Interagency Report 174

WYOMING WOLF RECOVERY
2006 ANNUAL REPORT

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

Photo by: Karen Colclough

This cooperative report presents information on the status, distribution, and management of wolves in Wyoming, including Yellowstone National Park, from January 1, 2006 through December 31, 2006.

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SUMMARY

The total gray wolf (*Canis lupus*) population in Wyoming increased approximately 23% from 252 wolves in 2005 to 311 wolves in 2006.The wolf population in Wyoming included Yellowstone National Park (YNP) and the entire state of Wyoming; however, wolf recovery occurred primarily in the northwest section of the state. The number of wolves in YNP increased 15% from 118 wolves in 2005 to 136 in 2006. Wolf numbers in Wyoming outside YNP increased 31% from 134 wolves in 2005 to 175 wolves in 2006. YNP had 13 packs including 10 breeding pairs producing > 60 pups surviving through December 31. Average pack size in YNP was 10.5 and ranged from 4 to 19 wolves. Wyoming outside YNP had > 23 packs including 15 breeding pairs producing > 58 pups that survived until December 31. Average pack size was 6.7 and ranged from 2 to 13. The wolf population in YNP rebounded 15% in 2006 after a population decline in 2005; however, the overall population in YNP has not increased since 2003. In contrast, wolf numbers in Wyoming outside YNP increased on average >28% each year since 2003.

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

Wolves in Wyoming were responsible for killing > 169 livestock (including 162 confirmed and 7 probable depredations) and 1 dog. Confirmed livestock depredations included 123 cattle (110 calves; 13 cows/yearlings); 38 sheep (22 ewes; 16 lambs); and 1 horse. Forty-four wolves (approximately 17% of the Wyoming wolf population outside YNP) were killed in control actions to reduce further depredations.

GREATER YELLOWSTONE RECOVERY AREA - WYOMING

PERSONNEL

Personnel in Wyoming outside Yellowstone National Park

Wolves in Wyoming outside Yellowstone National Park (YNP) were monitored by Project Leader Mike Jimenez (USFWS), Jim Pehringer (USDA Wildlife Services) (WS), Steve Cain, Sarah Dewey (Grand Teton National Park), and volunteers Susannah Woodruff, Karen Colclough, Lydia Dixon, Dylan Taylor, and Hilary Eisen. In 2006, the USFWS and WS combined funding for a second year to maintain a wolf management specialist position Jim Pehringer (WS) stationed in Cody, Wyoming and work under the direction of the USFWS.

USFWS law enforcement agents in Wyoming were Dominic Domenici (Resident Agent-in-Charge, Casper), Tim Eicher (Special Agent, Cody), and Roy Brown (Special Agent, Lander).

Wyoming employees of WS who were involved with wolf control or management in 2006 included State Director Rod Krischke, District Supervisors Craig Acres and Merrill Nelson, Asst. District Supervisor Rod Merrell, Specialists Jim Pehringer, Arnold DeBock, Tracy Frye, Stephen Moyles, Michael Peterson, Jed Edwards, Matt Lumley, Chuck Bunch, Jeremy Johnson, Wade Jones, Dan Bragg and Pilots Miles Hausner, Kelly Huseby and Ted Jensen .

Personnel in Yellowstone National Park

Three full-time employees worked for the Yellowstone Wolf Project in 2006: Project Leader Douglas Smith and Biological Science technicians Debra Guernsey and Daniel Stahler. This concludes a four-year term appointment for Dan, but he will continue as a student temporary employee while he is at UCLA working on his PhD.

The Wolf Project was able to hire paid seasonal staff through the Yellowstone Park Foundation and Yellowstone Association to assist in several key aspects to our annual work. Emily Almberg, Matt Metz, Abby Nelson, Jesse Newby, and Katie Yale worked for the summer field season and were crucial to summer den monitoring, invertebrate scavenger study, summer GPS predation work, as well as other duties. Emily, Matt and Abby worked all winter long in this capacity, and Katie assisted in the March Pelican Valley study. Rick McIntyre worked diligently year-round for the Wolf Project with six months as a seasonal Park Service employee and six months as a volunteer. Emily and Rick worked primarily for the Wolf and Human Road Management Project during the summer, but also assisted in many other project goals during winter months. All six spent many hours collecting data throughout the year and contributed largely to the increased research productivity of the Yellowstone Wolf Project for 2006.

Volunteer Program

Nineteen volunteer field technicians worked a total of 6200 hours in 2006, worth $52,147.20 at a GS-5 level (see Appendix), which was equal to 1.8 full time GS-5 employees. Volunteer field positions continued to be highly competitive with three to four applicants applying for each position. Chosen volunteers received free housing and $500/month food stipend.

Most positions are available during winter, when studies of wolf behavior and predation rate take place. A background in biological science is required. Interested persons should mail a cover letter and resume to the Yellowstone Wolf Project, P.O. Box 168, Yellowstone National Park, Wyoming, 82190.

MONITORING

Monitoring in Yellowstone National Park

Population and Territory Status

At the end of 2006, at least 136 wolves in 13 packs occupied Yellowstone National Park. This represents a 15% rebound in wolf numbers after the population decline in 2005. Disease was the cause of the population drop last year, and there appears to be no evidence of a disease outbreak in 2006; adult and pup survival was very good.

Unlike previous years, there was very little turnover in packs. Twelve of thirteen packs (92%) present in 2006 were present in 2005, and there was only one new pack, the Oxbow Creek pack. This pack formed by three Leopold wolves dispersing and joining with another unidentified wolf and taking over a portion of Leopold territory.

Seven packs (75 wolves, up 38% from 2005) used the northern range, and six packs (61 wolves, down 5% from 2005) used the rest of the park. Pack size ranged from 4 (Cougar Creek) to 19 (Leopold) wolves and averaged 10.5.

Despite being smaller in size (1000 km^2 compared to 7,991 km^2) the northern range of the park continues to support the majority of the park's wolves, a consistent pattern of previous years as well. Greater year round prey density is the reason for this finding, but recent analyses indicate that social strife (wolf-wolf killing and territorial clashes) and probably disease were limiting wolf numbers. In other words based on prey biomass available there should have been more wolves, but there were not, something else was limiting their numbers and we believe it to be wolf-wolf related mortality and dispersal.

There were indications of more social strife in 2006. Conflicts between Agate Creek and Hellroaring, Agate Creek and Slough Creek, and Slough Creek and Druid, Leopold and Oxbow Peak are all indicative of social competition that is related to wolf density and probably declining prey availability. Elk numbers have declined by about 50% since 1995, which are the wolves' primary winter prey, and this along with conflict inspired by high density has contributed to our observed increase in wolf-wolf conflict. Based on these observations, and despite the recent 1-year increase in wolf numbers, we expect wolf numbers to decline over the next several years.

A wolf decline may have already begun as by the end of the year the Swan Lake pack was residing north of the park without returning. The Hellroaring Creek pack, after one territorial clash with Agate Creek, moved north for a time as well. It will be interesting to watch the future of the Oxbow Creek pack as they live on a small territory essentially within the Leopold pack territory. How long these two packs will coexist is open to question and if short-lived, would lead to another lost pack from the northern range. Regardless of future projections, it is clear that Leopold, Agate Creek, and probably Druid Peak are dominant packs while the others are likely to be at a competitive disadvantage.

Packs in the park interior are much more stable and occur at lower density without the level of conflict observed on the northern range. Their numbers changed little, from 64 to 61, and they lost only one pack. Territories are large with space in between them. The Madison-Firehole has stabilized somewhat after a previous high density that supported three packs in 2004. The two southern packs (Bechler and Yellowstone Delta), the most isolated in the park, and ones that spend significant amounts of time outside YNP (boundary packs), both reproduced with good pup survival, which maintained relatively large packs (>10 wolves each). Two interior packs, however, are in decline. Although speculative, the Hayden Valley pack because of poor habitat (largely just bison in winter) in Hayden Valley and pressure from Mollie's pack; in the case of Cougar Creek an aging alpha female.

Across the park wolf distribution was unchanged, and has been so for several years indicating that all available wolf habitat is settled. Pack turnover, when it occurs, is always within the occupied wolf range and new areas of settlement have so far not been recorded.

Reproduction

Pup survival was excellent in 2006. After a poor year in 2005, there seemed to be some compensatory survival. Seventy-five pups were born parkwide and 60 (80%) survived compared to only 32% survival last year. The northern range did especially well with 39 of 52 (75%) pups surviving compared to last year only 16% survived. Pup numbers in the interior were slightly up, 21 compared to 14 in 2005, but it is hard to assess pups born and survived because interior pups are rarely seen early in the season at their dens.

Average pups born/pack was 6.8 but three packs had two females breed so the average pups born/female was 5.4 (splitting pups between females when there was >1 litter as we could not assign maternity). Park-wide pups surviving/pack was 5.9 and the northern range had more pups surviving/pack, 7.6 versus 4.2 which was due to no multiple litters in the park interior.

Three of 13 packs had no surviving pups. In two cases, Slough Creek and Hellroaring Creek, pups were born but none survived. Pup mortality in both cases was probably due to competitive interactions with other packs. In the third case of reproductive failure, the Cougar Creek pack, the cause of pup mortality is unknown but possibly related to old age in the breeding female. Field data indicated that this pack localized around a den, but only briefly suggesting that the pups died early.

Wolf Project staff visited every den site except Gibbon meadows pack and most rendezvous sites to collect scats for summer food habits studies. Dens were also visited because of unexpected surprises, like finding a dead wolf inside a secondary den, or the possibility of finding dead pups like in 2005.

Mortalities

Not counting over-summer pup mortality, 9 wolves died in 2006 (collared only). These included 1 yearling and 8 adults (2-5 years). Seven males and 2 females died. Again the leading cause of mortality (44%) was intraspecific strife. The mortality rate in 2006 was 18%, about equal to the 11 year average of 20%.

Monitoring in Wyoming outside Yellowstone National Park

Population status: We combined 3 census techniques to estimate the total number of wolves in Wyoming outside YNP: 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 counted the number of wolves in packs containing radio collared wolves using visual observations from the ground and aerial telemetry flights. Twenty-one wolves were radio collared in 2006. We monitored 27 radio collared wolves (15% of the population) in 16 packs (70% of the packs). We

tracked wolves in winter and counted the different sets of wolf tracks in snow. In areas where repeated sightings were confirmed, we incorporated those observations into our estimates. We averaged the high and low population estimates to calculate other statistics used to describe the wolf population in Wyoming. Visual observations from telemetry flights in early January 2007 were also used to improve our year-end estimates. As of December 31, 2006, we estimated that at least 175 wolves inhabited western Wyoming outside YNP in 2006. Twenty-three packs contained 154 wolves and another 21 wolves (single wolves and smaller groups of non-breeding wolves) were located throughout the western portion of the state (Appendix Figure 1). Pack size ranged from 4 to 13 and averaged 6.7 wolves.

Reproduction: Fifteen packs produced at least 58 pups that survived past December 2006: Washakie, Pacific Creek, Beartooth, Sunlight, South Fork, Gooseberry, Greybull River, Rock Creek, Owl Creek, Cub Creek, Bliss Creek, Buffalo, Gros Ventre, Snake River, and Huckleberry (Appendix Tables 4a and 4b). Mean litter size was 5.2 pups per litter. Only 1 pup survived in the Absaroka Pack and no pups were produced by Teton or Carter Mountain Packs. We were not able to confirm pup production in 5 packs: East Fork, Black Butte, Togwotee, Daniel, and Prospect Packs.

Population growth:
In 2004, we reported that the wolf population increased 23% from 82 wolves in 2003 to 101 wolves in 2004. In 2005, the wolf population increased 33% from 101 wolves in 2004 to 134 wolves in 2005. The number of wolves increased 31% in 2006 to >175 wolves (Figure 1).

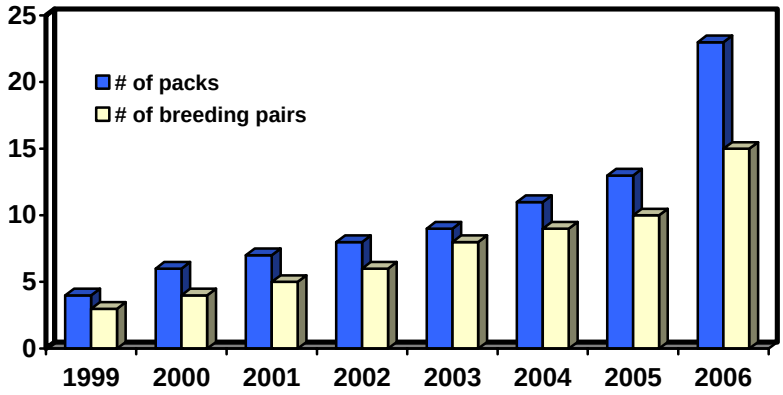

Figure 1. Number of wolf packs and breeding pairs in Wyoming 1999 – 2006.

Mortalities: In 2006, a total of 59 wolves (25% of the total population) were known to have died in Wyoming outside YNP. Causes of mortality included: control = 44 (75% of documented mortality); under law enforcement investigation = 8 (13%); natural = 1 (2%); vehicles = 3 (5%); other human caused = 2 (3%); and unknown =1(2%).

Sarcoptic mange was first documented in 2002, when a severely mange-infested wolf from the Absaroka Pack, east of YNP, was captured and radio collared. In 2003 and 2004, mange was documented in the Sunlight and Absaroka Packs in the Sunlight Basin area. Three wolves infested with mange from the Sunlight Pack were collared in 2004, however none of the wolves from the Sunlight Pack appeared to have mange in 2005 or 2006. We suspect the wolves infested with mange in the Absaroka Pack died in winter 2005. In spring 2006, other healthy wolves recolonized the area and continued to use the same general home range of the old Absaroka Pack. However, in summer 2006, several wolves in this re-established Absaroka Pack were again infested with mange. Yellowstone wolf #453m dispersed from the Slough Creek Pack and settled within the home range of the Absaroka Pack in spring 2006. Wolf #453m became severely infested with mange, began harassing livestock, and was eventually shot in a control action in 2006 for killing cattle.

Misc. wolves/Unconfirmed packs in Wyoming: In 2006, we documented at least 21 single wolves or small groups of non-breeding wolves throughout western Wyoming. We routinely received and recorded reports of possible wolf sightings throughout various regions of Wyoming. If we observed a clustering of wolf sightings in particular areas, we then spent time on the ground to determine if wolves were present. In winter 2006, we suspected that wolf packs may be trying to form in the several areas in northwest Wyoming (Table 1).

Population movement and dispersals in Wyoming: At least 4 radio collared wolves dispersed in 2006 from YNP to various areas in northwest Wyoming (Table 2).

Table 1. Miscellaneous packs in Wyoming – 2006.

General Location	# of wolves	Comments
Pinedale/Cora	5	no radio collars
Flat Creek	4-6	no radio collars
Big Horn Mountains	≥ 4	no radio collars
Kemmerer/Hamsfork	≥ 2	no radio collars
Big Piney	4	no radio collars
Minimum total:	21wolves	

Table 2. Radio collared wolves dispersing from YNP – 2006. Cause of mortality for wolves #493m and #487m are under law enforcement investigation.

YNP Dispersing Wolves	Natal Pack	New Location	Fate
493m	Delta	NW Wyoming	mortality
487m	Delta	NW Wyoming	mortality
481m	Gibbon Meadows	NW Wyoming	unknown
453m	Slough Creek	NW Wyoming	control

RESEARCH

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 during two winter-study sessions, 30-day periods in March and November–December during which wolves were intensively radio-tracked. The Leopold, Slough, and Hellroaring packs were the three main study packs monitored by two person teams from the ground and from aircraft. In addition, crews opportunistically monitored the Agate, Druid, Mollie's (March), and Oxbow Creek (Nov-Dec) packs collecting prey selection and kill rate data. The Swan Lake, Cougar Creek, Hayden, Gibbon Meadows, and remnant Nez Perce wolves 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. Project staff recorded and entered into a database behavioral interactions between wolves and prey, predation rates, the total time wolves fed on their kills, percent consumption of kills by wolves and scavengers, characteristics of wolf prey (e.g., sex, species, nutritional condition), and characteristics of kill sites. In addition, similar data were collected opportunistically throughout the year during weekly monitoring flights and ground observations.

Composition of Wolf Kills

Project staff detected 281 kills (definite, probable, and possible combined) made by wolves in 2006, including 219 elk (80%), 30 bison (14%), three deer (1%), two bighorn sheep (<1%), two moose (<1%), one beaver (<1%), one golden eagle (<1%), six coyotes (2%), five wolves (2%), and 12 unknown prey (4%; Fig 5). The composition of elk kills was 32 % calves (0–12 months), 16 % cows (1-9 years old), 14 % old cows (≥ 10 years old), 31 % bulls, and 7 % elk of unknown sex and/or age. Bison kills included 12 calves (unknown sex), 11 cows, three bulls, and two unknown sex and age.

This represents an increase in the percentage of calves taken but a decline for bull elk, a switch after two years of high selection for bull elk. Use of cow elk remains low, especially prime age cows, and has historically been so. Use of bison has increased.

Winter Studies

March **-** During the 2006 March winter study (30 days), study packs were observed for 423 hours from the ground. The number of days wolf packs were located from the air ranged from 11 (Swan Lake) to 18 (Leopold, Slough, Hellroaring). Fifty-seven definite or probable wolf kills were detected, including 41 elk, 11 bison, two bighorn sheep, one mule deer, and two unknown species. Among elk, five (12%) were calves, 20 (49%) were cows, 15 (37%) were bulls, and one (2%) was of unknown sex adult. In addition, 31 winterkilled ungulates (8 bison, 21 elk, 2 unknowns) were scavenged by wolf packs. Not since the heavy winterkill of later winter 1997

has wolf project staff documented such a high degree of winterkill, and this was reflected in the degree to which packs incorporated such carcasses into their biomass consumption for the month. The Hayden Valley and Mollie's packs were found to live exclusively off bison (as detected by monitoring), and most other packs had at least one bison killed or scavenged during the month, suggesting the importance of this ungulate in late winter diets for wolves. In a rare event, the Slough Creek pack killed two bighorn sheep that they encountered in an island of rocky habitat in one of the pack's main travel routes.

November-December **-** During the 2005 November–December winter study (30 days), wolves were observed for 271 hours from the ground. The number of days wolf packs were located from the air ranged from three (Bechler) to 13 (Leopold, Hellroaring Creek, Slough Creek, Oxbow Creek, Agate Creek, Swan Lake). Aerial monitoring was severely effected by poor weather conditions. Sixty-two definite or probable wolf kills were detected during the November-December 2006 winter study. Project staff only documented elk being killed by wolves, and their breakdown includes seven (11%) cows, nine (15%) bulls, 43 (63%) calves, and 3 (5%) were of unknown sex and age.

Compared to the prey selection in recent November-December winter studies that were dominated by selection for bulls, this year showed an increase use of elk calves. This likely reflects a greater availability of calves in the northern range elk herd. Although it is unclear to what degree these calf:cow ratios will contribute to population and predator-prey dynamics in the near future, data on prey selection this winter study suggests a response to greater availability of this age class in the elk herd.

Summer Studies

Summer Predation- In the summer of 2006, project staff continued efforts 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, increased nighttime activity of wolves, lack of pack cohesiveness, and smaller prey packages leading to quick consumption and loss of evidence. Traditionally, the best data concerning wolf summer food habits have come from analysis of scat contents collected at den and rendezvous sites. Although this effort on scat collection continued in 2006, downloadable GPS collars were deployed to facilitate a greater understanding of summer wolf predation.

In the 2006 capture season, the Wolf Project deployed four downloadable GPS (Global Positioning System) 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 data acquisition technology, the goal was to perform weekly data gathering on 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 wolf prey selection and kill rates, even for newborn elk calves.

As has been the case over the past several years, a combination of malfunctioning collars or the death of the wolves wearing GPS collars made summer predation patterns difficult to document. Hellroaring wolf 528M, who was slated to be one of our main summer predation wolves, was killed by the Slough Creek a couple weeks after collar deployment in January. Another summer predation collar on Leopold's 535M worked well until mid-March, after which time it malfunctioned, preventing any GPS monitoring of Leopold. Slough Creek's 527F was one of the breeding females that was involved in the conflict with the unknown pack during the denning season. She lost her litter and disappeared for a while, and when staff attempted to download data from her collar mid-summer, the collar malfunctioned and dropped off prematurely. Agate wolf 525F's collar did perform very well, but due to the pack's summer range being within the Antelope Creek Bear Management Closure, project staff were not able to conduct weekly downloads and cluster searches. Some effort to locate carcasses was possible when 525F spent time outside of the closure, allowing staff to find wolf kills from her points, affirming that the technology is adequate to study summer predation when the collars are working. Although future summer predation efforts are planned, more reliable and cost effective GPS collar technology is required to adequately address summer predation.

Summer Scavenging- An important aspect of wolf ecosystem effects as it relates to wolf restoration is the effect on scavenger guilds in the Yellowstone ecosystem. Research on wolf and scavenger interactions has been conducted since 1998 through support from Canon USA, Inc. and Yellowstone Center for Resources (YCR). This research, largely done in the winter, has monitored how wolves influence the abundance and distribution of carrion, both spatially and temporally, as well as how they facilitate food acquisition by other carnivores. Although we have learned a great deal about the magnitude and relative importance of wolf-killed carcasses to the winter scavenger communities, we know little about the impact on summer scavengers, both vertebrate and invertebrate communities. An unexplored area where wolves may be having the greatest effect of all, insect communities that feed off of their kills, remains unexplored. Prior to the reintroduction of wolves, two studies revealed an enormous community of insects utilizing elk carcasses in the summertime.

In summer of 2006, project staff conducted carrion insect research in collaboration with Dr. Chris Wilmers (University of California, Davis). Staff collected data on invertebrate diversity and abundance at summer carcasses. This data will be used to test the effects of wolf reintroduction on this specious community. We sampled invertebrates at eight carcasses (bison and elk) from May 15th to July 20th. Members of the order Coleoptera (including beetles) dominated the sampling, particularly those in the family Silphidae (carrion beetles). Insect samples will be identified by trained entomologists at the end of the study, which will continue in 2007. Once completed, an analysis will be done on this diverse and abundant component to Yellowstone scavenger guild and compared to pre-wolf data sets to test hypotheses on community structure and potential changes associated with wolf recovery.

Population Genetics

A collaborative effort with the University of California at Los Angeles was continued in 2006 to use genetic techniques to construct a population pedigree for all handled Yellowstone wolves and understand gene flow between the three Rocky Mountain wolf recovery areas. DNA

samples from over 500 wolves from Idaho, Montana, and Wyoming have been analyzed in the canid genetics lab of Dr. Robert Wayne at UCLA for genotyping and determination of diversity. In September, Dan Stahler began his Ph.D. at UCLA joining doctoral student Bridgett vonHoldt in the Wayne lab in an effort to combine field-based data with laboratory-based genetic analysis in order to integrate social, ecological, and genetic information to further our understanding of wolf ecology and conservation. In 2006, project staff made considerable efforts to get DNA samples from key breeders in the population that will allow for greater understanding of pack lineages, parentage, and relatedness among packs.

Through an internship with the Dog Genome Project at National Institute of Health (NIH), Bridgett learned new molecular techniques that will allow for higher resolution of analysis in the future, including collaborating with researchers who have identified the gene responsible for coat color in wolves. At the end of 2006, parentage analysis and population pedigrees for wolves from 1995-2004 were nearly completed, along with analyses of relatedness within and between packs and breeding pairs, genetic diversity of the population, and levels of gene flow. Using the population pedigrees and genetic parameters, Dan will address questions about how social and ecological factors influence reproductive strategies and their outcomes, as well as how kinship mediates wolf pack formation, interactions, and territoriality. Scientific papers on Yellowstone genealogies and genetic structure of the Rocky Mountain recovery areas are being written up for submission in 2007.

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

Two new students began work in collaboration with the Wolf Project in 2006: Daniel Stahler and Emily Almberg. Both long-time employees on the project they moved on to work in a new capacity and are partially supported by project funding. Dan's project focuses on combining behavioral data gathered in the field with genetic data gleaned from blood samples and overlaying the two techniques to better understand wolf social behavior. Dan works with Dr. Robert Wayne at the University of California at Los Angeles. Emily's project focuses on wolf diseases both from a current and historical perspective. With severe morality caused by disease in 2005, and evidence of a smaller outbreak in 1999, Emily plans to fully explain the role of diseases for wolf population ecology. Emily works with Dr. L. David Mech and the University of Minnesota.

Linking socioecological factors to reproductive success in complex kin-structured societies.

Graduate Student: Daniel Stahler

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 breeding strategies, reproductive success, 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 2006: Coursework and development of research questions.

Anticipated Completion Date: 2010

A comprehensive survey of the infectious diseases and parasites of Yellowstone wolves: Implications for population dynamics and management

Graduate Student: Emily Almberg

Committee Chair: Dr. L. David Mech, University of Minnesota, St. Paul
Project Summary: In 1999 and 2005, the Yellowstone wolf population experienced significantly reduced pup recruitment suggestive of a disease outbreak. Despite fuelling abundant speculation, these two suspected outbreaks have highlighted how little is known about the presence and role of disease in the Yellowstone wolf population. The present study seeks to (i) identify and describe the spatial and temporal patterns of select pathogens and parasites in the Yellowstone National Park (YNP) and the Greater Yellowstone Ecosystem (GYE) wolf populations, (ii) to attempt to understand the impacts of disease on population parameters such as adult wolf mortality and pup survival, (iii) to track the distribution, prevalence, and population-level effects of sarcoptic mange among wolves in YNP and the GYE, and (iv) to address the potential role of domestic dogs and sympatric carnivores in pathogen/parasite invasion and persistence in YNP. The study will begin its first field season in summer, 2007.

Project Activity in 2006: Coursework and development of research questions.

Anticipated Completion Date: May, 2010

Other Research or Collaborative Work with the Wolf Project

Topic	***Collaborator***	***Institution***
Wolf-cougar interactions	Toni Ruth,	Wildlife Conservation Society
Wolf-coyote interactions	Robert Crabtree, Jennifer Sheldon	Yellowstone Ecological Research Center
Wolf-bear interactions	Charles Schwartz, Mark Haroldson, Kerry Gunther	Interagency Grizzly Bear Study Team, Bear Management Office/YCR
Wolf-carnivore interactions	Howard Quigley	Beringia South
Wolf-scavenger interactions	Chris Wilmers	University of California, Davis
Wolf population genetics	Robert Wayne Bridgett vonHoldt Daniel Stahler	University of California, Los Angeles
Wolf-elk relationships-Madison-Firehole Watershed	Bob Garrott, Matt Becker, Claire Gower, P.J. White	Montana State University
Wolf-pronghorn	P.J. White, John Byers, Kerey Barnowe-Meyer	YCR, University of Idaho
Wolf-willow	Evelyn Merrill, Roy Renkin, Bill Ripple, David Cooper, Tom Hobbs, Don Despain	Univ of Alberta, USGS, YCR, Colorado State Univ.
Wolf –aspen	William Ripple, Eric Larsen, Roy Renkin, Matt Kauffman	Oregon State University, Univ of Wisconsin at Stevens Point, YCR, Univ. of Montana
Wolf –trophic cascades	L. David Mech; Mark Boyce, Nathan Varley; Rolf Peterson Dan MacNulty	USGS; University of Alberta; Michigan Technological University University of Minnesota
Wolf predation	Tom Drummer, John Vucetich, Rolf Peterson, Dan MacNulty	Michigan Technological University, University of Minnesota
Wolf survival	Dennis Murray	Trent University
Wolf Population Genetics	Robert Wayne, Daniel Stahler, Bridgett vonHoldt, John Pollinger	University of California, Los Angeles

Wolf Diseases & Parasites	L. David Mech, Emily Almberg	University of Minnesota
Wolf, Willows, & Songbirds	Andy Hansen Lisa Baril	Montana State University
Wolf Movements/Dispersals	Douglas McWhirter, L.D. Mech, Mike Jimenez	Wyoming Game & Fish, USGS, USFWS

Research in Wyoming outside Yellowstone National Park

Predator-Prey Relationships

Annual predation patterns of wolves near Jackson, Wyoming: USFWS Wolf Recovery Program, Jackson, Wyoming.

Cooperators: Grand Teton National Park, National Elk Refuge, Bridger-Teton National Forest, and Wyoming Game and Fish Department.

From 1999 to 2006, we monitored wolves to determine prey selection of wolves near Jackson, Wyoming. We divided the calendar year into 4 seasons: winter (1 December - 31 March); spring (1 April - 31 May); summer (1 June – 31 August); fall (1 September – 31 October). In winter, we used VHF radio telemetry to locate collared wolves daily. We tracked wolves in the snow to locate carcass remains of ungulates killed or scavenged by wolves. In spring, summer, and fall we radio collared wolves with downloadable GPS collars programmed to collect location data every half hour. We investigated location points on the ground to locate carcasses of wolf-killed ungulates. We located 281carcasses of ungulates killed by wolves in winters 2000-2006 and 74 ungulate carcasses in spring/summer/fall 2005-2006. Winter prey species consisted of 95% elk (*Cervus elaphus*), 4% moose (*Alces alces*), 0.7% deer (*Odocoileus hemionus*), and 0.3% bison *(Bison bison)*. Prey composition of elk killed by wolves was 38% cows, 15% bulls, and 47% calves. Prey composition of moose killed in winter was 50% cows and 50% calves. Mean age of adult elk killed was 9.3 years and the oldest elk was 23 years old. Prey species in spring/summer/fall consisted of 85% elk, 14% moose, and 1% bison. Prey composition of elk killed by wolves in spring/summer/fall was 43% cows, 16% bulls, and 41% calves. Prey composition of moose killed was 50% cows, 20% bulls, and 30% calves. Prior to wolf recolonization in 1999, elk and moose calf/cow ratios declined from 1989 through 1999 and the 10-year average ratio was 28.8 elk calves/100 cows and 41 moose calves/100 cows. Since wolf recolonization, calf/cow ratios averaged 25.5 elk calves/100 cows and 33 moose calves/100 cows.

Collaborative Research

A comparison of wolf and cougar kill sites in the southern Yellowstone Ecosystem

Graduate Student: Susannah Woodruff, Prescott College, Prescott, Arizona

Major advisor: David Parsons, Prescott College.

Status: Thesis and masters degree completed in 2006.

Cooperators: U.S. Fish and Wildlife Service, Grand Teton National Park, U.S. Forest Service, and Wyoming Game & Fish.

We examined kill site habitat characteristics of sympatric wolves (*Canis lupus*) and cougars (*Puma concolor*) in the southern Yellowstone ecosystem. We tracked radio collared wolves and cougars to locate and describe kill sites from December 1999-May 2006. Using computer mapping techniques, we: 1) identified kill site characteristics (elk density, vegetation cover types, distance to waterways, slope, aspect, elevation, and terrain roughness) associated with wolf and cougar kill sites; 2) compared and contrasted characteristics between wolf and cougar kill sites; and 3) compared and contrasted winter versus spring kill site characteristics. Analysis indicated wolf kill sites were not randomly selected; cougar kill sites generally did not differ from random sites. Wolf kills occurred on less steep slopes in more often open areas, and in areas with mid to high elk density. Cougar kill sites were characterized by rougher terrain and greater canopy cover and appeared unaffected by elk density. We concluded that variation in kill site habitat likely stems from differences in hunting techniques.

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: U.S. Fish and Wildlife Service, USDA Wildlife Services, and Wyoming Game & Fish Department.

Status: Field work will begin in summer 2007.

This project aims to analyze wolf habitat selection in response to elk and cattle distribution in the Absaroka Range of Wyoming. The GPS data from wolves, elk, and cattle as well as location data on wolf kills will provide information to develop a predictive model of the spatial occurrence of cattle depredations. This analysis will determine the extent to which wolf depredations on cattle are mediated by the proximity of cattle to resident elk herds, after accounting for other landscape

attributes. The project will also attempt to provide information to managers that will help identify characteristics that constitute high-risk areas for cattle depredations.

Other Collaborative Research Projects with the USFWS Wolf Recovery Program

Topic	Collaborators	Institution
Evaluating wolf impacts on ranch productivity and environmental quality.	Pat Clark	USDA Agricultural Research Service
Absaroka Elk Ecology Project	Doug McWhirter Matt Kauffman	WYG&F Univ. of WY
Wolf population genetics	Robert Wayne Bridgett vonHoldt	Univ. of Calif., Los Angeles
Wolf Diseases & Parasites	David Mech Emily Almberg	Univ. of Minn.

MANAGEMENT

Management in Yellowstone National Park

Area Closures

The Slough Creek den area was initially closed but the wolves abandoned their den after being supplanted by another pack, so the area was opened by late May (normally closed to July 1). The Hayden Valley pack also denned within view of the road and closure was put in place, first a particular section of the trail, then a complete trail closure, then a closure to off-trail hiking. Despite this level of protection this pack had numerous human intrusions on their den and rendezvous site. This pack, possibly as a result of this close contact with people, has made them the most human tolerant of any pack in the park, a concern both for their and human welfare. They also had only two pups survive, well below the park average, and it may be due to increased human disturbance.

Wolf Road Management Project (Formerly Druid)

Since wolf reintroduction, Lamar Valley and other areas in the park have become premier locations worldwide to observe free-ranging wolves. The main pack of interest has been the Druid Peak pack, which had denned in the valley from 1997 through 2004. Since then when the Druid Peak pack has not been visible, other packs such as, Slough Creek or Agate Creek, have been able to fill the void. Nonetheless, each year visitor numbers have grown and in 2000, the Yellowstone Center for Resources (YCR), Resource and Visitor Protection, and Division of Interpretation cooperated to better deal with the opportunities and problems that accompany

increasing visitors that want to see wolves. As a result, the Druid Management Project was initiated, with the following objectives: 1) human safety: protect visitors that are viewing wolves alongside the road, and control both traffic along the road and parking to prevent an accident; 2) wolf safety: protect wolves from vehicle strikes, permit wolves to cross roadways without harassment from visitors, and protect the closed area around the den from visitor intrusion; 3) visitor enjoyment: through protection of natural wolf behavior, preserve visitor opportunity to view wolves and interpret wolf and other wildlife ecology to visitors; and 4) wolf monitoring and research: continue to monitor and study the denning behavior, predation, activity, and interactions of wolves with other wildlife. Since the Druid Peak pack is less visible than they were, the project has evolved to manage other packs and educate visitors where they encounter wolves.

This was the seventh year that private funds were used to manage wolf viewing. Unlike the previous summer where the Slough Creek pack was the most visible pack, this summer two other packs were seen on a regular basis, the Druid Peak pack in Round Prairie and the Agate Creek pack in Antelope Creek. The Druid Peak pack denned in a forested area east of the Pebble Creek Campground. Visitors first started viewing pups at the end of June and they were visible through early July, after which time they moved east into Cache Creek. The Agate Creek pack denned in the Antelope Creek near the road. Scores of visitors were able to view both pups and adults on nearly a daily basis from mid-June to mid-September. The Slough Creek wolves were visible in April, but after the attack from the unknown pack, they abandoned their den (see ***Pack Histories***) and were not easily or predictably observed.

Because wolf viewing was not at one location, project staff split up and varied their daily schedule to meet visitors and observe wolves. Nonetheless, even with numerous areas to monitor that changed on a daily basis, there were no accidents or close-calls with wildlife. In all, it is estimated that over 13,000 visitors were able to view wolves during the summer of 2006.

The Hayden Valley pack in the interior of the park has become a reliable viewing opportunity for summer visitors in recent years. As with northern range packs, the Hayden Valley wolves are regularly required to negotiate the road corridor in order to hunt, bring food back to their pups, and maintain their territory. As a result, the Wolf Project staff worked closely with the Division of Resource and Visitor Protection and Division of Interpretation to monitor and manage visitors and situations involving wolves to ensure the objectives of wolf and human safety, education, and research.

Management in Wyoming outside Yellowstone National Park

Livestock depredation & management

Potential livestock depredations in Wyoming were investigated by WS and USFWS. 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 loses and do not reflect lost or missing livestock. In 2006, wolves in Wyoming

outside YNP were responsible for killing at least 169 livestock (including 162 confirmed and 7 probable depredations) and 1 dog. Confirmed livestock depredations included 123 cattle (110 calves; 13 cows/yearlings), 38 sheep (22 ewes; 16 lambs) and 1 horse (Appendix Tables 2, 5a, and 5b). One guard dog, 2 calves, and 1 mule were injured by wolves, but survived the attacks. The total number of livestock depredations recorded in 2006 increased approximately 64% from 2005 when >103 livestock were lost to wolves (Figure 2).

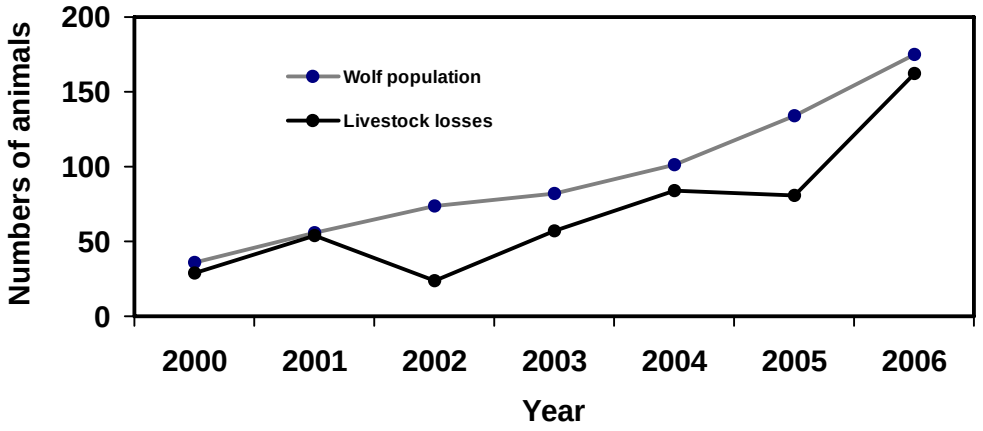

Figure 2. Annual wolf population size and number of confirmed livestock losses/year in Wyoming, 2000 - 2006.

Number of packs involved in depredations

Eight of the 23 known packs plus all four of the suspected or unconfirmed packs (44% of all known or suspected packs) in Wyoming were involved in at least 1 depredation in 2006 (Figure 3). Three packs (South Fork, Prospect, and Green River Packs) were responsible for 68 confirmed livestock depredations (42% of all confirmed losses). In an attempt to prevent additional livestock depredations, the entire Green River Pack was removed. After repeated depredations in summer 2006, the USFWS authorized lethal removal of the entire South Fork and Prospect Packs. Four wolves were killed in the South Fork Pack and a S.O.S permit was issued to the livestock producer. Five wolves were killed in the Prospect Pack. Despite continued effort to eliminate both packs, the South Fork and Prospect Packs still existed in December 2006. All 3 packs will be removed early in the 2007 grazing season if chronic depredations occur.

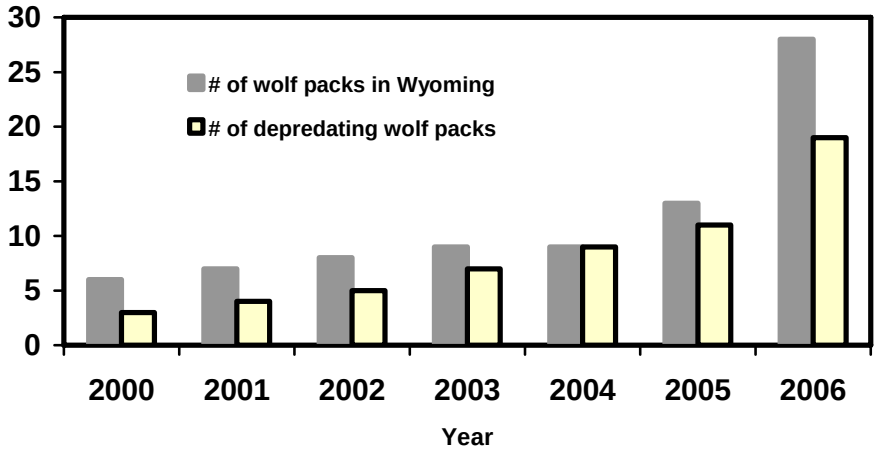

Figure 3. Annual number of wolf packs in Wyoming and number of wolf packs that are involved in at least 1 livestock depredation/given year.

Frequency of livestock losses to individual producers

From 2000 through 2006, we documented 108 people who experienced animal losses due to wolves. Losses were recorded as confirmed or probable and included all cattle, sheep, dogs, and horses that were killed or injured by wolves. Fifty people (46%) experienced multiple losses due to wolves and 58 individuals (54%) experienced a single loss to wolves in the 7-year period from 2000 through 2006 (Figure 4). Eighty-nine people had animals killed by wolves that were recorded as strictly confirmed depredations. Forty-seven of these individuals (53%) had losses due to wolves more than once and 42 people (47%) experienced a single loss to wolves in the 7-year time period from 2000 through 2006 (Figure 5).

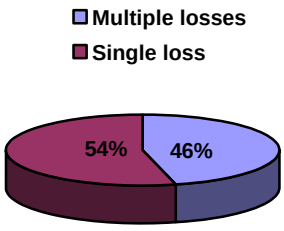

Figure 4. Frequency of multiple and single losses of all recorded wolf damges.

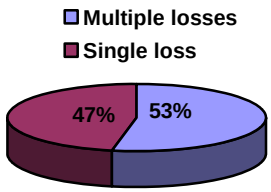

Figure 5. Frequency of multiple and single losses of all confirmed wolf depredations.

Time of year and location of livestock depredations

Cattle depredations in Wyoming followed a seasonal pattern from 2000 through 2006 with the highest number of depredations occurring in late summer from July through September (Figure 6). In 2006, most confirmed cattle depredations occurred in 3 counties: Sublette (58%), Park (32%), and Fremont (6%). Washakie County had 1.6% of all cattle depredations, Lincoln 0.8%, Hot Springs 0.8%, and Teton 0.8% (Figure 7).

From 2000 through 2006, sheep depredations peaked in June and July (Figure 8). In 2006, sheep depredations occurred in 3 counties: Johnson (53%), Fremont (31%), and Sublette (16%) (Figure 9).

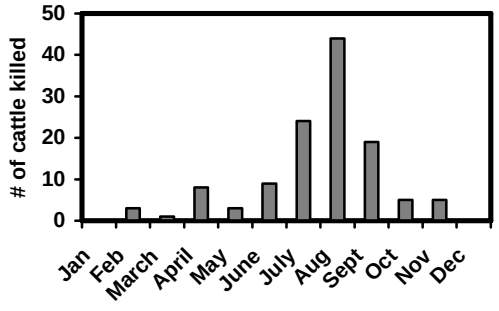

Figure 6. Number of confirmed cattle depredations/month.

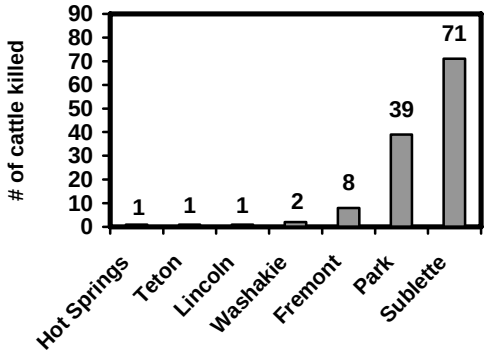

Figure 7. Number of confirmed cattle depredations/county.

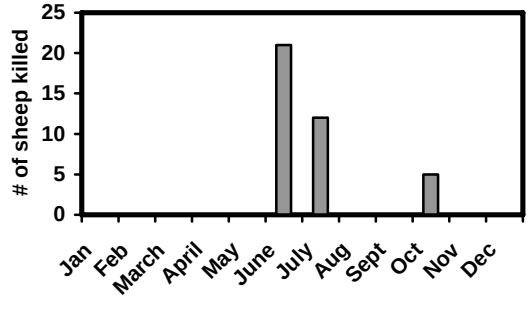

Figure 8. Number of confirmed sheep depredations/month.

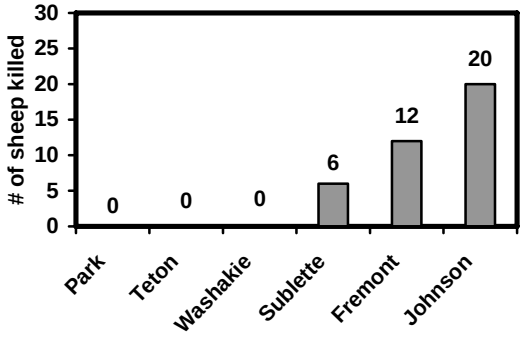

Figure 9. Number of confirmed sheep depredations/county.

Control Actions

Control actions in response to confirmed livestock depredations included trapping and radio collaring wolves; intensive monitoring; increasing riders on grazing allotments; harassing wolves with rubber bullets, lights, and cracker shells; moving livestock to different pastures; lethally removing wolves; and issuing shoot-on-site (SOS) permits. Non-lethal control was routinely considered but was often not applicable in many areas in Wyoming 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 where cattle grazed on public grazing allotments. When non-lethal control methods were not effective, wolves were lethally removed in an attempt to prevent further livestock depredations. Ten SOS permits were issued and livestock producers killed 1 wolf on private property. In 2006, 44 wolves (approximately 17% of the wolf population outside YNP) were lethally removed in control actions (Table 3).

Table 3. Wolves killed in control actions in Wyoming 2001 – 2006.

Year	# Confirmed Depredations	# Wolves Killed	% of Wolf Population
2000	29	2	--
2001	54	1	2
2002	24	4	7
2003	57	18	17
2004	84	29	23
2005	81	41	23
2006	158	44	17
Total:	487	139	18% (mean)

Wyoming Wolf Packs in 2006

The following is a brief summary of wolf packs in Wyoming including confirmed and probable depredations that occurred in 2006 and the subsequent control responses. Pack size and composition are based on our best estimates as of December 31, 2006.

1) Washakie Pack: (7 wolves: 4 adults/3 pups) Wolves from the Washakie Pack have chronically killed livestock in the Dunoir Valley since 1998. In 2006, 4 cattle were killed by wolves. One wolf was killed and 1 wolf (#560m) was trapped, radio collared, and released onsite. In late fall 2006, wolf #560m left the Washakie Pack and dispersed to the adjacent East Fork Pack.

2) East Fork Pack: (8 wolves: undetermined pack composition) The East Fork Pack formed in 2004 and its home range included the East Fork of the Wind River drainage and the Horse Creek drainage. Two calves were killed by wolves in summer 2006. We suspect the pack produced pups in 2006 but we were not able to confirm pup survival in fall or winter.

3) Teton Pack: (3 wolves: 3 adults/0 pups) The Teton Pack consisted of only 3 wolves and did not produce pups in 2006. After the pack lost the alpha male in 2005 and several younger wolves dispersed from the area, the pack's home range shifted to the southern portion of GTNP and the National Elk Refuge. USFWS confirmed that a calf was killed by wolves on a grazing allotment in GTNP, but we could not be absolutely certain which wolves were responsible; however, we suspect the Teton Pack was responsible. No additional depredations by the Teton Pack were reported.

4) Pacific Creek Pack: (9 wolves: 5 adults/4 pups) In 2004, wolves recolonized the Pacific Creek drainage north of Grand Teton National Park. The pack killed 4 cattle in summer 2005. In a proactive effort to minimize wolf/livestock conflicts in 2006, cattle were placed on a different allotment in GTNP. No livestock losses were reported in the area used by the Pacific Creek Pack in 2006.

5) Beartooth Pack: (7 wolves: 5 adults/2 pups) The Beartooth Pack used areas during summer and fall 2006 where very few livestock were grazed. No depredations were reported.

6) Sunlight Basin Pack: (13 wolves: 8 adults/5 pups) Wolves from the Sunlight Basin Pack killed 1 calf during summer 2006. Wolves and cattle in the area were closely monitored, but no additional depredations occurred. Several wolves from the Sunlight Pack were infested with sarcoptic mange in 2003 and 2004, but no mange was seen in Sunlight wolves in 2005 or 2006.

7) Absaroka Pack: (6 wolves: 5 adults/1 pup) Four wolves, all infested with mange, were lethally removed from the Absaroka Pack in response to wolves killing at least 6 calves in 2006. Since 2002, Absaroka wolves have been infested with mange. We suspect *sarcoptic scabiei* mites are prevalent on coyotes in the area used by the Absaroka Pack and wolves will continue to be infested with mange in the future.

8) South Fork Pack: (6 wolves: 2 adults/4 pups) The South Fork Pack formed in the South Fork of the Shoshone River drainage in 2005. Wolves from the South Fork Pack killed 3 calves in summer 2005. Two wolves were trapped, radio collared, and released. No further depredations were reported. In 2006, the South Fork Pack chronically killed livestock. Four wolves were killed in control actions and the USFWS authorized the removal of the entire pack. The livestock producer was issued a S.O.S permit. Despite several attempts to remove the remaining wolves in the pack, the wolves moved into more remote areas within their home range and are still present. The producer lost 19 cattle to wolves. The entire pack will be removed early in the 2007 grazing season if depredations occur.

9) Gooseberry Pack: (4 wolves: 2 adults/2 pups) The Gooseberry Pack (formerly called Wood River pack) killed 1 calf in summer 2005. Wolves and cattle in the area were closely monitored, but no additional depredations occurred. In 2006, 6 wolves from the Gooseberry Pack were removed for killing 6 calves.

10) Greybull River: (8 wolves: 2 adults/6 pups) In 2004, the Greybull River Pack killed at least 4 cattle on private property. Control actions were attempted but were unsuccessful. In 2005, the pack killed at least 5 calves and 1 heifer. Depredations stopped after 2 wolves were killed in control actions. In 2006, the pack killed 2 calves. The wolves and cattle were closely monitored, but no further depredations were reported.

11) Carter Mountain: (7 wolves: 7 adults/0 pups) In 2004, the Carter Mountain Pack killed 4 adult cows. The alpha male was removed and no additional depredations were reported. In 2005, the pack killed at least 6 calves and 1 heifer. Six wolves were killed in repeated control actions in attempt to prevent further depredations. No additional depredations were reported in late fall 2005 and the Carter Mountain Pack consisted of 6 wolves. The Carter Mountain pack began killing livestock again in 2006 and 4 wolves were removed to prevent additional depredations. This winter, the remaining radio collared wolf picked up several other wolves, and the pack consisted of 7 wolves.

12) Rock Creek: (5 wolves: 3 adults/2 pups); *13) Cub Creek:* (5 wolves: 3 adults/2 pups); and *14) Bliss Creek:* (6 wolves: 4 adults/2 pups). These 3 new packs formed in 2006 and used remote areas with no livestock. Efforts will be made to radio collar pack members in 2007.

15) Owl Creek: (5 wolves: 2 adults/3 pups) The Owl Creek Pack began as 3 adult wolves that denned west of Meeteetse, Wyoming in 2004 and produced 4 pups. After chronic livestock depredations the entire pack, except 1 adult female, was killed in early January 2005 in several control actions. Later in winter 2005, the surviving female wolf dispersed from the area and paired with another adult male wolf to form the Gooseberry Pack. In 2006, other wolves came in to the area and re-established the Owl Creek Pack. The pack killed 1 calf in summer 2006.

16) Buffalo: (13 wolves: 6 adults/7 pups) After the Teton Pack lost its alpha male in 2005 and numerous younger wolves dispersed, the remaining 3 pack members spent the winter on the National Elk Refuge. Another pack of wolves, possibly originating from the Yellowstone Delta Pack, moved in to the area. The pack denned and successfully reared 7 pups. The pack killed a horse on private land adjacent to GTNP.

17) Black Butte: (7 wolves: undetermined pack structure) The Black Butte Pack formed in 2006 near the Green River drainage, north of Pinedale, Wyoming. Three of the 5 original wolves were removed after repeated cattle depredations. No further depredations were reported and the pack increased to 7 wolves by the end of fall.

18) Gros Ventre: (6 wolves: 2 adults/6 pups) The Gros Ventre Pack formed again in 2005 and produced 4 pups in 2006. The pack was responsible for 1 confirmed cattle depredation in the Upper Green River drainage.

19) Togwotee: (7 wolves: undetermined pack structure) Wolf #396f dispersed from the Yellowstone Delta Pack and established the Togwote Pack in 2006. Wolf #396f had been in the general area since 2005, but we did not see other wolves or suspect that a pack had formed until 2006. We suspect the pack produced pups but were unable to determine pup survival in December 2006.

20) Snake River: (9 wolves: 2 adults/7 pups) The Snake River Pack denned in 2006 and produced 7 pups. We were not able to document the pack's home range because no wolves in the pack were radio collared. We will attempt to capture and radio collar pack members this winter and spring 2007.

21) Huckleberry: (7 wolves: 3 adults/4 pups) The Huckleberry Pack formed in 2006 north of GTNP. In summer the pack moved south and began using the Snake River drainage in GTNP. We documented another new pack with pups in this drainage (Sage Pack) earlier that spring. We lost contact with the Sage Pack when a GPS radio collar in the pack failed and a second collared wolf dispersed. It is unclear what occurred, but we suspect the 2 packs combined and successfully raised 4 pups.

22) Daniel: (4 wolves: undetermined pack structure) The Daniel Pack was first discovered in 2003 in the Wyoming Range, near Daniel, Wyoming and first began killing livestock in 2003. The pack killed at least 20 livestock (confirmed depredations) and was implicated in another 20 probable depredations. Five wolves were removed in 2004. No further depredations were reported until 3/23/05 when WS confirmed wolves from the Daniel Pack killed 1 cow and severely injured another cow on private property. Due to the pack's history of chronic depredations and the pack's large home range, the USFWS authorized WS to remove the remaining pack members. The livestock owners were issued SOS permits to kill wolves on their private property. On 3/28/05, WS aerial gunned all 5 wolves located at the previous depredation site. No other wolves were seen at that time and no further depredations occurred during spring 2005. The Daniel Pack formed again during summer 2005 and consisted of 8 wolves. Between 7/18/05 and 12/7/05, W.S. confirmed that the Daniel Pack killed at least 4 cows/yearlings and 6 calves. USFWS authorized WS to remove all remaining wolves in the Daniel Pack. In December 2005, 6 wolves were shot from a fixed-wing plane. Further control actions were attempted, but 2 wolves still remain in the area. In 2006, the pack re-established and killed 9 cattle. Despite several attempts to remove the pack, we were not able to locate the uncollared wolves. The pack will be removed early in the 2007 grazing season if depredations occur.

23) Prospect: (4 wolves: undetermined pack structure) An uncollared dispersing male and female wolf denned and produced 6 pups near Farson, Wyoming amongst thousands of ewes and lambs grazing on public and private land in 2005. After the wolves killed at least 13 ewes and 2 lambs, we determined that depredations would continue throughout the summer and the female and 4 pups were killed in control actions. Two pups were later found dead and the male wolf was not located again. In August 2005, 33 dead sheep (14 ewes and 19 lambs) were found on private property at the base of the Prospect Mountains, near Farson, Wyoming. In November 2005, 4 wolves were removed when 4 additional dead ewes were recorded as confirmed wolf-kills. Five wolves were killed in 2006 in response to 22 cattle depredations. USFWS authorized the removal of the entire pack, but the uncollared wolves could not be located. The pack will be removed early in the 2007 grazing season if repeated depredations occur.

Misc. Wolves/Unconfirmed Packs

Flat Creek Pack: The Flat Creek Pack (8 wolves: 3 adults and 5 pups) formed in 2005 north of Jackson, Wyoming. The pack spent most of the summer and fall in areas where no livestock were grazed in GTNP and the National Elk Refuge. No depredations were reported. The radio collared male wolf dispersed, and we lost contact with the pack in 2006. Given that we have not received reports of the pack since last year, it is possible that the pack no longer exists.

Driggs/Teton Pack: The Driggs/Teton Pack (5 wolves) formed in 2005 when a dispersing male wolf from the Teton Pack joined 4 other wolves. The pack spent much of the summer and fall in areas where livestock were grazed; however, no depredations were reported. In winter 2006, wolves from the Driggs/Teton Pack chewed the radio collar off the collared wolf. In summer 2006, the pack killed several livestock and 2 wolves were shot by the livestock producer under the Idaho amended 10j rule. ID WS responded to the livestock depredation by trapping and radio collaring a male wolf (#ID-276m). Wolf #ID-276m died of natural causes later in the fall, and it is unclear if the pack still exists.

Other Depredations (Misc. wolves/Unconfirmed packs): Single wolves or other wolves not associated with known packs in southwest Wyoming were responsible for 8 confirmed cattle depredations. Ten cattle were killed by wolves near Big Piney, Kemmerer, Pinedale/Cora, and Big Horn Mountains.

Packs removed in control actions

Green River Pack: Wolves in the Upper Green River drainage have chronically killed livestock since 2002 when they denned in an area with several thousand cattle grazing on USFS allotments. After repeated depredations, the entire pack was removed in 2004 and again in 2005 when the pack re-formed. In 2006, 4 adult wolves dispersed to the Green River drainage, re-established the Green River Pack, and produced 6 pups. The pack killed >27 cattle in 2006. Due to the chronic depredation history of wolves that have recolonized the Green River drainage, the USFWS authorized lethal control and WS removed the entire pack. If wolves recolonize the area in 2007 and repeated depredations occur, the entire pack will be removed early in the grazing season.

OUTREACH

Outreach in Yellowstone National Park

Yellowstone Wolf Project staff gave >100 talks at scientific conferences and to the general public. Douglas Smith was interviewed 60 times by all media sources about park wolves and research.

For the sixth straight years Smith and USFWS personnel road horseback into outfitter camps adjacent to the park boundary to discuss wolf issues. Rides alternate between the north and south boundary of YNP. This year three camps on the north boundary in Gallatin National Forest were visited. Besides Smith, Gardiner District Ranger Ken Britten and Gardiner District Wildlife Biologist Dan Tyers, and NPS Center for Resources Director Tom Olliff participated in the ride and outreach.

Outreach in Wyoming outside Yellowstone National Park

In 2006, the Wyoming wolf recovery program gave approximately 29 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 and newspaper feature stories.

USFWS LAW ENFORCEMENT

Enforcement efforts continue in Wyoming. 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.

ACKNOWLEDGEMENTS

We thank all of the Wolf Project 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 five major institutions and organizations: an anonymous donor, the Tapeats Foundation, the Perkins-Prothro Foundation, Canon, Inc., 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 know that a successful program needs a strong base of support and to all the above we are indebted.

We thank our pilots Gary Lust of Mountain Air Research, Dave Stintson from Sky Aviation, Steve and Lisa Robertson, and Mark Duffy at Central Helicopters. Laboratory work was done by Mattson's Laboratory in Milltown, Montana and Gary Haas of Big Sky Beetle Works in Hamilton, Montana.

Numerous agencies and agency personnel have contributed to the recovery program and we thank Dave Skates and Laurie Connel (USFWS Lander); USFS; Nancy Hall, Dave Cunningham, and Lance Koch at Bridger-Teton National Forest; Shoshone National Forest; Steve Cain and Sarah Dewey from Grand Teton National Park; Barry Reiswig and Eric Cole at the National Elk Refuge; Bureau of Land Management; Wyoming Game and Fish Department; and Howard Quigley and Derek Craighead from Beringia South.