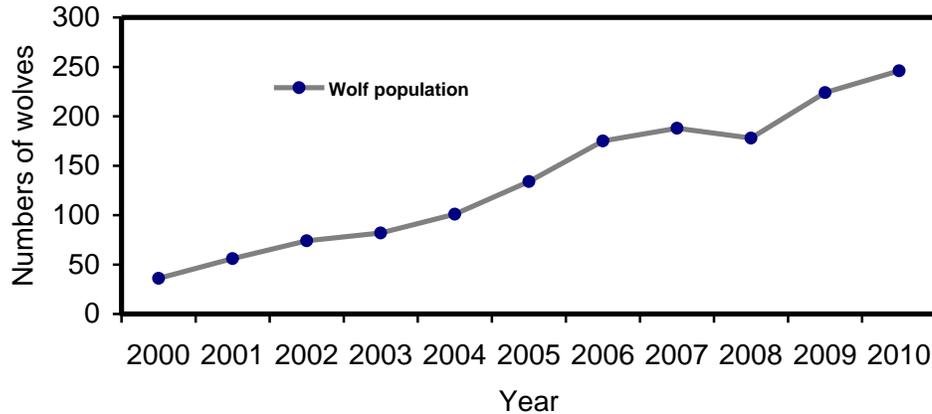
Wolf Pack	Pack Size Dec 2010			Control	Other Mortality	Confirmed Losses				
	Adult	Pups	Total			Cattle	Sheep	Dogs	Other	
Wyoming (outside YNP)										
<u>Absaroka</u>	4	2	6	4	1	4				
Antelope	4	0	4	0						
<u>Beartooth</u>	7	5	12	0						
Big Piney	4	?	4	0						
Black Butte	2	0	2	3		4				1
Bold Mtn	3	0	3	0						
Buffalo	14	0	14	0	4					
<u>Butte Creek</u>	5	4	9	0						
Carter Mtn.	3	?	3	0						
Gasper	1	0	1	0	1					
<u>Chagrin River</u>	4	4	8	0						
Clark	3	0	3	8		3				
Daniel	4	?	4	0						
Dempsey-Creek	0	0	0	8				4		
<u>Dog Creek</u>	5	5	10	0				4		
East Fork	3	3	6	2		3				
<u>Elk Fork Creek</u>	3	4	7	0						
<u>Gooseberry</u>	4	3	7	0						
<u>Green River</u>	3	5	8	5		7				
<u>Greybull River</u>	5	5	10	0						
<u>Hoodoo</u>	6	4	10	2	2	1				
Huckleberry	9	?	9	0						
<u>Lava Mtn</u>	5	5	10	0						
New Fork	2	0	2	0						
<u>Pacific Creek</u>	7	5	12	0						
Pahaska	7	?	7	0						
Phantom Springs	6	3	9	0	3					
<u>Pinnacle Peak</u>	6	5	11	0	4					
Popo Agie	2	0	2	0						
Prospect	2	0	2	0						
Rim	4	?	4	0						
<u>South Fork</u>	4	4	8	0						
<u>Sunlight</u>	4	5	9	5	1	3				
<u>Washakie</u>	4	4	8	0						
Whiskey Basin	3	0	3	0						
<u>Wiggins Fork</u>	2	2	4	3						
Others and lone wolves	15	0	15	0	2	1	25			
<b>Sub-total</b>	<b>169</b>	<b>77</b>	<b>246</b>	<b>40</b>	<b>18</b>	<b>26</b>	<b>33</b>			<b>1</b>

Table 1. Composition of confirmed packs in Wyoming in 2010.

Underlined packs are counted as breeding pairs.

### ***Population Growth***

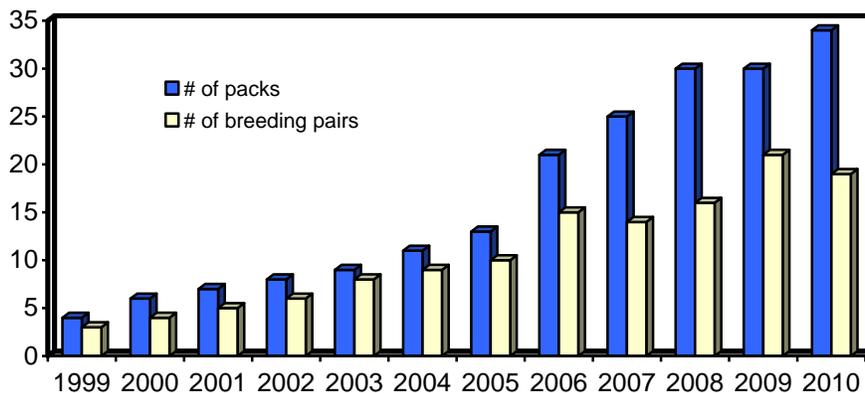
The WY wolf population (outside YNP) increased in 2010 approximately 10% from  $\geq 224$  wolves in 2009 to  $\geq 246$  wolves in 2010 (Figure 2). Average increase from 2002-2010 has been approximately 17% per year.



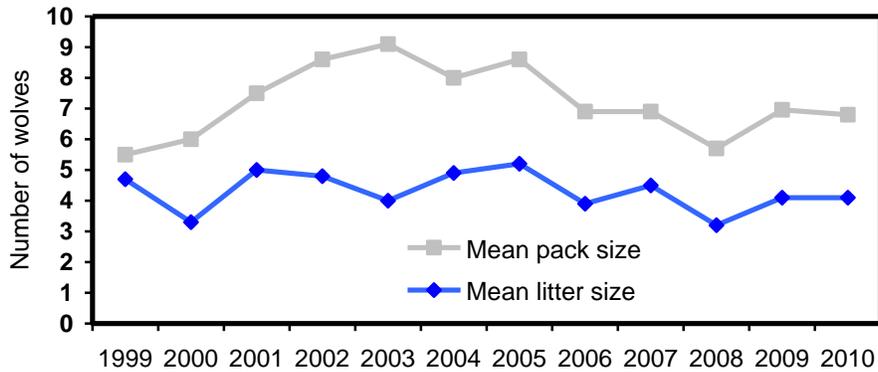
**Figure 2.** Wolf population growth in WY: 2000 - 2010.

### ***Reproduction***

A total of  $\geq 19$  packs produced  $\geq 77$  pups and met the USFWS breeding pair definition ( $\geq 1$  adult male and  $\geq 1$  adult female in a pack producing  $\geq 2$  pups that survived through 31 December of that year). Mean litter size was 4.1 pups per litter and ranged from 2-5 pups (Figures 3 and 4).



**Figure 3.** Number of wolf packs and breeding pairs in WY: 1999 – 2010.



**Figure 4.** Mean pack size and mean litter size for wolves in WY: 1999 - 2010.

***Mortalities***

In 2010, 58 wolves (19% of the population) were known to have died in WY. Causes of mortality included: agency control = 40 (69% of all documented mortality); unknown or under law enforcement investigation = 12 (21%); natural = 2 (3%), and other = 4 (7%).

***Radio Collars***

A total of 32 wolves were radio collared in 2010 (helicopter darting=24 and trapping=8). We monitored a total of 63 radio collared wolves (26% of the population) in 21 packs (62% of all packs). From 1999 through 2010, we maintained radio collars on approx. 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.

***Disease***

Mange: Sarcoptic mange is a highly contagious skin disease caused by mites (*Sarcoptes scabiei*) and is commonly found in wolf populations throughout the world. Mange was first detected in Wyoming in 2002. Between 2002 and 2008, we suspected that four packs east of YNP were infested with mange and at least one pack near Jackson, WY had mange (Jimenez et al. 2010). This year we observed signs of mange (alopecia and seborrhea) in 2 packs west of Cody, WY and in the same pack near Jackson, WY.

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. Over 80% of the wolves in WY routinely test positive for CDV and CPV. Based on other areas of the world that have experienced epizootic CDV and CPV infections, these diseases 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.

## **Monitoring in Yellowstone National Park**

### ***Population and Territory Status***

At the end of 2010, at least 97 wolves in 11 packs (8 breeding pairs) with 6 loners occupied YNP. The same number of wolves (96) as in 2009. Number of packs, however declined, from 14 to 11, but breeding pairs increased from 6 to 8. There was no evidence of disease (e.g., distemper) impacting the population in 2010, although sarcoptic mange was present, its severity was reduced (it peaked in 2008) and its population affects appear limited.

This was significantly fewer wolves than the park-wide population peak in 2003 at 174, a decline that was related to food stress, causing lower recruitment and higher mortality through disease and interspecific conflict. This forecasts a low population equilibrium for YNP wolves, especially on the northern range. Northern range wolves have declined 60% since 2007 compared to only a 23% for interior wolves during the same period. Northern range wolves are much more dependent on elk as a food source, which have declined 60% since 2007, than interior wolves which prey on elk and still a widely available bison. Disease impacts have also likely played a larger role in the wolf decline on the northern range because of higher canid density (wolves, coyotes and foxes) than in the interior where canid density was lower.

There were three fewer packs in 2010 than in 2009; six packs (the Madison pack was not listed at the end of 2009) either dissolved or left YNP and two new packs formed. Gibbon Meadows and Madison emigrated as packs to the Centennial Mountains and to west of West Yellowstone, Montana, respectively, and the Cottonwood Creek pack likely persisted after 4 of them, including both breeders, were legally harvested by hunters north of the park in 2009. This could not be confirmed because none of the 6 survivors were radio collared, but sightings indicated that they continued to range north of YNP. Druid Peak, Lava Creek and Everts packs dissolved either through mortality or emigration. The two new packs were Lamar Canyon (7 wolves including pups) which settled mostly into the old Druid Peak and Slough Creek territories and Mary Mountain (6 wolves including pups) occupying Hayden Valley and the Nez Perce Creek region. Pack size ranged from 3 (Grayling Creek) to 16 (Mollie's) and averaged 8.3, slightly higher than last year's 7.1, but still lower than the long-term average of 10.

### ***Reproduction***

Eight (73%) of the 11 packs successfully reproduced. One pack that was not counted in the year-end total, the Madison pack, had pups in the park, but they permanently moved to Idaho where they remain to the present time. Counting pups from the Madison pack, 50 pups were born in YNP, 45 counting only year-end packs and of those 38 (84%; Table 2b) survived until early winter. This was significantly more pups (+39%) surviving than in 2009. Average number of pups/pack at year end was 4.8 (counting only those packs that had pups).

### ***Mortalities***

Nine radio-collared wolves died in YNP in 2010. Intraspecific strife was again the leading cause of mortality with 4 (45%) wolf deaths followed by natural/unknown (3 or 33%), interspecific (1 or 11%; killed by a bison), and disease/malnutrition (1 or 11%). Continued high mortality from wolf-wolf strife probably indicates food stress among wolves and is corroborated by a steep population decline on the northern range from 94 wolves in 2007 to 38 at the end of 2010. Disease, primarily distemper in pups and possibly mange, has also played a role in the population decline.

***Wolf Capture and Collaring***

Eighteen wolves were captured and radio-collared in 2010 and 29% of the population was collared at year end. Eight adults, 4 yearlings and 6 pups were captured (8 were males and 10 females). Both VHF and downloadable GPS collars were deployed. Collars were used for a variety of reasons including research and management

**MANAGEMENT**

**Management in Wyoming outside Yellowstone National Park**

***Livestock Depredations***

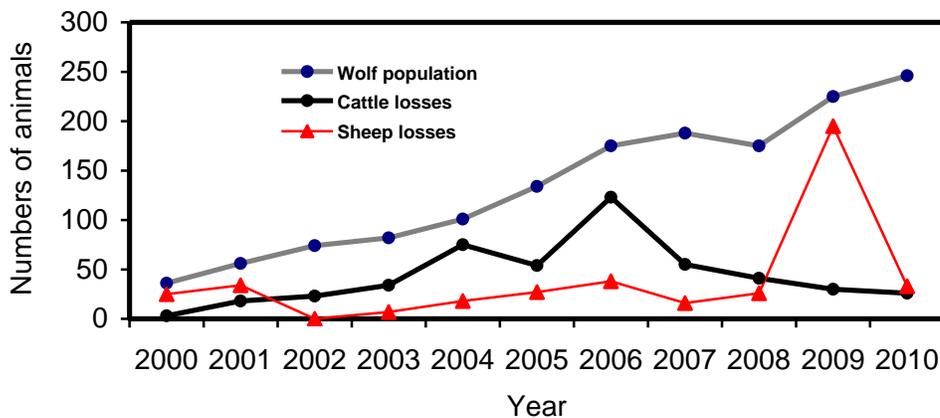
Potential livestock depredations in WY were investigated by WS, USFWS and WGFD. Depredations were classified as confirmed, probable, or other based on specific criteria agreed upon by the USFWS and WS. The following livestock depredation statistics were based on reported livestock losses and do not reflect lost or missing livestock. In 2010, wolves in WY were responsible for killing  $\geq 59$  livestock and 1 horse (foal). Confirmed livestock depredations included 26 cattle (19 calves and 7 cows/yearlings) and 33 sheep (6 ewes and 27 lambs) (Table 2) (Appendix Tables 2a, 5a, and 5b). Two horses were chased by wolves and injured when they ran through a fence. One horse was chased by wolves and broke its leg when it ran over a cattle guard. All 3 injured horses had to be euthanized. One dead calf was recorded as a probable wolf-kill. Eleven calves and 1 steer were injured by wolves, but survived. The total number of confirmed livestock depredations was the lowest number recorded since 2003 (Tables 3 and Figure 5).

<b>Confirmed</b>	<b>Probable</b>	<b>Injured</b>
19 calves killed	1 calf killed	11 calves
7 cows killed		1 steer
33 sheep killed		
1 horse (foal) killed		

**Table 2.** Depredations in WY in 2010 (confirmed, probable, and injured livestock and horses).

Depredations	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cattle	3	18	23	34	75	54	123	55	41	20	26
Sheep	25	34	0	7	18	27	38	16	26	195	33
Dogs	6	2	0	0	2	1	1	2	0	7	0
Goats	0	0	0	0	10	0	0	0	0	0	0
Horses	0	0	0	2	0	1	0	1	0	0	1
Wolves Controlled	1	2	4	6	18	29	41	44	63	31	40

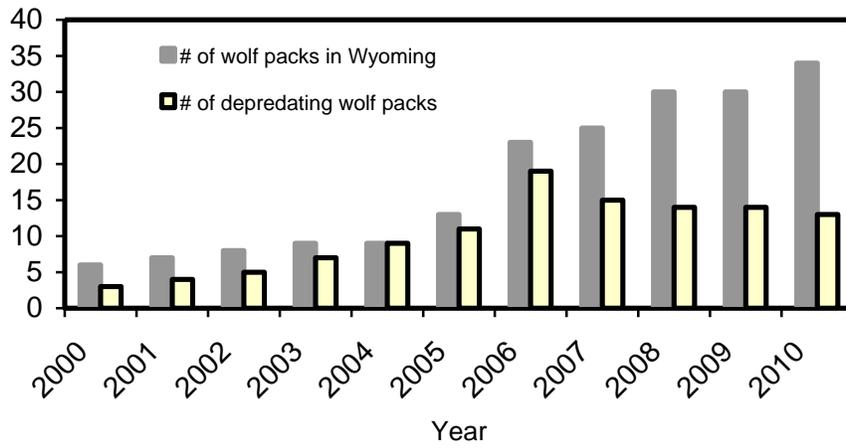
**Table 3.** Confirmed livestock depredations in WY: 2000 – 2010.



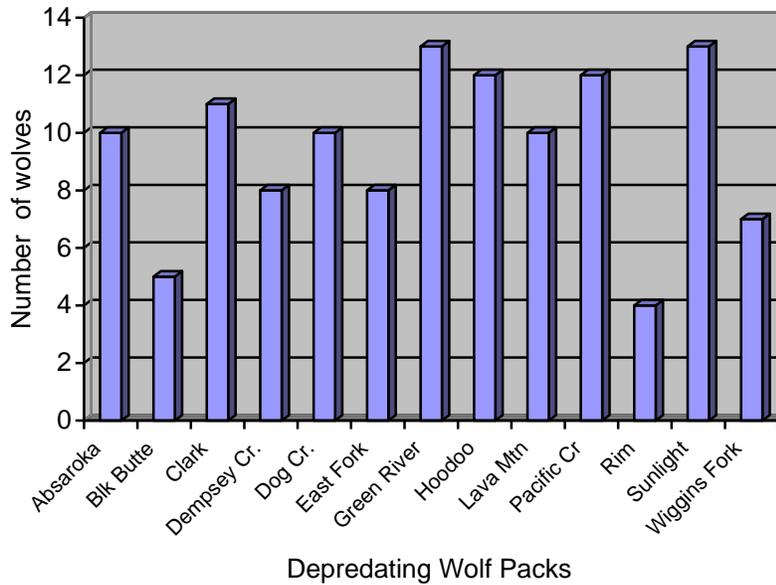
**Figure 5.** Annual wolf population size and number of confirmed cattle and sheep losses/year in WY: 2000 - 2010.

***Number of Packs Involved in Depredations***

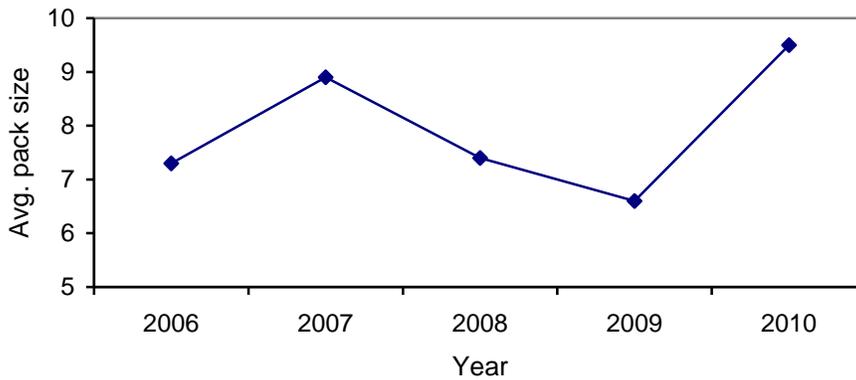
Thirteen packs in WY were involved in at least 1 depredation in 2010 (Figure 6). Depredating wolf packs averaged 9.5 wolves/pack (range = 4-13) (Figure 7). The average size of chronic depredating packs from 2006-2010 ranged from 6.6 to 9.5 wolves (Figure 8). Since 1999, the WY wolf population has increased 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 were involved in at least 1 livestock depredation/given year.



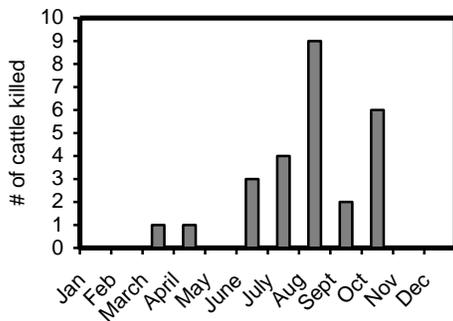
**Figure 7.** Size of 13 wolf packs (prior to control actions) involved in depredations in 2010.



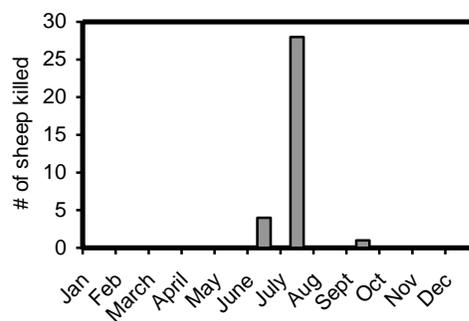
**Figure 8.** Average size of depredating wolf packs from 2006 – 2010.

***Time of Year of Livestock Depredations***

Cattle depredations followed a seasonal pattern in 2010 with the highest number of depredations occurring in summer/fall from August through October (Figure 9). Sheep depredations occurred in June and July (Figure 10).



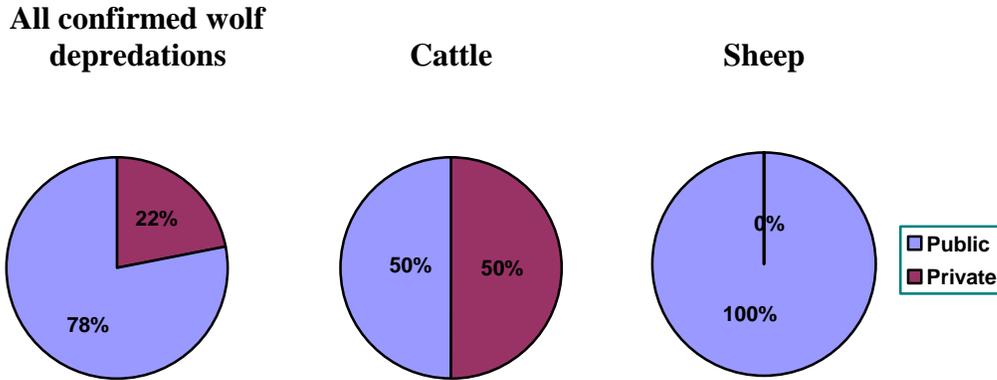
**Figure 9.** Number of confirmed cattle depredations/month.



**Figure 10.** Number of confirmed sheep depredations/month.

***Location of Livestock Depredations***

Seventy-eight percent (n=46) of all confirmed wolf depredations (13 cattle and 33 sheep) were on public land and 22% (n=13) of all depredations (13 cattle) were on private land. Fifty percent (n=13) of cattle depredations were on public land and 50% (n=13) of cattle depredations were on private property. All 33 sheep depredations occurred on public land (Figure 11).



**Figure 11.** Land status where confirmed wolf depredations occurred in 2010.

### Counties

In 2010, confirmed cattle depredations occurred in 3 counties: Sublette 46% (n=12), Park 42% (n=11), and Fremont 12% (n=3). Wolves killed sheep in 3 counties: Big Horn 73% (n=24), Lincoln 24% (n=8), and Sublette 3% (n=1) (Table 4).

**Table 4.** Confirmed cattle and sheep depredations by county from 2006 through 2010.

Cattle						Sheep					
County	2006	2007	2008	2009	2010	County	2006	2007	2008	2009	2010
Fremont	8	12	3	3	3	Johnson	20	4	2	54	0
Park	39	27	23	5	11	Lincoln	0	12	12	45	8
Sublette	71	14	15	10	12	Sublette	6	0	14	37	1
Sweetwater	0	0	0	1	0	Big Horn	0	0	0	0	24
Converse	0	0	0	1	0	Washakie	0	0	0	59	0
Lincoln	1	2	0	0	0	Fremont	12	0	0	0	0
Hot Springs	1	0	0	0	0	Total:	38	16	28	195	33
Teton	1	0	0	0	0						
Washakie	2	0	0	0	0						
Total:	123	55	41	20	26						

### *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 2010, 40 depredating wolves (approximately 13% 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 2 Less-than-Lethal Munitions (rubber bullets) to harass wolves; lethally removing wolves through agency control actions; and issuing 3 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 2010 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.

### ***Compensation for Livestock Depredations***

The WGFD paid \$73,489.77 to compensate cattle producers and wool growers who lost livestock to wolves during the 2010 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.”

## **Wolf Management in Yellowstone National Park**

### ***Area Closures***

To reduce 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 Canyon and Lamar Canyon packs’ den and rendezvous areas were closed for various lengths of time this summer. Den sites for the Leopold, Mollie’s, and Agate Creek packs were protected from disturbance coincidental to area 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.

### ***Wolf Road Management***

Since wolf reintroduction began in Yellowstone, the Lamar Valley has become the premier location worldwide to easily observe free-ranging wolves. The main pack of interest was traditionally the Druid Peak pack, which dened in or near the Lamar Valley from 1997 through 2009, but this year differed with the emergence of two new packs in the area: Lamar Canyon and Silver packs. The NPS established the Wolf Road Management Project 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 2010 season (16,225 people) and the summer season was characterized by high wolf viewing opportunities.

### ***Habituated Wolves***

There were fewer instances of wolves showing habituated behavior in 2010. None of the cases involved food conditioned wolves. On four occasions wolves were hazed, three of which were very low level (e.g., hand clapping, yelling, honking) and the other involved cracker shells. Three of the four hazing events involved the Canyon pack and the other was lone wolf #587M near Old Faithful. All events were considered successful with the wolves responding to the stimulus and moving away from the undesirable area.

## **RESEARCH**

### **Research in Wyoming outside Yellowstone National Park**

In 2010, 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.

***Title:*** Comparison of Two Methods Used to Characterize the Summer Diet of Gray Wolves: A preliminary report

***Graduate Student:*** Bonnie Trejo

***Committee Chair:*** Richard Golightly, Humboldt State University

***Cooperators:*** USFWS, GTNP, YNP, Grand Teton National Park Foundation

***Project Summary:*** Fecal (scat) analysis is commonly used to document wolf summer diet; however, biases, technical, and interpretational difficulties can influence the value of this method. Recently, GPS-telemetry has been utilized in Yellowstone National Park (YNP) and Grand Teton National Park (GTNP) to investigate wolf summer predation patterns. Dietary information collected using GPS-collar techniques has not been compared to the more frequently used method of scat analysis. The objectives of this study are to: (1) analyze wolf scat collected in YNP and GTNP to determine percent frequency of occurrence of prey, and adjust to suggest relative number of prey consumed, (2) compare scat analysis to GPS-collar techniques to evaluate the differential assessment of prey composition and biomass between the two approaches, and (3) compare wolf summer diet among years, between packs, seasons (summer and winter), and parks.

**Project Activity in 2010:** A total of 1,781 scats were analyzed for prey remains. Based on hair identification, neonate cervids could not be separated to species level. Additionally, mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*) hair were not differentiated from each other. Mean frequency of occurrence ( $\pm$ SE) was calculated for adult wolves, combined across years, and for packs in each park. Preliminary results should be interpreted with caution, as diet varied between packs, and was confounded by different years of collection. In GTNP, the most frequent prey item was neonate cervid  $0.54 \pm 0.09$  followed by adult elk (*Cervus elaphus*)  $0.27 \pm 0.08$ , adult deer (*Odocoileus* spp.)  $0.11 \pm 0.03$ , adult moose (*Alces alces*)  $0.05 \pm 0.02$ , small rodents (Rodentia)  $0.05 \pm 0.02$ , beaver (*Castor canadensis*)  $0.04 \pm 0.01$ , birds (Aves)  $0.02 \pm 0.01$ , and bison (*Bison bison*)  $0.01 \pm 0.01$ . In scats collected from YNP, neonate cervid  $0.38 \pm 0.17$  also occurred most frequently followed by adult elk  $0.33 \pm 0.08$ , adult deer  $0.24 \pm 0.07$ , bison  $0.05 \pm 0.03$ , small rodents  $0.05 \pm 0.03$ , and birds  $0.02 \pm 0.01$ . Moose and beaver were not detected in scats collected in the northern range of YNP. Tests between dietary methods, packs, years, seasons, and parks are ongoing. *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:** The Absaroka Elk Ecology Project is a research collaboration of the U.S. Fish and Wildlife Service, the University of Wyoming, and the Wyoming Game and Fish Department initiated in 2007. The project seeks to understand recent changes in the demography and distribution of the Clarks Fork elk herd, a partially-migratory population of about 4,500 individuals that ranges widely in the Absaroka Mountains between Cody, WY and the upper reaches of the Lamar River inside Yellowstone National Park. The primary objectives of this research project are to determine the proportion of migratory elk in the Clark's Fork herd; 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 versus habitat conditions on elk movements and behavior. The project relies on a sample of 90 GPS-collared elk cows in the Clark's Fork herd, and 1-2 GPS-collared wolves in each of four resident wolf packs. Preliminary project data revealed comparatively low pregnancy (<70%) in the migratory portion of the Clarks Fork herd, suggesting that nutritional stress might be contributing to low levels of migrant recruitment. To investigate the potential causes of low pregnancy, biannual recaptures of collared females were conducted in spring and fall, 2008-2010, to estimate body fat levels and determine reproductive status. This series of five recaptures was completed in March 2010. During the same period, field observations were conducted to quantify the activity budgets of these same marked females. Altogether, the field data collected on this project will help improve our understanding of the extent to which wolves and/or habitat conditions influence the nutritional condition and reproduction of their prey. The field component of this project was concluded in summer 2010, and the analysis and reporting phase are now underway.

**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. The 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 15 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 2011 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, predation, and climate effects on elk group sizes and *Brucellosis* in the Greater Yellowstone ecosystem.

**Graduate Student:** Angela Brennan

**Major Advisors:** P.C. Cross<sup>2</sup>, S. Creel<sup>1</sup>, M. Higgs<sup>1</sup>, W.H. Edwards<sup>3</sup>, and B. Scurlock<sup>4</sup>.

<sup>1</sup>Department of Ecology, Montana State University, Bozeman, MT, 59715; <sup>2</sup>U.S. Geological Survey, Northern Rocky Mountain Science Center, 2327 University Way, Bozeman, MT 59715; <sup>3</sup>Wyoming Game and Fish Department, 1174 Snowy Range Rd, Laramie, WY, 8207; <sup>4</sup>Wyoming Game and Fish Department, 423 East Mill St., Pinedale, WY 82941.

**Project Summary:** The Greater Yellowstone Ecosystem (GYE) is the last reservoir of brucellosis in the United States, where roughly 45-75% of wild bison (*Bison bison*) and 0-35% of elk (*Cervus elaphus*) have been exposed to the bacteria (*Brucella abortus*) that causes the disease. Elk, being distributed across much of the region, can come into contact with domestic livestock and potentially transmit *Brucella*, causing costly trade restrictions, disease testing, and culling of infected cattle herds. Critical to our understanding of elk-brucellosis dynamics and the development of effective disease control strategies, is the relationship between elk density and among elk *Brucella* transmission rates. Defining this relationship is also important to further inform theoretical models of disease transmission in a social species. As previous studies examining elk density at broad spatial scales (i.e. population densities) have shown weak support for a density effect on seroprevalence in elk, however, we suspect brucellosis dynamics are affected by fine scale variations in elk aggregation (i.e. group size and density). Therefore, we plan to conduct aerial elk surveys during 2010 and 2011 to construct elk group size distributions for 10 elk native winter ranges in western Wyoming and determine the measure of group size (i.e. median group size, largest group size) that best explains the variation in brucellosis seroprevalence. Because external factors may

influence host aggregation patterns and play a large role in our understanding of disease transmission in applied and conceptual settings, we will also determine the anthropogenic, habitat, predation and climate factors associated with recorded elk groups. Human disturbance, snowpack, and habitat attributes will be quantified via GIS and remotely sensed data. Predation risk will be determined by hunter use and cumulative wolf presence. The latter will be compiled from distribution maps and pack sizes obtained from U.S. Fish and Wildlife Service annual reports, as well as howling and track surveys.

### ***Winter Predation study***

GTNP and the USFWS began a collaborative winter wolf predation study in early January 2011. We monitored wolves in the north end of Grand Teton National Park and the surrounding national forest to investigate wolf predation patterns in areas with relatively low winter elk density. We used radio telemetry to locate wolves daily and back tracked wolves to locate carcasses of ungulates that were killed by wolves. During winter 2010, field crews located 38 carcasses of ungulates killed by wolves: 25 (66%) elk and 13 (34%) moose. Sex and age composition of prey was 29% calves, 17% cows, and 54% bulls for elk, and 8% calves, 67% cows, and 25% bulls for moose. Mean age of wolf-killed ungulates was 4.2 years (range: 0-18) for elk and 6.0 years (range: 1-10) for moose, respectively.

## **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 2010 during which wolves were intensively radio-tracked and observed for 30-day periods in March and from mid-November to mid-December. The Agate Creek (Nov-Dec), Blacktail (March and Nov-Dec), Lamar Canyon (March and Nov-Dec), Quadrant Mountain (March), and Silver (March) packs were the main study packs monitored by three-person ground teams. In both winter studies, crews monitoring the Quadrant pack switched early on to Lamar Canyon (March) and Agate (Nov-Dec) due to difficult monitoring logistics. Along with the ground monitored packs, all park packs were monitored from aircraft; Canyon, Cougar Creek, Grayling, Madison River, Mary Mountain, Mollie's, Gibbon Meadows packs were monitored from aircraft only. The Yellowstone Delta and Bechler packs were rarely located by due in part to their absence from the park, poor conditions for aerial monitoring, and lack of radio collars (Bechler). The summer predation study utilized data from downloadable GPS collars on wolves from the Blacktail pack (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 268 kills (definite, probable, and possible combined) made by wolves in 2010, including 211 elk (79 %), 25 bison (9%), 7 deer (3 %), two moose (<1%), two pronghorn (<1%), two grizzly bears (< 1%), four coyotes (1%), two ravens (< 1%), 4 wolves (1%), and ten unknown prey (4%). The composition of elk kills was 25 % calves, 43 % cows, 18 % bulls, and 15 % elk of unknown sex and/or age. Bison kills included four calves, six cows, seven bulls, and eight unknown sex adults.

Given the ecological significance and controversy surrounding wolf impacts on ungulate populations, wolf and elk interactions continue to be a primary focus of predation studies in YNP. Since wolf reintroduction, the northern range elk population has declined approximately 50% with wolves being one of the main factors. Other factors include other predators, management of elk outside YNP, and weather patterns (e.g. drought, weather severity) that influence forage quality and availability, ultimately impacting elk condition. Consequently, changes in prey selection and kill rates through time result from complex interactions between these factors, particularly the link between wolf and ungulate population dynamics and seasonal weather patterns. For example, wolves selected primarily elk calves during the November-December predation study and bull elk in March, likely due to their relative availability and condition during those seasons. In contrast to recent non-drought years, we propose that 2010 winter and summer precipitation contributed to greater elk calf availability and fewer vulnerable bull elk in early winter due to forage quality. Collaborative research with Dr. Chris Wilmers at University of California, Santa Cruz aims to evaluate this hypothesized link between climate, forage quality, and predator-prey dynamics. Interestingly, although predation patterns vary through time, biomass consumption (kg/wolf/day) by wolves has remained relatively stable since 1995.

### ***Winter Studies***

***March*** - During the 2010 March winter study (30 days), study packs were observed for a combined total of 307 hours from the ground. The number of days wolf packs were located from the air ranged from 4 (Yellowstone Delta) to 19 (Agate, Blacktail, Canyon, Lamar Canyon, Mollie's, and Silver). A total of 36 carcasses utilized by wolves were discovered by air and ground teams, made up mostly of wolf kills, with some scavenged winter-killed ungulates. The carcasses included 25 elk, 7 bison, one moose, and three unknown species. Among the elk, five (20%) were calves, seven (28%) were cows, 12 (48%) were bulls, and one (4 %) was of unknown sex and age. In addition, two bison and two unknown ungulate species were killed by wolves. Seven of the discovered ungulate carcasses (five bison, one elk, and one moose) were winter-killed and scavenged by wolf packs. Documenting the consumption of biomass from ungulates not killed by wolves is important in 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 winter-killed ungulates in the spring.

***November-December*** - The 2010 November–December winter study was characterized by extreme weather conditions during much of the study, including heavy snowfall, cold temperatures, and high winds. As such, data collection by field crews, and particularly

the air crew, was challenging. Despite this, wolves were still observed for 207 hours from the ground. Unfortunately, weather conditions only allowed for 4 flights (a record low) during the entire 30-day study, locating Agate, Blacktail, Cougar, Grayling, Mollie's, and Mary Mountain packs those days. A total of 26 ungulate carcasses utilized by wolves were discovered by air and ground teams, made up mostly of wolf kills, with some scavenged natural and human-caused mortalities. The wolf kills included 25 elk, 7 bison, one moose, and three unknown species.. These carcasses were made up mostly of wolf kills, with some other natural and human-caused mortalities that wolves scavenged on. The carcasses included 22 elk, two bison, one mule deer, and one big horn sheep. Of the 19 wolf-killed elk, there were eight calves (42%), eight cows (42%), one bulls (5%), and two (11 %) of unknown sex and age. Wolves also scavenged four ungulates (2 elk, 2 bison) that died from non-predation natural causes and one road-killed elk.

### ***GPS Collars and Winter Predation***

Beginning with the 2009 November-December winter study, the Yellowstone Wolf Project began to incorporate GPS clustering methodology to better understand if ungulates killed by wolves are missed via our traditional monitoring methods (aerial and ground). 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, clusters may not always detect a kill, so our efforts also seek to understand why kills may be missed by GPS clusters. Ultimately, combining GPS clustering methodology with our traditional methods of detecting kills may allow for our most complete assessment of prey composition and kill rate.

During both the March and November-December winter study periods of 2010, we continued to search clusters of GPS locations. During March, project staff searched clusters created by Blacktail Deer Plateau wolves 642F and 752F. Most kills during March were found by both GPS clusters and our traditional methods. The few kills that were missed by our traditional methods were typically made on days when the ground crew was unable to obtain a visual observation of the Blacktail Deer Plateau pack and the fixed-wing airplane could not fly. By November-December winter study, we were only able to download the GPS locations from 642F (although 752F was still present, her GPS collar malfunctioned). We were unable to adequately search 642F's GPS clusters from the first 10 days of winter study because extremely large amounts of snowfall covered any wolf sign or potential carcasses. However, we were able to search the clusters created during the final 20 days of winter study. Through these searches, we determined that both our traditional methods and GPS clusters missed a few kills. This November-December winter study represents the first period where kills were occasionally missed through GPS clustering methodology. A possible explanation for this is that the Blacktail Deer Plateau pack numbered 14 wolves during the November-December winter study, and larger packs tend to spend less time feeding from a carcass. In order to further investigate the value of GPS clustering methodology, the Yellowstone Wolf Project plans to continue this aspect of winter study in 2011.

### ***Summer Predation***

Beginning in 2004, the Yellowstone Wolf Project began utilizing GPS clustering methodology to assess the predation patterns of wolves during summer (1 May – 31 July). In 2010, we continued to search GPS clusters in order to further understand how and why the predation patterns of Northern Range wolves differ among seasons. We searched the GPS clusters of Blacktail Deer Plateau wolves 642F and 752F. Through these searches, we found 54 suspected kills or fresh carcasses, which included 48 elk, 2 deer, 2 bison, 1 pronghorn, and 1 unknown species. Accordingly, 89% of the ungulates fed upon by wolves from 1 May – 31 July were elk, which is similar to most previous years. Among elk, 48% were neonate calves and 38% were cows. The remaining 14% of elk carcasses were bulls and 11-13 month old elk. As was observed in 2009, the Blacktail wolves utilized less bull elk than the Leopold pack (which had resided in this area). Currently, it is unknown why these packs have had such different patterns of prey composition while residing in the same general territory during the summer.

### ***Population Genetics***

Collaborative efforts between the Yellowstone Wolf Project and the University of California, Los Angeles (UCLA) continued in 2010. Dan Stahler completed his last graduate quarter at UCLA in the spring, and continued collecting data in the YNP population throughout 2010 for his dissertation. In May, Stahler and Smith became collaborators on a National Science Foundation grant awarded to co-principal investigators Dr. Robert Wayne and Dr. John Novembre at UCLA that aims to further understand the evolutionary and ecological dynamics of coat color in wolves. Previous work has shown 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. Given the frequency of both gray and black colored wolves in Yellowstone is roughly equal, it has been hypothesized that there are fitness trade-offs associated with the gene responsible for coat color. Current research aims to evaluate fitness and health differences relative to coat color, and how this contributes to the maintenance of this polymorphism.

The Wolf Project is also collaborating with UCLA on a new project that will be the first to sequence entire genomes of wild wolves. A DNA sample of the well-known wolf 302M is being used for whole genome sequencing that will create the entire genetic map of 302M, allowing us to better understand how genes may impact wolf behavior, health, life history, and canid evolution.

### ***Disease***

Our most active area of disease research this past year was on sarcoptic mange, an infection caused by the mite, *Sarcoptes scabiei*, which reached epidemic proportions on the Northern Range in 2009. The mite is primarily transmitted through direct contact and burrows into its host's skin where it feeds and lays its eggs. This process can initiate an extreme allergic reaction in the host, causing the host to scratch infected areas resulting in

hair loss and secondary infections (Jimenez et al. 2010).

In 2008, the Yellowstone Wolf Project began a partnership with the U.S. Geological Survey to rigorously address questions about how mange is affecting individual wolves and their overall population in the Yellowstone region. This collaboration now includes Paul Cross and Mike Ebinger of the U.S. Geological Survey, Colby Anton of the Wolf Project, Emily Almberg and Peter Hudson of Penn State University, and Andy Dobson of Princeton University. This team has begun to analyze the impacts of mange on the survival, reproduction, and behavior of Yellowstone's wolves with the data collected to date. Furthermore, we initiated several new projects in 2010. In particular, we started a project that will use thermal imagery cameras to measure the heat loss associated with infection-induced hair loss. These measurements will allow us to estimate the caloric costs of infection and ask questions about how infection alters the energy balance that wolves must maintain for survival. The Druid Peak, Everts, and Leopold packs' demise were associated with mange; we hope the additional information about the costs of infection will allow us to better understand the relationships between mange infection, energy needs, hunting behavior and ability, and ultimately, pack stability and longevity.

### **Collaborative Research**

The Wolf Project and the 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, much of which is pioneering research.

#### ***Wolf Project Students: Direct Assistance***

Four graduate students worked in collaboration with the Wolf Project in 2010: Matt Metz, Kira Cassidy-Quimby, Daniel Stahler, and Alessia Uboni. Metz and Cassidy-Quimby 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 maintained his role as Project Biologist while fulfilling degree requirements and data analysis. Uboni became a collaborator after working as a GIS technician in Yellowstone Center for Resources.

*Title:* Behavioral, ecological, and genetic influences on life-history strategies and social dynamics of gray wolves

*Graduate Student:* Daniel Stahler, Ph.D. candidate

*Committee Chair:* Dr. Robert Wayne, University of California, Los Angeles

*Title:* Individual participation in intraspecific encounters and the benefits of aggression in gray wolves of Yellowstone National Park

*Graduate Student:* Kira Cassidy-Quimby, Master of Science candidate

*Committee Chair:* Dr. L. David Mech, University of Minnesota, St. Paul

*Title:* Seasonal patterns in foraging and predation of gray wolves in Yellowstone National Park

*Graduate Student:* Matt Metz, Master's student

*Committee Chair:* Dr. John Vucetich, Michigan Technological University

*Title:* Wolf spatial analysis: habitat use and territorial patterns

*Graduate Student:* Alessia Uboni

*Committee Chair:* Dr. John Vucetich, Michigan Technological University

## **VISITING SCHOLARS**

Once an annual program that involved a scientist or manager from another agency or university to visit and work with YNP Wolf Project personnel, several years elapsed where there were no visitors. This year Tim Coulson from Imperial College London visited in late November to assist with field work and help analyze data looking at environmental effects on the wolf population. Dr. Coulson innovatively analyzed wolf project data extending our knowledge of YNP wolves and at year end had a manuscript almost completed. Further, Dr. Coulson is interested in participating in more studies with YNP and Rocky Mountain wolves specifically wolf survival in Idaho, Montana and Wyoming from 2005-2010, the period of time after the earlier (1982-2004) survival study ended (Smith et al. 2010, Murray et al. 2010).

Sue Ware a paleontologist from the Denver Museum continued to clean YNP wolf skulls with the museum's dermestid beetle colony and analyze wolf skulls for pathologies that could have lead to mortality. She also independently gathered post-cranial material for research of her own looking at wolf skeletal morphology. Dr. Ware has had access to skull collections across North America allowing her to compare YNP wolves to other wolves leading to greater insights into the evolution and pathology of canids.

## **Yellowstone Wolf Project Research**

### ***Predator-Prey***

A major objective for Yellowstone wolf 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. In addition, GPS collars are now being used simultaneous to winter studies. During these established predation studies, and opportunistically throughout the year, project staff records behavioral interactions between wolves and prey, predation rates, total time wolves feed on carcasses, percent consumption of kills by scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites.

### ***Hunting Behavior***

This aspect of wolf-prey relationships 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. Recent published research has focused on predatory performance of wolves with respect to age, body size, and group size and their relationship to 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 grizzly bears emerging in early spring.

### ***Population Dynamics***

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

### ***Dispersal***

The ecological, demographic, and genetic implications of dispersal are an important research focus for Yellowstone wolf biologists. Using radio collar tracking information 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.

### ***Breeding Behavior***

During January and February each year, project staff monitors 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.

### ***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 leadership behavior is 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 wolf 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 disease 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, aerial photographs, and thermal imagery.

### ***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, effect of kinship on breeding strategies, territoriality and strife. Additionally, genome sequencing on Yellowstone wolf samples has begun through collaboration with UCLA.

### ***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 such as 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 comparisons between GPS and VHF collars.

## OUTREACH

### **Outreach in Yellowstone National Park**

Yellowstone Wolf Project staff gave 248 talks and 38 interviews. Talks were at both scientific conferences and to general audiences. Interviews were to all forms of media. Staff assisted visitors in the field helping 38,000 people view wolves, making 16,225 visitor contacts and giving 561 informal talks in the field.

### **Outreach in Wyoming outside Yellowstone National Park**

In 2010, 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

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

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