2013 WYOMING GRAY WOLF POPULATION MONITORING AND MANAGEMENT ANNUAL REPORT

Prepared by the Wyoming Game and Fish Department in cooperation with the U.S. Fish and Wildlife Service, National Park Service, USDA-APHIS-Wildlife Services, and Eastern Shoshone and Northern Arapahoe Tribal Fish and Game Department to fulfill the U.S. Fish and Wildlife Service requirement to report the status, distribution and management of the wolf population in Wyoming from January 1, 2013 to December 31, 2013.

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LIST OF ABBREVIATIONS

Grand Teton – Grand Teton National Park

Hunt area – wolf hunt area

NRM – Northern Rocky Mountain Gray Wolf Distinct Population Segment

Wolf Management Plan – the Wyoming Gray Wolf Management Plan and Addendum as approved by USFWS in 2012

Tribal Fish and Game – Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department

USFWS – United States Fish and Wildlife Service

WGFD – Wyoming Game and Fish Department

Wind River Reservation – tribal lands in the Wind River Reservation

Wildlife Services – United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

WTGMA – Wolf Trophy Game Management Area

WYO – that portion of the state of Wyoming outside Yellowstone and tribal lands in the Wind River Reservation

Yellowstone – Yellowstone National Park

NOTE: Any use of the word "Wyoming" refers to all lands within the exterior boundary of the state including all portions of Yellowstone that are within the state, Grand Teton, the National Elk Refuge and the Wind River Reservation.

EXECUTIVE SUMMARY

At the end of 2013, the gray wolf population in Wyoming remained above minimum delisting criteria, making 2013 the 12th consecutive year Wyoming has exceeded the numerical, distributional, and temporal delisting criteria established by USFWS. At least 306 wolves in ≥43 packs (including ≥23 breeding pairs) inhabited Wyoming on December 31, 2013. Of the total, there were ≥95 wolves and ≥11 packs (including ≥8 breeding pairs) inside Yellowstone, ≥12 wolves and ≥2 packs (≥0 breeding pairs) in the Wind River Reservation, and ≥199 wolves and ≥30 packs (including ≥15 breeding pairs) in WYO. A total of 109 wolf mortalities were documented statewide in Wyoming in 2013 (101 in WYO, 7 in Yellowstone, and 1 in the Wind River Reservation). Causes of mortality included: human-caused = 99 (91%; control = 33, hunting = 62, vehicles = 2, illegal = 2); natural = 8 (7%); and unknown = 2 (2%). The total mortality rate for wolves in Wyoming in 2013 was 26% (109 known wolf mortalities compared to 415 wolves known to have been alive in 2013). Sixty-one wolves were captured and radio-collared in 2013. Seventy-one radio-collared wolves were being monitored at the end of 2013 in Wyoming (23% of the year-end population). A total of $876,552.66 was spent to monitor and manage wolves, not including livestock depredation compensation, in Wyoming by all jurisdictions combined (WGFD = $541,594.86; Yellowstone = $193,000.00; Grand Teton = $60,000.00, Wildlife Services = $60,957.80; USFWS Lander Fish and Wildlife Conservation Office on the Wind River Reservation = $18,000.00; Tribal Fish and Game = $3,000.00).

In 2013, WGFD instituted a wolf hunting season with the biological objective to reduce the wolf population by approximately 5% in the WTGMA/Seasonal WTGMA and secondly to provide recreational hunting opportunity to Wyoming sportsmen. Wolf harvest was focused primarily in areas with high levels of historic wolf-livestock conflict and/or areas with relatively high wolf densities in an attempt to reduce livestock damage and excessive predation on ungulate herds. A mortality quota of 26 wolves was subdivided between 12 hunt areas (hunt areas) in WYO. Wolf hunting seasons were open from October 1, 2013 to December 31, 2013 with the exception of hunt area 12, which opened on October 15, 2013. A total of 23 wolves were legally harvested and 1 wolf was illegally killed during the hunting season. Wolves could also be taken anytime in any legal manner in WYO where they are designated as predatory animals. Thirty-nine wolves were taken under predatory animal status in 2013.

Wolves were confirmed to have killed 75 head of livestock (41 cattle, 33 sheep, and 1 goat) and 1 dog in Wyoming in 2013. An additional 6 cattle, 2 sheep, 1 horse, 1 bison, and 1 dog were injured by wolves but survived. Sixteen packs (48% of 33 packs in Wyoming outside Yellowstone) were involved in ≥1 depredation in 2013. Of the 16 packs involved in ≥1 depredation; 9 packs (56%; 27% of packs in Wyoming outside Yellowstone) were involved in ≥2 depredations; and 6 packs (38%; 18% of packs in Wyoming outside Yellowstone) were involved in ≥3 depredations. Control efforts lethally removed 33 depredating wolves in an effort to reduce livestock losses due to wolves (11% of the wolf population in WYO known to be alive during 2013). A combined minimum of $157,195.60 was spent on wolf damage management in WYO by Wildlife Services ($60,957.80) and livestock depredation compensation by the State of Wyoming ($96,237.76) in 2013.

BACKGROUND

In 1995 and 1996, the USFWS reintroduced 31 wolves into Yellowstone National Park, Wyoming (Yellowstone) as a nonessential experimental population under the Endangered Species Act with the goal of reestablishing a sustainable gray wolf population in the northern Rocky Mountains (NRM). The USFWS was the federal agency charged with administering, monitoring, and managing the wolf population following reintroduction until wolves reached recovery levels and Endangered Species Act protections could be removed (i.e., referred to as "delisting"). The wolf population expanded quickly in number and distribution throughout northwest Wyoming. The population reached the required delisting criteria by late 2002 and has exceeded the criteria every year since. More information on wolves and the background and history of the wolf reintroduction program can be found on USFWS's Gray Wolves in the NRM website and the Wyoming Game and Fish Department's (WGFD) Wolves in Wyoming website at the following links:

http://www.fws.gov/mountain-prairie/species/mammals/wolf/
http://wgfd.wyo.gov/web2011/wildlife-1000380.aspx

In August 2011, the USFWS and the state of Wyoming finalized a cooperative planning effort which outlined a mutually agreed upon wolf management framework for the wolf population in Wyoming. The Wyoming Gray Wolf Management Plan (and an addendum that was added for clarification; referred to collectively as the "Wolf Management Plan" hereafter), applicable state statutes, and Wyoming Game and Fish Commission regulations were subsequently revised and given final approval by USFWS on September 10, 2012. Wolves were delisted in Wyoming as of September 30, 2012 The WGFD has monitored and managed wolves in Wyoming following delisting outside Yellowstone, Grand Teton, the Wind River Reservation, and the National Elk Refuge. Monitoring and management of wolves was conducted by the National Park Service in Yellowstone and Grand Teton, the Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department (Tribal Fish and Game) in cooperation with the USFWS Lander Fish and Wildlife Conservation Office on tribal lands in the Wind River Reservation, and the USFWS on National Elk Refuge.

As mentioned above, once wolves were delisted, wolf management responsibility was transferred to multiple jurisdictions in Wyoming. Each management agency has different laws, regulations, and/or management plans governing wolf management and, accordingly, each jurisdiction has varying wolf management objectives and philosophies. The following is a summary of the management direction by agency.

National Park Service

The National Park Service is responsible for monitoring and managing wolves in national parks in Wyoming. The National Park Service's primary wolf management approach is to allow natural processes to occur within the boundaries of national parks with minimal human intervention. More information on the National Park Service in Wyoming, including more

detailed reports on wolf monitoring and management in Yellowstone, can be found at the following links:

http://www.nps.gov/yell/naturescience/wolves.htm
http://www.nps.gov/grte/index.htm

Tribal Fish and Game Department

The Tribal Fish and Game in cooperation with the USFWS Lander Fish and Wildlife Conservation Office is responsible for wolf monitoring and management of wolves on tribal lands within the boundaries of the Wind River Reservation. The Wolf Management Plan for the Wind River Reservation designates wolves as a trophy game animal, but there was no open hunting season in 2013 and wolves could only be legally killed to defend life or property. For more information, see the Wolf Management Plan for the Wind River Reservation at:

http://www.fws.gov/mountain-prairie/species/mammals/wolf/Wind_River_Res_Wolf_Plan_20070413.pdf

USFWS

The National Elk Refuge, managed by the USFWS, was established to provide winter habitat and supplemental winter feeding for the Jackson Elk Herd. The USFWS is responsible for the management of all wildlife species, including wolves, within National Elk Refuge boundaries. More information on National Elk Refuge can be obtained at:

http://www.fws.gov/nationalelkrefuge/

WGFD

Wolves in WYO are monitored and managed by the WGFD. The WGFD wolf management approach is to maintain a recovered wolf population in Wyoming while balancing the need to minimize to the extent practical, wolf conflicts with livestock and wild ungulate herds. Wyoming's Wolf Management Plan also seeks to incorporate sport hunting opportunity into its wolf population management strategy. Wyoming's wolf management framework is more complex than the National Park Service's and the Wind River Reservation's and warrants more detailed explanation. As required by state law, wolves in WYO are managed under the dual classifications of trophy game animal and predatory animal as outlined in the Wolf Management Plan and approved by the USFWS. There are 3 wolf management "zones" in WYO, as follows:

1. *Wolf Trophy Game Management Area (WTGMA):* Wolves are designated as trophy game animals year-round within the WTGMA. Wolves in the WTGMA are managed similar to other trophy game species (e.g., black bears and mountain lions) and may only be taken by members of the public when in the act of doing damage to private property, under the authority of a lethal take permit, or by licensed hunters during an open wolf hunting season. Livestock owners who have confirmed wolf depredations on livestock in the WTGMA may qualify for compensation from the state.

2. *Seasonal WTGMA:* Wolves are designated as trophy game animals in the Seasonal WTGMA from October 15 through the end of February of the subsequent year and as predatory animals from March 1 to October 14 each year. Wolves may be taken by the public similar to wolves in the WTGMA while they are designated as trophy game animals, or may be taken as predatory animals for the remainder of the year (see below). Livestock owners who have confirmed wolf depredation on livestock in the Seasonal WTGMA may qualify for compensation from the state regardless of designation.

3. *Areas when and where wolves are designated as predatory animals:* Wolves are designated year-round as predatory animals in areas outside of the WTGMA and also within the Seasonal WTGMA from March 1 to October 14 (see above). Predatory animals may be taken anytime in any legal manner consistent with regulations related to legal take. Livestock owners who have confirmed wolf depredation on livestock outside the WTGMA/Seasonal WTGMA do not qualify for compensation from the state.

For more information on the wolf management framework in WYO, including the Wolf Management Plan and wolf management and hunting regulations, please visit the following link:

http://wgfd.wyo.gov/web2011/wildlife-1000380.aspx

Wolf Population Delisting Criteria and Post-Delisting Monitoring

The USFWS set specific recovery goals for wolves in the NRM that were required to be met prior to delisting. The wolf population in the NRM must also continue to meet or exceed USFWS' delisting criteria post-delisting to ensure the population remains recovered. The USFWS developed minimum delisting criteria of ≥300 wolves and ≥30 breeding pairs (a pack with at least 1 adult male and 1 adult female wolf that successfully raise at least 2 pups of the year until December 31) in the NRM for 3 consecutive years. These criteria were developed using input from many wolf experts from around the world. Additionally, the USFWS developed delisting criteria that required the states to maintain a 50% buffer above minimum delisting criteria (i.e., ≥450 wolves and ≥45 breeding pairs in the NRM) to ensure the population never fell below minimum delisting goals. The delisting criteria were then subdivided equally among the states of Montana, Idaho, and Wyoming, resulting in a minimum population requirement of ≥150 wolves and ≥15 breeding pairs in Wyoming at the end of the calendar year. Under the terms of the delisting agreement between Wyoming and USFWS, the state of Wyoming is required to maintain wolves at or above the minimum delisting criteria of ≥100 wolves and ≥10 breeding pairs in WYO, with Yellowstone and the Wind River Reservation providing the additional buffer of ≥50 wolves and ≥5 breeding pairs necessary to meet the ≥150 wolf and ≥15 breeding pair requirement for the state.

Under the Endangered Species Act, states are required to manage delisted species in a sustainable manner to ensure the population will remain above the minimum delisting criteria into the foreseeable future. Once delisting occurs, USFWS is required, in cooperation with the states, to monitor the status of delisted species. The primary goal of post-delisting monitoring is to provide the USFWS with a mechanism for evaluating the status of the population and ensure

states are managing the delisted population at or above minimum delisting criteria. This annual report is a product of cooperation between all agencies in Wyoming with wolf monitoring and management responsibility and will provide the USFWS with the necessary information required for their post-delisting monitoring evaluation for the 2013 calendar year.

Reporting Wolf Population Data by Jurisdiction

Generally, states are solely responsible for monitoring and managing delisted species. In Wyoming, however, multiple large jurisdictions where the state does not have management authority, primarily Yellowstone and the Wind River Reservation, contain significant portions of the wolf population or suitable wolf habitat. This sharing of large portions of the wolf population complicated management in Wyoming and made it difficult to determine which jurisdiction was responsible for what proportion of minimum delisting criteria. Therefore, it was necessary to clarify how many wolves and breeding pairs each jurisdiction would contribute toward minimum delisting criteria (i.e., ≥150 wolves and ≥15 breeding pairs in Wyoming at the end of the calendar year). The USFWS and state of Wyoming agreed on a framework that would assign proportions of the minimum delisting criteria to the 3 major jurisdictions as follows:

1. The state of Wyoming is responsible for maintaining ≥100 wolves and ≥10 breeding pairs in WYO. While the state does not have management authority over wolves in all areas in WYO such as Grand Teton and National Elk Refuge, these areas are small and the majority of wolf packs are shared among these jurisdictions and are, therefore, assigned to WYO.

2. Yellowstone, in combination with the Wind River Reservation, is expected to contribute the remaining buffer of ≥50 wolves and ≥5 breeding pairs necessary to meet the ≥150 wolf and ≥15 breeding pair requirement. Data for these jurisdictions are reported independently in the body of this report.

For purposes of this report, data are presented on the wolf population as a whole in Wyoming and are further summarized by the 3 major jurisdictions (i.e., WYO, Yellowstone, and the Wind River Reservation) to allow for proper evaluation of the wolf population both statewide and by major jurisdiction.

MONITORING

Wolf Population Monitoring Statewide

At the end of 2013, the gray wolf population in Wyoming remained above minimum delisting criteria, making 2013 the 12th consecutive year Wyoming has exceeded the numerical, distributional, and temporal delisting criteria established by USFWS. At least 306 wolves in ≥43 packs (including ≥23 breeding pairs) inhabited Wyoming on December 31, 2013. Of the total, there were ≥95 wolves and ≥11 packs (including ≥8 breeding pairs) inside Yellowstone, ≥12 wolves and ≥2 packs (≥0 breeding pairs) in the Wind River Reservation, and ≥199 wolves and ≥30 packs (including ≥15 breeding pairs) in WYO. A total of 109 wolf mortalities were documented statewide in Wyoming in 2013 (101 in WYO, 7 in Yellowstone, and 1 in the Wind River Reservation). Causes of mortality included: human-caused = 99 (91%; control = 33, hunting = 62, vehicles = 2, illegal = 2); natural = 8 (7%); and unknown = 2 (2%). The total mortality rate for wolves in Wyoming in 2013 was 26% (109 known wolf mortalities compared to 415 wolves known to have been alive in 2013). Sixty-one wolves were captured and radio-collared in 2013. Seventy-one radio-collared wolves were being monitored at the end of 2013 in Wyoming (23% of the year-end population). A total of $876,552.66 was spent to monitor and manage wolves, not including livestock depredation compensation, in Wyoming by all jurisdictions combined (WGFD = $541,594.86; Yellowstone = $193,000.00; Grand Teton = $60,000.00, Wildlife Services = $60,957.80; USFWS Lander Fish and Wildlife Conservation Office on the Wind River Reservation = $18,000.00; Tribal Fish and Game = $3,000.00).

Wolf Population Monitoring in WYO

Capture and Radio-collaring

Radio-collars are the primary tool used for monitoring wolf populations in WYO and throughout the NRM. Wolves were captured using foothold traps or darted/net gunned from a helicopter. Radio-collars were affixed to captured wolves and personnel collected morphological information, genetic samples, and blood for disease testing. Radio-collared wolves were released on site and monitored to document territories, movements (including dispersal), pack numbers, pack composition, breeding status and success, to mitigate livestock conflicts, and to aid in law enforcement investigations.

Forty-three wolves were radio-collared in 2013 (helicopter capture = 30; trapping = 13), including 3 recaptures. At the end of 2013, there were 43 radio-collared wolves in 21 packs and 3 collared single wolves that had dispersed from their packs, for a total of 46 radio-collared wolves (23% of the year-end population in WYO). Winter capture efforts continued through the end of March 2014 in conjunction with 2013 year-end population surveys, at which point a total of 83 wolves (42% of the population in WYO) were radio-collared in 25 packs. The proportion of radio-collared individuals is generally highest at the end of winter following aerial capture efforts and decreases throughout the remainder of the year as pups are born in April and radio-collared wolves die, disperse, or go missing when collars fail or batteries expire. From 1999-2013, radio-collars were maintained on approximately 20-25% of the wolf population at the end

of each year. VHF radio-collars were used for general monitoring purposes and various types of global positioning system (GPS and ARGOS) collars for specific research projects.

Population and Breeding Pair Status

The minimum population for wolves in WYO on December 31, 2013 was estimated using standard wolf monitoring methods that have been used since reintroduction. The number of wolves in individual packs was estimated at the end of the year by counting wolves from the air during aerial telemetry flights and capture operations, observations confirmed by qualified agency personnel, or pictures of known packs taken with remote cameras. Only pack observations obtained from winter 2013-2014 were included to ensure they were reflective of the minimum number of wolves present on December 31, 2013. All pack counts used to estimate the end of the year wolf population for 2013 were obtained after December 31, 2013, and therefore represent a minimum number of wolves in each pack at the end of the year. Single wolves were included in the estimate only if the observations were confirmed by qualified agency personnel and the animal was not a member of a known pack. Standard techniques used by the USFWS prior to delisting were used to identify and assign trans-boundary packs to their appropriate jurisdiction both between jurisdictions within Wyoming, and between Idaho and Montana. The final minimum population estimate was the sum of all pack counts and single wolves known to be present in WYO on December 31, 2013. It should be noted that wolf monitoring in WYO is focused in the WTGMA with less intensive monitoring in the Seasonal WTGMA and predatory animal areas.

Breeding pair status was determined using methods utilized since wolves were reintroduced. Denning behavior was confirmed for individual packs using aerial and ground telemetry and ground investigations during spring. The presence of pups with packs was confirmed using observations made during aerial and ground monitoring efforts using telemetry equipment, investigations of potential den and rendezvous sites, howling surveys, public reports confirmed by qualified agency personnel, pictures taken with remote cameras, evaluations of changes in pack size, or a combination of methods. If 1 adult male and 1 adult female and ≥2 pups were adequately documented at the end of the calendar year, they were counted as a known breeding pair. Breeding pairs will continue to be documented using this method for at least the post-delisting monitoring period, but WGFD is also investigating the use of more efficient methods to determine breeding pair status over the long term. The model reported in Mitchell et al. (2007) for Wyoming is an efficient method for estimating breeding pairs based on pack size. This method uses historic data for unhunted wolves in Wyoming to estimate the probability that a pack with ≥4 wolves is a breeding pair. The probability that each pack is a breeding pair can then be summed to produce an estimate of the number of breeding pairs in the population. Mitchell et al.'s model will be applied to packs of ≥4 members with unknown breeding pair status to determine how many of these packs were likely to be breeding pairs at the end of 2013. The results of this model will only be considered as informative and will be reported as an estimated number of breeding pairs in addition to the confirmed number of breeding pairs in this report.

As of December 31, 2013, ≥199 wolves in ≥30 packs were documented in WYO, of which ≥179 wolves in ≥26 packs resided primarily within the WTGMA/Seasonal WTGMA and ≥20 wolves in ≥4 packs resided primarily in areas where wolves are designated as predatory animals (Figure

1 and Table 1). Pack size ranged from 2-15 and averaged 5.8 wolves/pack. Fifteen packs qualified as breeding pairs on December 31, 2013, all of which were located primarily within the WTGMA (Figure 1 and Table 1). Breeding pair status could not be determined for 7 packs with ≥4 members at the end of the calendar year. Using the model reported in Mitchell et al. (2007), 5 packs would likely have qualified as breeding pairs in addition to the 15 breeding pairs confirmed by field data, which would yield an estimate of 20 breeding pairs in WYO on December 31, 2013. The WGFD spent $541,594.86 to monitor and manage wolves in WYO in 2013, not including $96,237.76 paid in compensation for livestock depredation.

Population Trend

The WYO end of year wolf population increased 7% from 2012 to 2013 (≥186 wolves at the end of 2012 compared to ≥199 wolves at the end of 2013) and remained above the minimum delisting criterion of at least 100 wolves (Figure 2). In 2013, the WGFD implemented hunting seasons to reduce the wolf population in the WTGMA/Seasonal WTGMA from ≥169 wolves at end of year 2012 to ~160 wolves at end of year 2013 (approximately a 5% reduction). The primary goal of hunting seasons was to reduce the population in areas with historically high livestock conflict and high relative wolf-ungulate densities to reduce livestock damage and excessive predation on ungulates using public harvest while providing recreational hunting opportunity for wolves in WYO outside Grand Teton and the National Elk Refuge. Implementation of the Wyoming Game and Fish Commission wolf hunting strategy in 2013 did not reduce the wolf population in the WTGMA/Seasonal WTGMA as intended (5% increase vs. 5% predicted decline) with a population of ≥179 wolves at the end of 2013. Wolf populations usually respond to reductions in population size and density, particularly those induced by hunting or population control, by increasing pup production, recruitment or emigration (NRC 1997). This resiliency of wolf populations to human-induced reduction has been demonstrated in multiple studies where wolf populations were reduced to increase productivity of ungulate herds, yet wolf populations recovered to pre-reduction levels within a few years after reductions ceased (NRC 1997). Likewise, the wolf population in WYO historically was more resilient to human-caused mortality at moderate population levels, but the hunting mortality quota was set using data collected in 2012 when the population was higher and less resilient to human-caused mortality. The result was a more conservative mortality quota for the 2013 hunting season (see discussion in the *Wolf Hunting in the WTGMA/Seasonal WTGMA* section below). The WGFD will consider the results of the 2013 wolf hunting season, mortality and recruitment rates, and commitments made in the Wolf Management Plan and other regulatory documents to develop responsible and appropriate wolf hunting seasons in 2014 that will ensure the wolf population remains above minimum delisting criteria.

Harvest of wolves designated as predatory animals successfully limited wolf numbers in areas exemplified by low habitat suitability, low re-colonization potential and historically high wolf-livestock conflicts. The slight increase in the number of wolves counted in the predatory animal areas is likely the result of wolves dispersing from the WTGMA in response to the increased population in that area in 2013. The wolf population, and potential livestock damage, in the predatory animal areas would have been significantly greater without wolf hunting under predatory animal status.

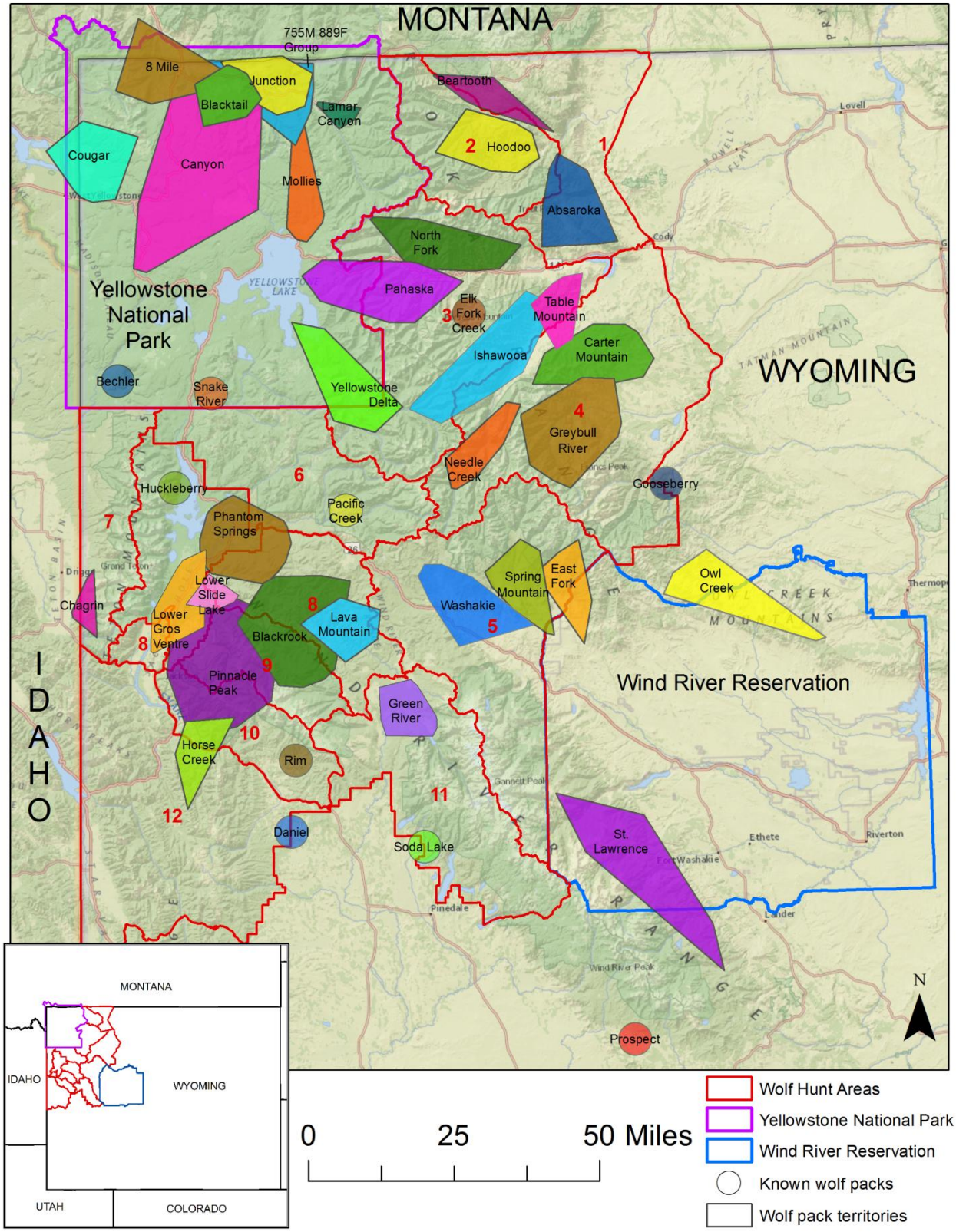

Figure 1. Home ranges of confirmed wolf packs in Wyoming in 2013.

Table 1. Wolf packs, population data, and depredation information for confirmed wolf packs in WYO and the Wind River Reservation in 2013. (Note: The column "REF #" refers to the reference number in the NRM wolf annual report compiled by USFWS covering all states in the NRM wolf recovery area.)

REF #	WOLF PACK[1,2]	RECOV AREA	STATE	MIN. ESTIMATED PACK SIZE DEC 2013	DOCUMENTED MORTALITIES NATURAL	HUMAN[3]	UNKN[4]	HARVEST[5]	CONTROL[6]	KNOWN DISPERSED	MISSING[7]	CONFIRMED LOSSES[8] CATTLE	SHEEP	DOGS	OTHER
	Wyoming Outside Yellowstone National Park and the Wind River Reservation (WYO)														
153	Absaroka	GYA	WY	7				1				1			
154	Beartooth	GYA	WY	5				2							
	~~Big Piney~~	GYA	WY					1							
	~~Black Butte~~	GYA	WY					3							
155	Blackrock	GYA	WY	4	2			1	3	2		7			
156	Carter Mountain	GYA	WY	12				1	4			5			
157	Chagrin River[9]	GYA	WY	5								1			
158	Daniel	GYA	WY	5				5							
	~~Dog Creek~~	GYA	WY					4	1				19	1	
159	East Fork	GYA	WY	7				4		1		1			
160	Elk Fork Creek	GYA	WY	8				1							
161	Gooseberry	GYA	WY	5				2	1						
162	Green River	GYA	WY	5				1	3	1		7			
163	Greybull River	GYA	WY	5				1		2					
	~~Greys River~~	GYA	WY					6							
164	Hoodoo	GYA	WY	6		1		3		1	1				
165	Horse Creek	GYA	WY	5				2	1	1					
166	Huckleberry	GYA	WY	11											
167	Ishawooa	GYA	WY	12					1			1			
168	Lava Mountain	GYA	WY	15				3		1					
169	Lower Gros Ventre	GYA	WY	2					11			3			1
170	Lower Slide Lake	GYA	WY	2											
171	Needle Creek	GYA	WY	2											
172	North Fork	GYA	WY	5		1									
173	Pacific Creek	GYA	WY	6				2							
174	Pahaska	GYA	WY	5											
175	Phantom Springs	GYA	WY	11				1		1					
176	Pinnacle Peak	GYA	WY	12	1										
177	Prospect	GYA	WY	3				3	3			1	7		
178	Rim	GYA	WY	2								1			
179	Soda Lake	GYA	WY	3		1									
180	Spring Mountain	GYA	WY	11				1	1			2			
181	Table Mountain	GYA	WY	3					1			4			
	~~Upper Gros Ventre~~	GYA	WY												
182	Washakie	GYA	WY	6								1			
	Misc/Lone wolves	GYA	WY	9				9	1			3	7		
	WYO Total	GYA	WY	199	3	3	0	57	31	10	1	38	33	1	1
	Wind River Reservation (WRR)														
	~~Bold Mountain~~	GYA	WY												
183	Owl Creek[a]	GYA	WY	6				5	2			2			
184	St. Lawrence	GYA	WY	6								1			
	Misc/Lone wolves	GYA	WY		1[b]										
	WRR Total	GYA	WY	12	1	0	0	5	2	0	0	3	0	0	0
	Wyoming Total (outside YNP)			211	4	3	0	62	33	10	1	41	33	1	1

[1] Underlined packs are counted as breeding pairs toward recovery goals.
[2] Strikethough packs were not documented during 2013 and/or did not exist on Dec. 31, 2013 and are not displayed in Figure 1.
[3] Excludes wolves killed in control actions and legal harvest.
[4] Includes wolves that died of unknown causes.
[5] Number of wolves legally harvested in 2013.
[6] Includes agency lethal control under federal/state regulations and wolves legally killed by private citizens to defend livestock or under terms of a lethal take permit.
[7] Collared wolves that became missing in 2013.
[8] Includes only domestic animals confirmed killed by wolves. Does not include 6 cattle, 2 sheep, 1 horse, 1 bison, and 1 dog that were injured by wolves but survived.
[9] Border pack shared with the State of Idaho; dens in Wyoming.
[a] Border pack shared with WYO and WRR; assigned to WRR. Mortalities and livestock depredations for the Owl Creek pack occurred outside the WRR boundary.
[b] Wolf was a member of the East Fork pack that died inside the WRR boundary.

The number of wolf packs in WYO remained relatively stable at ≥30 packs at the end of 2013 compared to ≥31 packs at the end of 2012 (Figure 3). This reduction occurred because 2 packs in the Seasonal WTGMA (Dog Creek, Greys River) and 2 packs in areas where wolves are designated as predatory animals (Big Piney, Black Butte) were removed through take as predatory animals. An additional pack (Upper Gros Ventre) reported at the end of 2012 was not confirmed by the end of 2013. Four new packs were established in 2013 (Lower Slide Lake, Needle Creek, North Fork, Table Mountain), resulting in the net loss of only 1 pack. No wolf packs were removed in control actions following confirmed livestock depredations and no wolf packs in the WTGMA were known to have been directly or indirectly eliminated by legal take during the 2013 hunting seasons.

There was 1 additional pair of wolves documented in the area of Clark, WY during 2013 monitoring efforts that may produce pups in 2014. This pair was not reported as a pack because they were newly formed in late 2013 or early 2014 and WGFD will determine whether they persist in 2014 prior to designating them as a pack. There was little evidence suggesting the presence of wolf packs in WYO that were not adequately documented in the minimum end of 2013 wolf population estimate. The vast majority of wolf observations recorded in WYO could be attributed to documented packs included in this report.

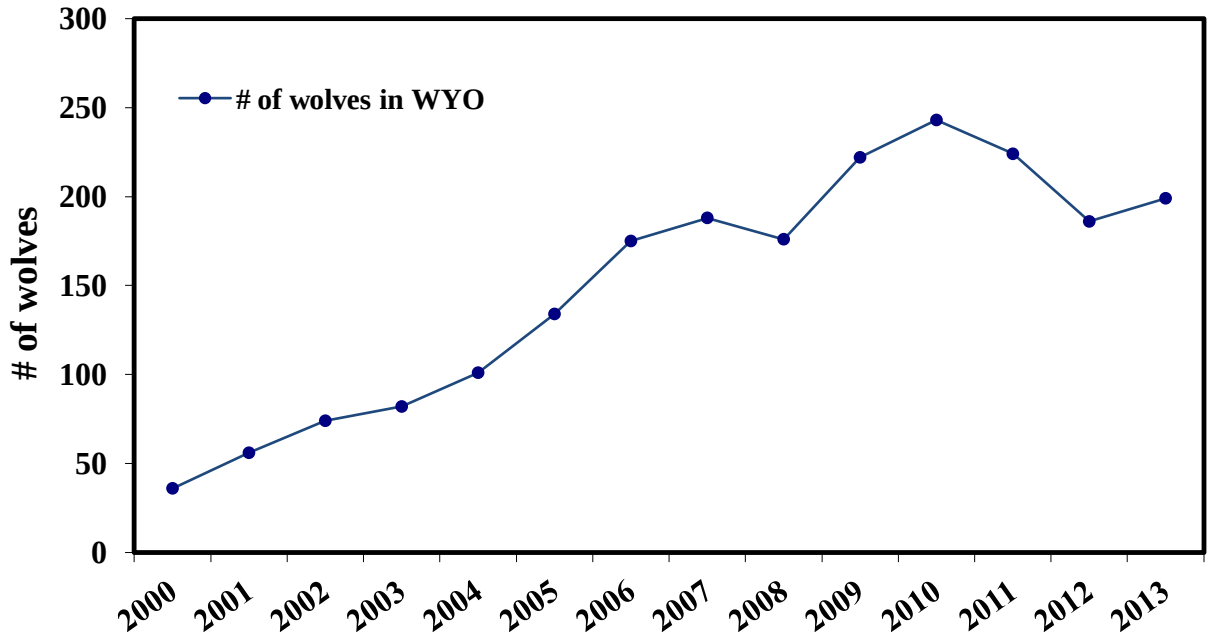

Figure 2. Wolf population trend in WYO from 2000-2013.

The number of known breeding pairs remained stable at ≥15 at the end of 2013 compared to ≥15 at the end of 2012 (Figure 3). Ten packs identified as breeding pairs in 2012 also qualified as breeding pairs at the end of 2013 (Absaroka, Carter Mountain, East Fork, Huckleberry, Ishawooa, Lava Mountain, Pahaska, Phantom Springs, Pinnacle Peak, Spring Mountain). Five packs that were not identified as breeding pairs in 2012 qualified as breeding pairs in 2013 (Beartooth, Chagrin River, Green River, Hoodoo, Horse Creek). Five packs that were breeding pairs in 2012 were not identified as breeding pairs at the end of 2013 for the following reasons: 1

from control mortality following confirmed livestock depredations (Lower Gros Ventre); 1 from a combination of natural mortality, control mortality, and dispersal (Blackrock); and 3 from unidentified factors not related to known causes of mortality (Gooseberry, Greybull River, Pacific Creek) Each of these packs are likely to produce pups in spring 2014 and could qualify as breeding pairs at the end of the year. Despite increased human-caused mortality compared to pre-delisting, most packs in the WTGMA, including those that did not qualify as breeding pairs in 2013, appear to be stable based on monitoring conducted during winter 2013-2014 and are likely to produce pups in 2014.

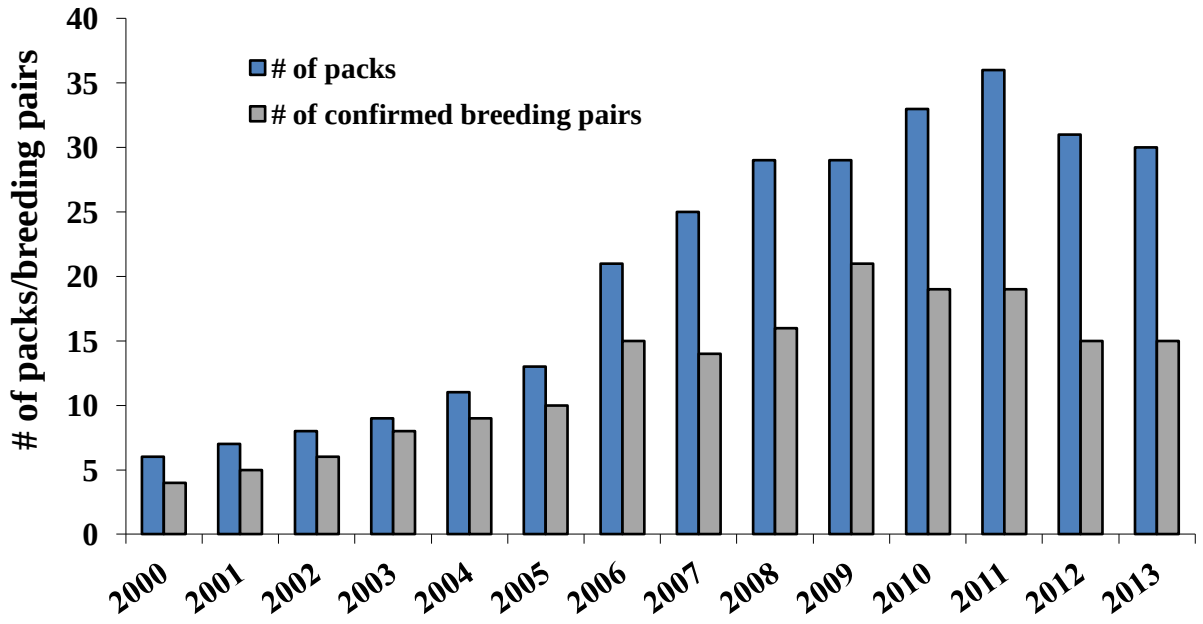

Figure 3. Number of wolf packs and confirmed breeding pairs in WYO from 2000-2013.

Mortality

Wolf mortality was monitored in WYO using multiple methods. Tracking radio-collared wolves was the primary method used for determining wolf mortalities occurring from non-hunting related causes. Radio-collars were programmed to change pulse rate after the collar remained motionless for 5 hours, thereby allowing managers to monitor collared wolves for mortality status and visit the site to evaluate cause-specific mortality and collect carcasses for further evaluation through necropsy. Wolf hunting mortality was monitored via reporting and registration by successful hunters as required in Wyoming Game and Fish Commission regulation Chapter 47. This requirement allowed WGFD personnel to document mortalities, collect information on harvested wolves, update mortality quotas, and close seasons quickly if the mortality quota was met. Cooperating agencies also provided information on wolf mortalities, including wolves killed in control actions by Wildlife Services. Wolf mortalities from all causes were documented and confirmed, including those found by the public, cooperating agencies, and WGFD personnel.

In 2013, 101 wolves were known to have died in WYO, 53 of which were in the WTGMA, 13 were in the Seasonal WTGMA and 35 were in areas where wolves are designated as predatory animals year-round (Table 1 and Table 2). Causes of mortality included: control = 33; legal public harvest = 62; other human causes = 3 (vehicle strikes = 1 [predatory animal area], illegal kills = 2 [in WTGMA]); and natural = 3 (Table 1 and Table 2). The number of wolves that died in 2013 (101 wolves) was lower than in 2012 (124 wolves) primarily because hunting quotas were reduced in 2013 in the WTGMA and there was less wolf depredation on livestock resulting in fewer mortalities from wolf control. The reduction in mortality was partially offset by the increase in take of wolves designated as predatory animals. This level of mortality did not reduce the population; rather the population increased slightly and remained well above minimum delisting criteria (Figure 2).

Table 2. Summary of wolf mortality in WYO in 2013 by cause of death and wolf management area. (# of wolves known to be alive in 2013: 199 alive at end of year + 101 mortalities = 300 total wolves known to be alive in WYO in 2013)

Cause of death	# of wolves	% of total mortality	% of mortality from known	WTGMA	Seasonal WTGMA	Predatory animal area
Legal hunting	62	0.61	0.21	23	12	27
Control	33	0.33	0.11	25	1	7
Other human	3	0.03	0.01	2	0	1
Natural	3	0.03	0.01	3	0	0
Unknown	0	0.00	0.00	0	0	0
Total Mortality	101	1.00	0.34	53	13	35

Disease Monitoring

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 WYO in 2002. Between 2002 and 2008, 4 packs east of Yellowstone and at least 1 pack near Jackson, WY were suspected of having mange (Jimenez et al. 2010). During summer 2013 signs of mange (alopecia and seborrhea) were observed in the Absaroka pack west of Cody, WY. Wolves captured from the Absaroka pack in January 2014 continued to show signs of active mange infection. There were 3 other wolves showing signs of mange that were not members of a known pack but were in close proximity to the Absaroka pack's territory in early 2014 and may have contracted the mite from members of the Absaroka pack or may be dispersing members of the pack. No other packs showed signs of mange infection in 2013.

Canine Distemper Virus and Canine Parvovirus: Canine distemper virus (distemper) and canine parvovirus (parvovirus) are highly contagious diseases that infect domestic dogs, coyotes, foxes, raccoons, skunks, and wolves. Based on other areas of the world that have experienced epizootic distemper and parvovirus infections, these diseases will occasionally cause mortality, particularly among pups. Outbreaks usually remain localized in specific areas/years and do not threaten regional wolf population viability. There was no documented mortality caused by distemper or parvovirus during 2013. Blood samples were collected from 35 wolves captured during the

winter of 2012-2013 to screen for diseases and were tested for distemper. Test results indicate 6 of the 35 wolves (17%) had been exposed to distemper. Parvovirus exposure has not been tested for these samples to date, but is expected to occur at a high rate among wolves in Wyoming (>80% of wolves exposed) based on historic prevalence rates. Monitoring for parvovirus and distemper will continue as more blood samples are collected during capture efforts in 2014.

Genetic Monitoring

The USFWS determined that, in addition to minimum population criteria, genetic interchange must also occur between the 3 wolf recovery areas in the NRM. To monitor whether this delisting criterion is met, USFWS requires that all states collect and analyze genetic samples from wolf populations in the NRM. Analysis of genetic interchange will be conducted cooperatively between USFWS and the states of Wyoming, Montana, and Idaho on a periodic basis (possibly every 12-20 years following 3-5 wolf generations). Genetic samples will continue to be collected from wolves in WYO to ensure enough genetic information is available to determine whether genetic interchange is occurring in the NRM.

In 2013, genetic samples were collected from 128 wolves that will be used in analysis of genetic connectivity. Genetic samples were collected from 33 wolves captured for monitoring purposes (33 samples), 32 wolves that were killed in control actions (32 samples), 60 harvested wolves (60 samples), and 3 wolves that died from other causes (3 samples). As required by wolf hunting regulations, 23 samples were submitted by wolf hunters who harvested wolves designated as trophy game animals and samples were voluntarily submitted by wolf hunters for 37 of 39 wolves taken in areas where they are designated as predatory animals.

Genetic connectivity between the recovery areas may also be confirmed through dispersal movements of marked wolves (e.g., ear tagged, radio-collared, etc.) and subsequent identification of successful reproduction through observation data and/or subsequent genetic testing of potential offspring. Since 2009, 3 wolves from Idaho and 1 wolf from Montana have been captured or killed in Wyoming. The histories of these wolves are as follows:

- Idaho B271M (Wyoming 698M) was captured in the Steel Mountain pack in the Central Idaho recovery area in 2006 as yearling. This male wolf dispersed into Wyoming northwest of Cody and was captured as a member of the Beartooth pack in 2009. He remained with the Beartooth pack through 2012, likely as the breeding male, until he dispersed from the Beartooth pack and was located dead in Yellowstone from unknown causes in June 2012.
- Montana SW266M was captured in the Mill Creek pack in southwest Montana in 2007 as a pup. This male wolf dispersed from his natal pack in summer 2008 and was missing until he was killed in a control action following confirmed sheep depredations in the Bighorn Mountains of Wyoming in October 2009.
- Idaho B261M was captured in the Packer John pack in the Central Idaho recovery area in 2005 as a 2 year old. This male wolf dispersed from his natal pack in 2006 and was not located until he was legally harvested west of Cody, WY in October 2013 at

approximately 10 years of age. The pack membership of this wolf was unknown at the time of harvest, but he had likely been in Wyoming since 2006-2007. Future testing will determine whether he successfully reproduced following dispersal and if his genetic signature can be detected among wolves living in Wyoming.

- Idaho B377M was captured in the Bishop Mountain pack in eastern Idaho in 2008 as a yearling. This male wolf was captured in January 2014 with a female wolf 781F in the Lower Slide Lake pack, which formed in 2013. This pack did not successfully reproduce in 2013, but has continued to maintain its territory. Field monitoring will determine whether these wolves successfully reproduce in 2014.

Wolf Population Monitoring on the Wind River Reservation

Capture and Radio-collaring

Two wolves were captured and radio-collared from the St. Lawrence pack for population monitoring purposes in 2013. At the end of 2013, 25% (3 wolves) of the known wolves in the Wind River Reservation were radio-collared, including 2 in the St. Lawrence pack and 1 in the Owl Creek pack.

Population and Breeding Pair Status

Currently, wolves are classified as a trophy game animal on tribal lands in the Wind River Reservation, for which there is no open season and legal take can only occur to defend life or property. Wolves have been present in the Wind River Reservation for at least 12 years and are currently distributed across the Wind River and Owl Creek mountain ranges (Figure 1 and Figure 4). The wolf subpopulation in the Wind River Reservation has been slowly increasing since 2007 (Figure 4). As of December 31, 2013, ≥12 wolves in ≥2 packs (St. Lawrence and Owl Creek) and ≥0 breeding pairs were documented on the Wind River Reservation (Table 1, Figure 1, and Figure 4). No radio-collared wolves had been in the St. Lawrence pack prior to 2013, when 2 wolves were captured and radio-collared. Based on telemetry data from the collared members of the St. Lawrence pack and their use of the area formerly assigned to the Bold Mountain pack, the Bold Mountain pack designation was discontinued and replaced by St. Lawrence. The East Fork pack also uses portions of the Wind River Reservation, but is assigned to WYO because the majority of its territory and denning activities occur outside the Wind River Reservation. Additional packs may have been present within the Wind River Reservation but were not documented in 2013.

Breeding likely occurred in the Owl Creek pack based on an increase in pack size between February when 3 wolves were documented and November when 10 wolves were counted during an aerial telemetry flight. Pups could not be confirmed for this observation because distinguishing pups from adults during late-year aerial observations is difficult. Six wolves were documented in the Owl Creek pack at the end of 2013, but only 1 could be verified as a pup so the Owl Creek pack was not confirmed as a breeding pair in 2013. The St. Lawrence pack was also suspected of producing pups based on a trail camera picture of a lactating female wolf taken in May 2013, but pups were not observed during subsequent telemetry flights and could not be

verified at the end of the year. A total of $21,000.00 was spent on wolf monitoring and management in the Wind River Reservation in 2013 ($18,000.00 by the USFWS Lander Fish and Wildlife Conservation Office and $3,000.00 by Tribal Fish and Game).

Mortality

One wolf from the East Fork pack was killed by other wolves on tribal lands in the Wind River Reservation in early 2013. This was the only wolf mortality documented on tribal lands in the Wind River Reservation in 2013 (Table 1).

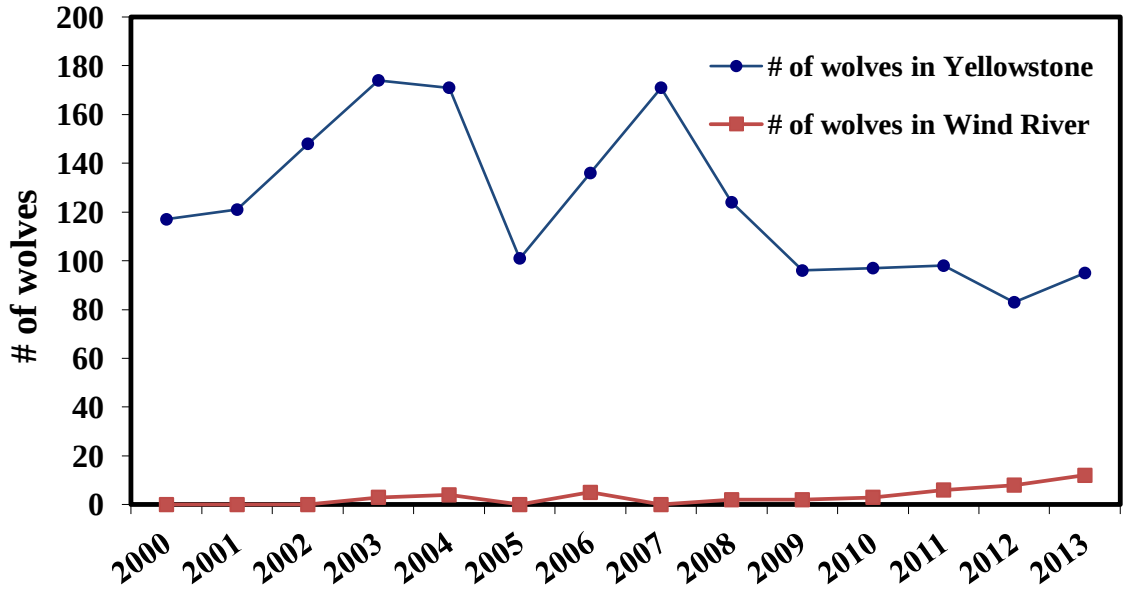

Figure 4. Wolf population trend in Yellowstone and the Wind River Reservation from 2000-2013.

Wolf Population Monitoring in Yellowstone National Park

Capture and Radio-collaring

Wolf collaring occurred during two time periods in 2013. Nine wolves in 4 packs were collared during February and early March. Seven wolves in 3 packs were collared during December in an early start to the 2013/2014 winter capture season. At year's end, 24% (21 wolves) of the wolf population was collared. Of the total 16 wolves captured and radio-collared in 2013 (7 females, 9 males), 9 were adults, 4 were yearlings, and 3 were pups. Both VHF and downloadable GPS collars were deployed.

Population and Breeding Pair Status

At the end of 2013, ≥95 wolves in ≥10 packs and one group (≥8 breeding pairs) occupied Yellowstone (Figure 1 and Table 3). This is higher than the 2012 count of 83 wolves and very similar to the previous 3 years where the population had stabilized around 100 wolves (Figure 4).

Breeding pairs increased from 6 the previous year. The wolf population has declined by about 50% since 2007 mostly because of a smaller elk population, the main food of northern range wolves (Figure 4). The interior wolf population has declined less, probably because they supplement their diet with bison. State-managed wolf hunts adjacent to Yellowstone continued in 2013 but did not decrease the wolf subpopulation found primarily within Yellowstone as it did in 2012. The severity of mange continued to decline in 2013, although some individuals still showed signs of the mite. There was no evidence of distemper being a mortality factor as it was in 1999, 2005 and 2008. Pack size ranged from 2 (Lamar Canyon and 755M/889F group) to 18 (8 Mile) and averaged 8.6, which is slightly smaller than the long-term average of 10.

Table 3. Confirmed wolf packs, population data, and depredation information for packs present in Yellowstone in 2013. (Note: The column "REF #" refers to the reference number in the NRM wolf annual report compiled by USFWS covering all states in the NRM wolf recovery area.)

REF #	WOLF PACK[1]	RECOV AREA	STATE	MIN. ESTIMATED PACK SIZE DEC 2013	DOCUMENTED MORTALITIES NATURAL	HUMAN[2]	UNKN[3]	HARVEST[7]	CONTROL[5]	KNOWN DISPERSED	MISSING[4]	CONFIRMED LOSSES[6] CATTLE	SHEEP	DOGS	OTHER
	Yellowstone National Park Northern Range														
185	8 Mile^	GYA	WY/MT	18											
186	Blacktail	GYA	WY	3			1								
187	Junction Butte	GYA	WY	9	1					1					
188	Lamar Canyon	GYA	WY	2			1			5	1				
189	755M/889F Group	GYA	WY	2											
	Misc/Lone wolves	GYA	WY		1										
	Northern Range Total			34	2	0	2	0	0	6	1	0	0	0	0
	Yellowstone National Park Non-Northern Range														
190	Bechler %	GYA	WY/ID	11											
191	Canyon	GYA	WY	8											
192	Cougar Creek	GYA	WY	13		1					1				
193	Mollie's	GYA	WY	7						2					
194	Snake River#	GYA	WY	9											
195	Yellowstone Delta#	GYA	WY	13						1					
	Misc/Lone wolves	GYA	WY	0	2										
	Non-Northern Range Total			61	2	1	0	0	0	3	1	0	0	0	0
YNP Total in WY		GYA	WY	95	4	1	2	0	0	9	2	0	0	0	0

1 Underlined packs are counted as breeding pairs toward recovery goals.
2 Excludes wolves killed in control actions and lawful harvest.
3 Does not include pups that disappeared before winter.
4 Collared wolves that became missing in 2013.
5 Includes agency lethal control under federal regulations. Includes wolves killed by private citizens to defend livestock or under terms of a lethal take permit.
6 Includes only domestic animals confirmed killed by wolves.
7 Number legally harvested by humans in 2013.
% Border pack with ID, denned in YNP, territory largely in YNP.
^ Border pack with MT, denned in MT, territory largely in YNP.
# Border pack with WY, denned in YNP, territory largely in YNP.

For the fifth consecutive year, population growth in Yellowstone has stabilized with just under 100 individuals in the population at the end of December (Figure 4). Down from the park-wide population peak in 2003 at 174, this stabilization suggests long-term lower population equilibrium for Yellowstone wolves, especially on the northern range (Figure 4). Northern range wolves have declined 60% since 2007 compared to only a 23% decline for interior wolves during the same period. Northern range wolves are much more dependent on elk as a food source than interior wolves that prey on elk and bison which are still a widely available in the interior of Yellowstone. 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) on the northern range compared to the interior where canid density was lower.

No packs were lost or added to the Yellowstone population in 2013. Previous to 2012, the Snake River pack existed at the south boundary of Yellowstone, but field observations and radio collar data revealed denning and regular use inside Yellowstone in 2012. In 2013, there were no collared wolves to monitor, but field observations and reports by National Park Service staff and

visitors indicate the pack produced pups at a traditional den and used a similar territory, hence its inclusion in the Yellowstone population count.

Nine out of 10 packs (90%), along with a temporary group (split from the Junction pack) produced pups in 2013. The average number of pups per pack in early winter (not including Snake River) for packs that had pups was 4.6, compared to 2.5 in 2012, 4.1 in 2011 and 4.8 in 2010. At least 41 pups in Yellowstone survived to the end of 2013, double those surviving in 2012. Only the Blacktail pack did not produce pups in 2013. A total of $193,000.00 was spent on monitoring and managing wolves in Yellowstone in 2013.

Mortality

Five radio-collared wolves from YNP packs died in 2013 inside the park. Intraspecific aggression was again the leading cause of natural mortality (3 deaths). The alpha female of the Blacktail Pack (693F) was found dead near the end of the year but decomposition and scavenger activity made it impossible to determine a cause of death. Wolf 860F's (suspected Lamar Canyon) mortality signal has not yet been investigated but she is inside the park boundary and believed to be dead. In addition, Wolf Project recorded two uncollared wolf deaths inside the park; one intraspecific and the other hit by a car on Highway 191 along the western boundary. No wolves were known to be harvested from packs living primarily in Yellowstone (Table 3). Effects of the harvest of wolves on reproduction, pack dynamics, and territory continue to be monitored. Wolves often quickly fill vacant biological and social niches that are a result of wolf losses from any cause.

Disease Monitoring

Our most active area of disease research this past year continued to be on sarcoptic mange, which reached epidemic proportions on the Northern Range in 2009. The mite is primarily transmitted through direct contact of an infected individual 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. In 2013, 2 out of 11 monitored packs in Yellowstone were infected and within these, prevalence ranged between 22-33%. Uninfected packs tended to be those in the interior of Yellowstone. Although the mange mite has been isolated from Yellowstone wolves in the past, we recently attempted additional skin scrapings without success in isolating the mite. Those efforts will continue. Despite our difficulty in isolating the mite, the hair-loss patterns are highly consistent with sarcoptic mange as opposed to other parasites that result in hair-loss.

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

MANAGEMENT

Wolf Management Statewide

In 2013, WGFD instituted a wolf hunting season with the biological objective to reduce the wolf population by approximately 5% in the WTGMA/Seasonal WTGMA and to provide recreational hunting opportunity to resident and nonresident Wyoming sportsmen. Wolf harvest was focused primarily in areas with high levels of historic wolf-livestock conflict and/or areas with relatively high wolf densities in an attempt to reduce livestock damage and excessive predation on ungulate herds. A mortality quota of 26 wolves was subdivided between 12 hunt areas (hunt areas) in WYO. Wolf hunting seasons were open from October 1, 2013 to December 31, 2013 with the exception of hunt area 12, which opened on October 15, 2013. A total of 23 wolves were legally harvested and 1 wolf was illegally killed during the hunting season. Wolves could also be taken in any legal manner in WYO where they are designated as predatory animals. Thirty-nine wolves were taken under predatory animal status in 2013.

Wolves were confirmed to have killed 75 head of livestock (41 cattle, 33 sheep, and 1 goat) and 1 dog in Wyoming in 2013. An additional 6 cattle, 2 sheep, 1 horse, 1 bison, and 1 dog were injured by wolves but survived. Sixteen packs (48% of 33 packs in Wyoming outside Yellowstone) were involved in $\geq$1 depredation in 2013. Of the 16 packs involved in $\geq$1 depredation; 9 packs (56%; 27% of packs in Wyoming outside Yellowstone) were involved in $\geq$2 depredations; and 6 packs (38%; 18% of packs in Wyoming outside Yellowstone) were involved in $\geq$3 depredations. Control efforts lethally removed 33 depredating wolves in an effort to reduce livestock losses due to wolves (11% of the wolf population in WYO known to be alive during 2013). A combined minimum of $157,195.60 was spent on wolf damage management in WYO by Wildlife Services ($60,957.80) and livestock depredation compensation by the State of Wyoming ($96,237.76) in 2013.

Wolf Management in WYO

Hunting

Wolf Hunting Season Background: The WGFD implemented regulated wolf hunting as a population management tool in WYO following removal of Endangered Species Act protections in 2012. Wolf hunting regulations (Wyoming Game and Fish Commission regulation Chapter 47: Gray Wolf Hunting Seasons) for 2013 were approved in July 2013 by the Wyoming Game and Fish Commission. Chapter 47 governs wolf hunting in WYO and was part of the management framework evaluated and approved by USFWS during the delisting process. Chapter 47 outlined specific hunt areas, mortality quotas, season dates, reporting requirements, and other wolf hunting regulations in areas of WYO where and when wolves were designated as trophy game animals (the WTGMA and the Seasonal WTGMA from October 15 to the last day of February of the subsequent year). Trapping was not permitted for wolves designated as trophy game animals in 2013. There were no hunting season dates or quotas for wolves occupying areas where and when they were designated as predatory animals and, accordingly, wolves could be hunted anytime without a license, in any legal manner in these areas. Trapping is a legal method of take for wolves designated as predatory animals. Chapter 47 included

reporting requirements for wolves taken in areas designated as predatory animals and required that radio-collars, if present, be surrendered to WGFD at the time the wolf was registered regardless of trophy game or predatory animal designation.

The Wolf Management Plan required the WGFD to delineate hunt areas smaller than the 4 hunt areas proposed in WYO in 2008. This focused harvest where wolf conflicts with livestock and/or ungulate herds may be occurring while allowing for lower levels of harvest in core population areas where conflicts were minimal. Multiple factors were considered in determining hunt areas boundaries including distribution of livestock conflicts, areas where wolf predation may be impacting ungulate herds, land status and ownership (e.g., private lands, national parks, national forest land, etc.), seasonal changes in wolf designation (i.e., Seasonal WTGMA), and boundaries that were easily recognizable by WGFD and hunters. Eleven hunt areas were delineated throughout the WTGMA to spatially distribute wolf mortality and hunter activity, and the Seasonal WTGMA was included as a 12th hunt area (Figure 5).

The WGFD held wolf hunting seasons in conjunction with fall big game hunting seasons. The majority of elk and/or deer seasons opened during mid-September and many elk seasons did not close until mid-November to late December, so open wolf hunting seasons were set from October 1 to December 31, 2013. The wolf hunting season in hunt area 12 (i.e., the Seasonal WTGMA) differed from the other 11 hunt areas and opened on October 15 (the date wolves changed from predatory to trophy game animal designation as prescribed by Wyoming state statute) to December 31, 2013. Wolf harvest was limited by mortality quotas established for each hunt area using a general license hunting structure in each hunt area. Legal and illegal wolf harvest during the open hunting season counted toward these mortality quotas. The season for each hunt area closed when the mortality quota was met or at the season end date, whichever occurred first.

Total wolf mortality quotas were set to reduce the population from ≥169 wolves at the end of 2012 to approximately 160 wolves and 14 breeding pairs in the 12 hunt areas at the end of 2013. The reduction in the mortality quota was the direct result of the measured response of the wolf population to wolf hunting in 2012 and the management goal of a 5% reduction in the wolf population in 2013 compared to an 11% reduction in 2012. The estimated human-caused mortality rate required to stabilize wolf population growth, natural mortality, estimated recruitment rates, and estimated non-harvest human-caused mortality rates (e.g., mortalities from control actions, illegal kills outside the hunting season, vehicle kills, etc.) were considered in the mortality quota calculation. The WGFD estimated the population would be reduced in the 12 hunt areas from 169 wolves at the beginning of 2013 to approximately 160 wolves at the end of 2013 if 36.7% of the wolves present at the beginning of 2013 died from all human-caused mortality, as predicted from the wolf population's measured response to wolf hunting in 2012. The average non-harvest human-caused mortality rate for the previous 3 years (21.0%) was then subtracted from 36.7% to obtain a 15.7% harvest rate, which equaled a total mortality quota of 26 wolves when applied to the minimum wolf population estimate of ≥169 wolves present in the 12 hunt areas at the beginning of 2013. The total quota of 26 wolves was then sub-divided among the 12 hunt areas. Hunt areas with larger wolf populations, higher levels of livestock conflicts, and/or those where impacts to ungulates were a concern received a larger proportion of the total quota. This approach has an objective to reduce wolf-livestock conflicts and predation

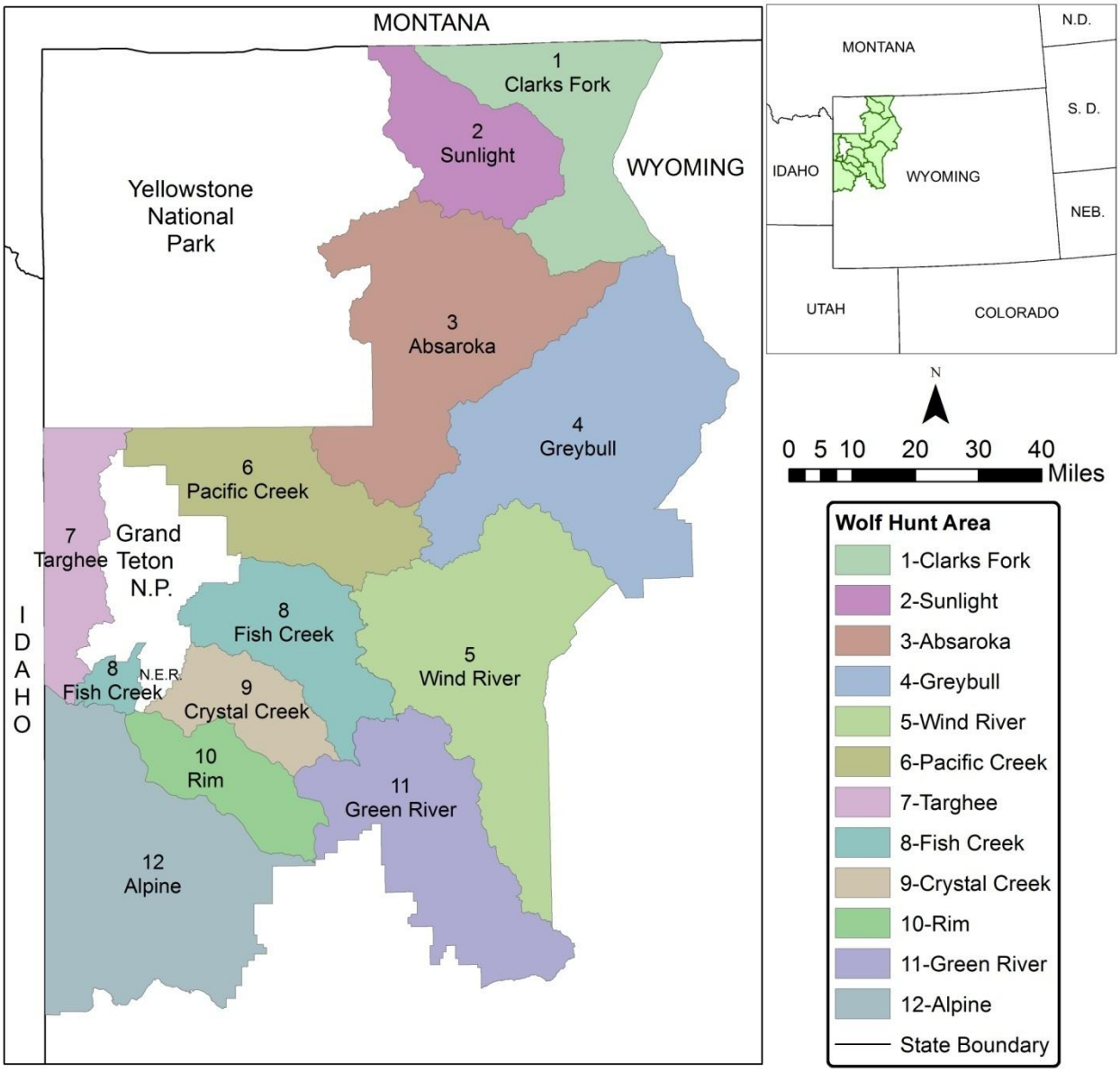

Figure 5. Hunt areas delineated for the 2012 and 2013 wolf hunting seasons in the WTGMA/Seasonal WTMGA in northwest Wyoming.

pressure on ungulate herds, however, monitoring will be required over several years to evaluate the relationship between wolf harvest and livestock depredation (see the *Livestock Depredation* section below).

Wolf Hunting in the WTGMA/Seasonal WTGMA: A total of 2,153 wolf hunting licenses (2,013 resident and 140 nonresident licenses) were sold for the 2013 wolf hunting season, less than half the number of licenses sold in 2012 (4,492 licenses). A total of 24 wolves out of the 26 wolf mortality quota were taken during open wolf hunting seasons in the 12 hunt areas, 1 of which was illegally killed during the hunting season and was applied to the mortality quota (Table 4). One of the 24 harvested wolves (4% of wolves taken) wore a functioning radio-collar, which was

much less than the proportion of radio-collared wolves in the population (~21% of the WYO population was collared prior to the 2013 hunting season) suggesting that there was not hunter selection for collared wolves. One additional wolf was taken that was wearing a non-functional radio-collar. The majority of hunters who legally harvested a wolf complied with reporting and registration requirements, including submission of a genetics sample.

Table 4. Summary of hunting seasons and wolf harvest in WYO in 2013; available online on the WGFD website at:
http://wgfd.wyo.gov/web2011/HUNTING-1001852.aspx

WOLF HUNTER HARVEST SUMMARY 2013						1/2/2014 3:00 PM
Note:	Hunt Areas in red indicate total harvest is at or above quota.					
	HUNT AREA	QUOTA FROM REGS	SEASON DATES GENERAL	HARVEST COUNTED TOWARDS QUOTA *1	AREA STATUS	DATE/TIME AREA CLOSED
	1	2	Oct 1 - Dec 31	2	CLOSED	11/10/2013 @ 11:00 AM
	2	4		5	CLOSED	10/13/2013 @ 1:30PM
	3	3		3	CLOSED	10/20/2013 @ 12:15 PM
	4	2		2	CLOSED	10/27/13 @ 2:30 PM
	5	3		3	CLOSED	10/8/2013 @ 11:50 AM
	6	3		3	CLOSED	12/22/13 @ 7:20 PM
	7	0		0	CLOSED	Closed in 2013
	8	4		4	CLOSED	12/26/2013 @ 1030
	9	1		0	CLOSED	12/31/13 per regulations
	10	1		1	CLOSED	10/1/2013 @ 11:35 AM
	11	2		1	CLOSED	12/31/13 per regulations
	12	1	Oct 15 - Dec 31	0	CLOSED	12/31/13 per regulations
	Total 2013 Trophy Quota	26	Total 2013 Trophy Harvest	24		
STATE WIDE	PREDATORY	No Quota	Total 2013 Predator Zone Harvest	39		

*1 All legal or illegal human-caused gray wolf mortalities associated with hunting during the open season will be counted towards the quota. One wolf was illegally killed while the hunting seasons were closed in 2013. All mortalities will be factored into the 2013 minimum wolf population estimate. For further information on specific non-hunting caused mortalities see the Wyoming Gray Wolf Management Month Updates at: http://wgfd.wyo.gov/web2011/wildlife-1000380.aspx

This will be updated when a wolf harvest is reported.

One hunt area (7) was closed for the duration of the wolf hunting season (quota of 0), 8 of the 12 hunt areas closed once the mortality quota in those hunt areas was met and 3 hunt areas closed on the season end date of December 31, 2013 (Table 4). The quota was exceeded by 1 wolf in hunt area 2 because 3 wolves were taken within 24 hours in different locations when only 2 wolves were remaining on the mortality quota (Table 4). Harvest was well distributed spatially across hunt areas, with trophy game harvest occurring in 14 of 27 packs (52%) that regularly use the 12 hunt areas and 3 wolves from unknown pack origin. Of the 14 packs that had ≥1 wolf harvested, 10 packs had 1 wolf harvested (72%), 2 packs had 2 wolves harvested (14%), and 2 packs had 3 wolves harvested (14%). Harvest occurred primarily in October (74%) during elk hunting seasons, declined in November (4%) and increased again in December (22%) prior to the end of the hunting season on December 31. There was little difference between the gender (13M vs. 10F), or the color of harvested wolves (12 black vs. 11 gray). Few adult wolves (>2 years old) and nearly equal proportions of subadults (1-2 years old) and pups (>1 year old) were harvested (3 adults vs. 9 subadults vs. 11 pups). No known wolves from trans-boundary packs that were assigned to Yellowstone at the end of 2013 were harvested in WYO during the wolf hunting season.

Development of 2014 Wolf Hunting Seasons: Evaluation of the 2013 wolf hunting season data demonstrated the hunting strategy in 2013 did not reduce the wolf population as intended (5% increase vs. 5% predicted decline). As stated earlier, multiple factors were responsible for this such as wolf population resiliency to harvest, pup production and recruitment, reduced removal due to depredation, and lower harvest. The historic data for the wolf population in Wyoming suggests a significant negative relationship between wolf population size in the 12 hunt areas and the level of human-caused mortality that would be required to stabilize the population (Figure 6). This relationship demonstrates a typical case where the resilience to any mortality cause is high when the population is at moderate levels, but is reduced as the population increases toward carrying capacity. It was necessary, however, for the WGFD to determine whether this relationship would continue to be valid for the wolf population in the 12 hunt areas following the initiation of wolf hunting prior to using this data for developing future wolf hunting seasons. The WGFD will continue to evaluate and utilize this information as appropriate when setting wolf hunting seasons in future years.

Wolf hunting regulations are revised annually using an adaptive management approach that includes internal review within the WGFD and an extensive public input process. Data collected during the previous and current year will be evaluated and then used to develop 2014 wolf hunting regulations, including the response of the population to wolf hunting seasons in 2012 and 2013. This data and other commitments made in the Wolf Management Plan and regulatory documents will be used to develop responsible, appropriate, and scientifically defensible wolf hunting seasons in 2014 that will ensure the wolf population remains above minimum delisting criteria. The Wyoming Game and Fish Commission will finalize the 2014 wolf hunting regulations in July 2014. This approval date will allow WGFD to use the most relevant and recent data possible when developing wolf hunting season regulation recommendations.

Wolf Hunting Outside the WTGMA/Seasonal WTGMA: We include all wolves taken as a predatory animal by the public, predator boards, or agencies not in response to a specific and recent wolf-livestock conflict as hunting mortality for the purposes of this report. A total of 39

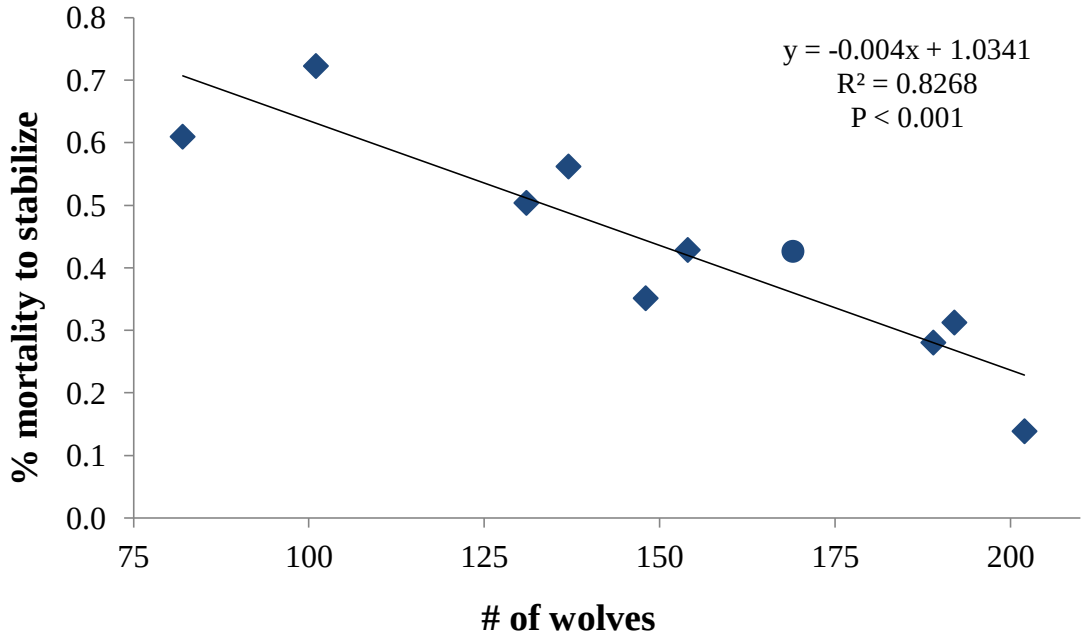

Figure 6. Relationship between the number of wolves in the 12 wolf hunt areas and the percent human-caused mortality that would have resulted in stabilization of the wolf population for calendar years 2004-2013. The data point for 2013 is depicted as a circle to allow for specific identification.

wolves were taken under predatory animal designation in 2013 (Table 4). Four of the 39 harvested wolves (10% of wolves taken) were wearing functional radio-collars, which was half the proportion of radio-collared wolves in the population (~21% of the WYO population was collared prior to the 2013 hunting season). An additional 2 wolves were taken that were wearing non-functional radio-collars. All persons who harvested a wolf under predatory animal designation complied with reporting requirements during 2013. Most wolves taken under predatory animal designation were on private lands (59%). Wolves were also taken on US Forest Service lands (25%), state lands (8%), or Bureau of Land Management lands intermixed with private lands (8%). Two wolf packs (East Fork, Horse Creek) had wolves harvested under both predatory animal and trophy game animal status. Wolves killed as predatory animals were taken using firearms (32 wolves, 82%) and traps (7 wolves, 18%). Tissue samples were voluntarily submitted for 37 of 39 wolves taken as predatory animals and will be included in the evaluation of genetic interchange between recovery areas. Slightly more female wolves were taken than males (17M vs. 22F) and there was no difference between the pelage color of wolves harvested (20 black vs. 19 gray). Most wolves taken as predatory animals were adults and subadults (21 adults vs. 15 subadults vs. 3 pups), which is expected because the majority of wolves outside the WTGMA/Seasonal WTGMA are likely to be single dispersing wolves or members of small establishing packs that did not produce pups in 2013. Few wolves have successfully formed packs and reproduced outside the WTGMA/Seasonal WTGMA even after 18 years of Endangered Species Act protections because of wolf removals in response to chronic livestock damage.

Livestock Depredation

From 2000-2009, the WYO wolf population increased annually, then stabilized between 200 and 250 wolves from 2010-2011 (Figure 7). During this period of wolf population growth, wolves also expanded in range and recolonized new areas. Beginning in 2006, the USFWS switched to a more aggressive approach to wolf control following confirmed livestock depredation, leading to a decrease in the number of livestock losses despite an increase in the overall wolf population. Since 2000, wolves have commonly recolonized areas outside the WTGMA/Seasonal WTGMA, but have rarely persisted more than a year or 2 before being removed for confirmed livestock depredation. The state of Wyoming developed its wolf management framework to restrict wolf range expansion into areas of unsuitable habitat and high livestock density by designating wolves as predatory animals in these areas. Predatory animal designation is a tool that allows livestock producers more flexibility in protecting their livestock as well as liberal public harvest of wolves where conflicts are common. In general, wolves living in areas with relatively high native ungulate densities and relatively low exposure to domestic livestock have caused fewer conflicts with livestock than wolves that recolonized areas of unsuitable habitat where large numbers of livestock grazed on private and public lands, especially those areas outside the WTGMA.

During 2013, reported livestock depredations in WYO were investigated by WGFD or Wildlife Services. Only confirmed depredations were documented in this report and are based on specific criteria within Wyoming Game and Fish Commission regulation (Chapter 28) requiring confirmed evidence at the scene or on the livestock carcass indicating wolves were responsible for the death of the individual livestock. In the majority of confirmed cases, this evidence includes bite marks from wolves with pre-mortem hemorrhaging and tissue damage on the livestock carcass affirming that wolves were directly responsible. All reported livestock damage is investigated in the WTGMA and Seasonal WTGMA and should provide consistent year to year comparisons for the number of wolf depredations occurring in these areas. In these areas, all suspected livestock depredation caused by wolves that is discovered is expected to be reported because verification is required to qualify for compensation or for control actions to be undertaken. Reporting and investigation of livestock depredation by wolves designated as predatory animals year-round is incomplete because compensation is not offered for livestock killed by wolves and verification of depredation is not required for the public, predator boards, or cooperating agencies to initiate wolf control actions in this area. Therefore, the number of confirmed wolf depredations where wolves are designated as predatory animals year-round as presented in this report should be considered as a minimum. (The following livestock depredation statistics were based on confirmed livestock losses only.)

In 2013, wolves in WYO were responsible for killing 74 head of livestock and 1 dog (Table 5 and Figure 7). Confirmed livestock depredations included 40 cattle (33 calves and 7 cows/yearlings), 33 sheep (15 adults and 18 lambs), and 1 goat (Table 1 and Table 5). An additional 6 cattle, 2 sheep, 1 horse, 1 bison, and 1 dog were confirmed to have been injured by wolves but, to the knowledge of personnel involved, these animals recovered from their injuries. Confirmed cattle depredations were slightly lower and sheep depredations were >3x lower in 2013 compared to 2012 despite the small increase in the wolf population (Table 5 and Figure 7). The only category where damage caused by wolves increased was livestock injured by wolves but not killed in 2013 compared to 2012 when 5 calves and 1 dog were injured.

Management actions in response to confirmed livestock depredations included trapping and radio-collaring wolves, intensive monitoring, lethal removal through agency control actions, and issuance of 22 lethal take permits to livestock producers (15 initial permits, 7 of which were renewed due to continued livestock damage). Two wolves were killed in 2013 under the authority of lethal take permits. An additional 2 wolves were killed for defense of private property as provided in state statute and regulation. Non-lethal control was routinely considered, but was often not applicable or cost-effective in many areas in WYO 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 covered vast areas including very large grazing allotments. In instances when non-lethal control methods were ineffective, wolves were removed through agency control actions in an attempt to prevent further livestock depredations. In addition to monies spent by WGFD, Wildlife Services spent $60,957.80 to investigate possible depredations and conduct control actions.

Table 5. Confirmed livestock and dog depredations and number of wolves killed in control actions in WYO from 2000-2013.

Depredations	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cattle	3	18	23	34	75	54	123	55	41	20	26	35	44	40
Sheep	25	34	0	7	18	27	38	16	26	195	33	30	112	33
Dogs	6	2	0	0	2	1	1	2	0	7	0	1	3	1
Goats	0	0	0	0	10	0	0	0	0	0	0	0	0	1
Horses	0	0	0	2	0	1	0	1	0	0	1	1	1	0
Total Depredations	34	54	23	43	105	83	162	74	67	222	60	67	160	75
Wolves Controlled	2	4	6	18	29	41	44	63	46	31	40	36	43	33

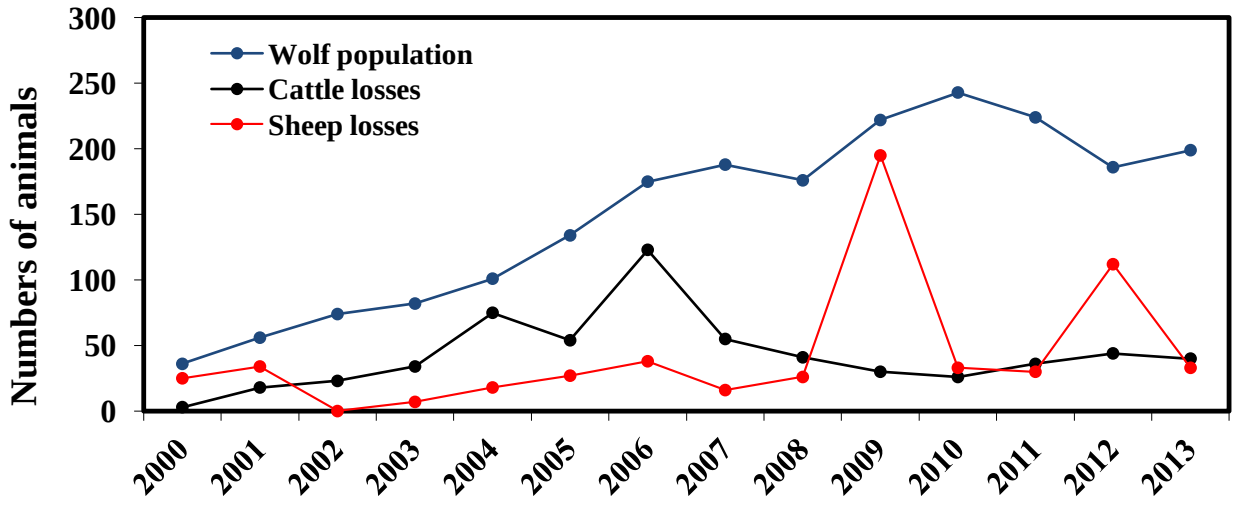

Figure 7. Annual wolf population size and number of confirmed cattle and sheep depredations/year in WYO from 2000-2013.

Number of Packs Involved in Confirmed Depredations: Fifteen packs (47% of 32 packs) in WYO were involved in ≥1 depredation in 2013 including Dog Creek which was not confirmed at the end of 2013 and Owl Creek which was assigned to the Wind River Reservation but killed

livestock in WYO in 2013 (Table 1 and Figure 8). Of the 15 packs involved in ≥1 depredation; 9 packs (60%; 28% of packs in WYO) were involved in ≥2 depredations; and 6 packs (40%; 19% of packs in WYO) were involved in ≥3 depredations. A total of 14 packs were involved in confirmed cattle depredation, of which the Green River and Blackrock packs were each responsible for 18% of cattle depredations (7 cattle each), and combined were responsible for 36% of the total confirmed cattle depredations. The Dog Creek pack was responsible for 58% of sheep depredations (19 sheep), with the Prospect pack and unknown wolves in Sweetwater County, WY responsible for 7 sheep depredations each (21% of sheep depredations each). All of the packs responsible for sheep depredation occupied areas with high domestic sheep numbers outside the WTGMA.

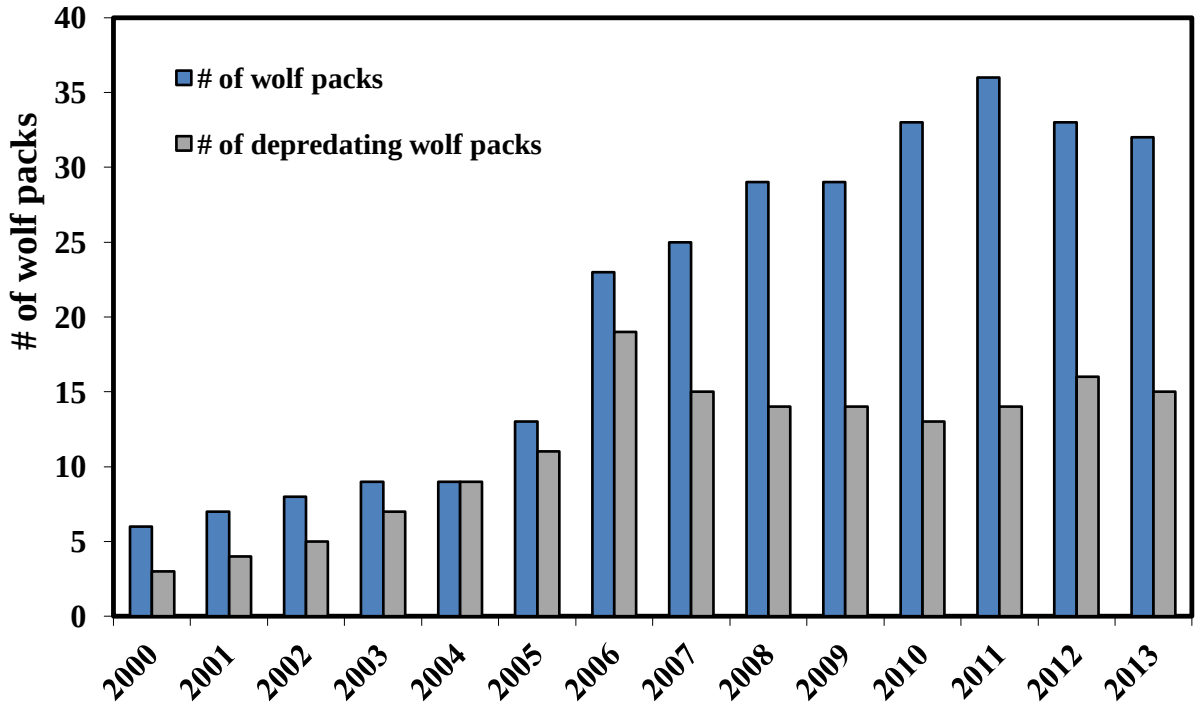

Figure 8. Annual number of wolf packs and number of wolf packs that were involved in ≥1 confirmed livestock depredation/year in WYO from 2000-2013.

Seasonal Trend in Livestock Depredations: Confirmed cattle depredation followed a seasonal pattern in 2013 that differed from 2011 and 2012. Depredation began in March and was higher in April and May during spring calving than in past years (Figure 9). Cattle depredation in June was low and increased in late summer and declined in autumn similar to past years (Figure 9). Sheep depredations began in March 2013, which was earlier than in 2011-2012. Sheep depredations continued in June through August but did not peak as they did during the previous 2 years (Figure 10). The seasonal trend in depredations, with the exception of higher cattle depredation in the spring of 2013, compared to other years and followed the pattern of open range summer grazing of livestock where livestock are distributed over large grazing allotments during the summer and autumn overlapping wolf distribution in northwest Wyoming.

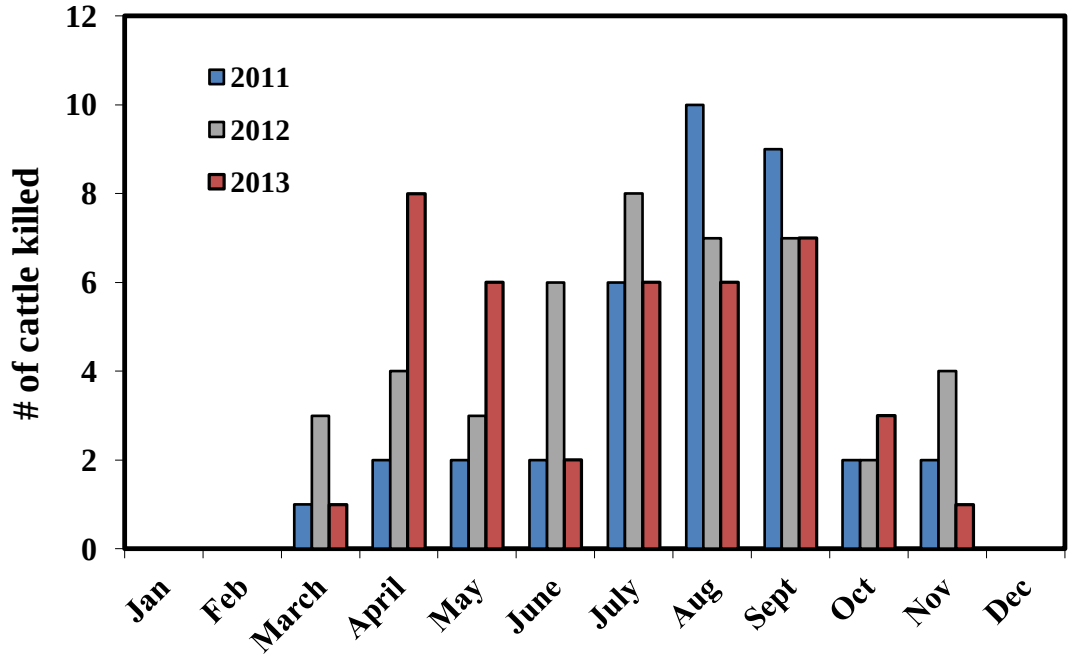

Figure 9. Number of confirmed cattle depredations/month by wolves in WYO from 2011-2013.

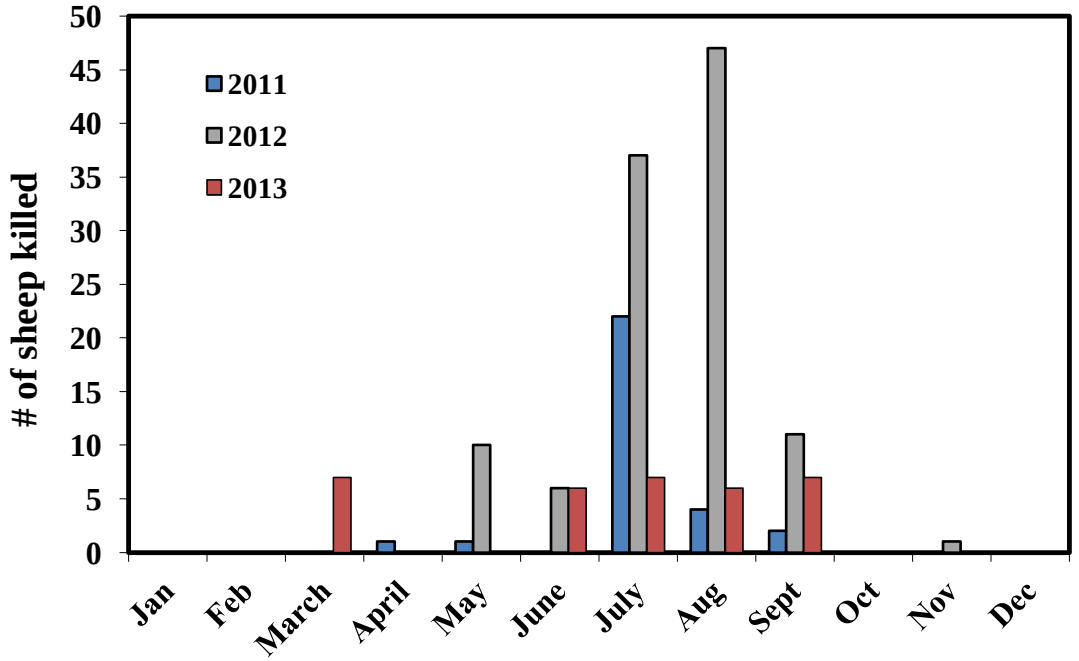

Figure 10. Number of confirmed sheep depredations/month by wolves in WYO from 2011-2013.

Location of Livestock Depredations: In 2013, 61% (45 livestock) of all confirmed wolf depredations (12 cattle and 33 sheep) were on public land and 39% (29 livestock) of all depredations (28 cattle and 1 goat) were on private land (Figure 11). Thirty percent (12 cattle) of

confirmed cattle depredations were on public land and 70% (28 cattle) of cattle depredations were on private property (Figure 11). All confirmed sheep depredations in 2013 occurred on public land (Figure 11).

In 2013, confirmed cattle depredations occurred in all but 3 hunt areas (hunt areas 2, 6 and 12). Confirmed sheep depredations occurred primarily in hunt area 12 (58% of confirmed sheep depredations), which is the Seasonal WTGMA, and in areas of the state where wolves are designated as predatory animals year-round (42% of confirmed sheep depredations: Table 6).

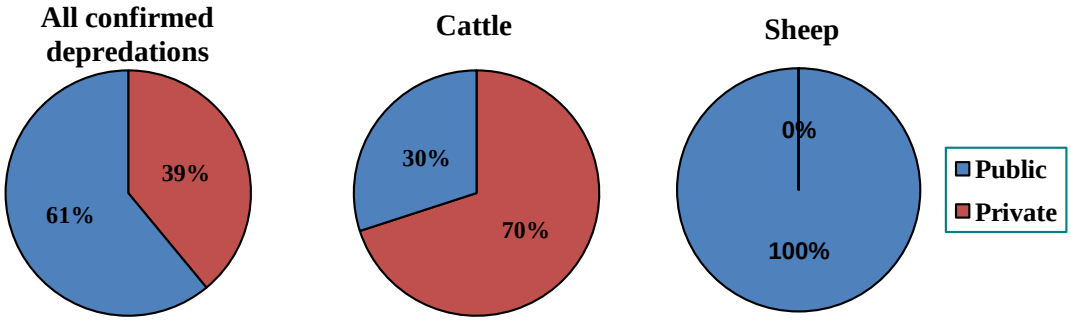

Figure 11. Land status where confirmed wolf depredations occurred in 2013.

Table 6. Confirmed cattle and sheep depredations in WYO by wolf hunt area ("WHA") and in areas of the state where wolves are designated as predatory animals ("Pred") in 2013.

WHA	1	2	3	4	5	6	7	8	9	10	11	12	Pred	Total
Cattle	3	0	5	5	4	0	1	3	7	1	7	0	4	40
Sheep	0	0	0	0	0	0	0	0	0	0	0	19	14	33
Total	3	0	5	5	4	0	1	3	7	1	7	19	18	73

Compensation for Livestock Depredations: The WGFD paid $96,237.76 to compensate livestock producers who lost livestock to wolves during 2013. Compensation payments were made entirely from state funds; no federal funds were available in 2013. Wyoming Game and Fish Commission regulation Chapter 28 and state statute authorizes compensation only for damage that occurs in the WTGMA/Seasonal WTGMA. Livestock depredations in areas of the state where wolves are designated as predatory animals year-round are not eligible for compensation under statute or Wyoming Game and Fish Commission regulation Chapter 28.

Unacceptable Impacts to Ungulates or Elk Feedgrounds

Under the Wolf Management Plan, state statute, and Wyoming Game and Fish Commission regulation Chapter 21, WGFD may lethally remove wolves when it is determined that "wolf predation is causing an unacceptable impact on a wild ungulate population or herd" or when a "wolf-wild ungulate conflict has occurred at any state operated elk feedground." An "unacceptable impact on a wild ungulate population or herd" is defined in Chapter 21 as:

> "Unacceptable impact on a wild ungulate population or herd" means any decline in a wild ungulate population or herd that results in the population or herd not meeting the Commission population management goals, objectives or recruitment levels established for the population or herd. The Department shall determine whether a decline in a wild ungulate population or herd constitutes an "unacceptable impact" and whether wolf predation is a significant factor causing the "unacceptable impact" based upon the best scientific data and information available.

In addition, under Chapter 21, wolves may be lethally removed for conflicts caused at state-operated elk feedgrounds only "when a gray wolf or wolves displace elk from a feedground and it results in one of the following conflicts:"

1. Damage to private stored crops by displaced elk; or,
2. Elk co-mingling with domestic livestock; or,
3. Displacement of elk from a feedground onto a highway right of way causing human safety concerns.

No agency directed lethal removal actions (hunting seasons aside) were taken in 2013 to address unacceptable impacts on a wild ungulate population or herd or to address wolf-caused conflicts on state-operated feedgrounds. Wolves from the Horse Creek pack displaced elk from the Horse Creek elk feedground onto adjacent private land where they caused damage and also displaced elk from the Camp Creek elk feedground into areas closely adjacent to US Highway 189/191 south of Jackson, WY on many occasions in early 2013. Instead of conducting lethal removal, the WGFD erected dynamic message signs to warn motorists of elk on the roadway in this general area and the landowner was reimbursed for damages caused by elk displaced onto his property. Analyses of impacts to ungulate populations remain an integral part of ongoing management of wolves and their prey in Wyoming.

Wolf Management on the Wind River Reservation

Currently, wolves are classed as a trophy game animal on the Wind River Reservation for which there is no open season and legal take can only occur to defend life or property. Reported livestock depredations by wolves are investigated by Tribal Fish and Game. One calf was confirmed to have been killed by the St. Lawrence pack in summer 2013. No other depredations were reported or confirmed. No wolves were killed in management actions or by the public in defense of life or property in 2013.

Wolf Management in Yellowstone

Area Closures

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

Wolf Road Management Project

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

Yellowstone staff established the Wolf Road Management Project 14 years ago 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 2013 season (18,822 people) even though the summer season was characterized by only moderate wolf-viewing opportunities.

Habituated Wolves

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

RESEARCH

Wolf Research in WYO

Research Completed in 2013

Middleton, A.D., M.J. Kauffman, D.E. McWhirter, M.D. Jimenez, J.G. Cook, R.C. Cook, S.E. Albeke, H. Sawyer, and P.J. White. 2013. Linking antipredator behavior to prey demography reveals limited risk effects of an actively hunting large carnivore. Ecology Letters 16:1023-1030.

Stephenson, J., M. Jimenez, S. Dewey, and S. Cain. In preparation. Wolf predation patterns in an area of low winter elk density in northern Jackson Hole.

Wyoming Game and Fish Department. Change in elk cow:calf ratio during the winter period in the Upper Gros Ventre and Upper Green River drainages. (Note: this research/survey effort was discontinued because the dynamic movements of elk within the Upper Gros Ventre drainage prevented reliable data from being collected throughout the winter period. Alternative research is planned in this area for the future)

Ongoing Research

Title: Winter wolf predation patterns in Grand Teton National Park, WY.
Collaborators: J. Stephenson, S. Dewey, and S. Cain, Grand Teton; M. Jimenez, USFWS.
Description: This research is a continuation of previous winter wolf predation research in Grand Teton and is aimed at investigating winter wolf predation patterns on wolf packs that inhabit portions of Grand Teton through 2014.

Title: Summer wolf predation patterns in Grand Teton National Park, WY.
Collaborators: J. Stephenson, S. Dewey, and S. Cain, Grand Teton; M. Jimenez, USFWS.
Description: In 2011 and 2012, Grand Teton personnel documented summer predation patterns of the Phantom Springs pack with the aid of GPS collars. This research will continue in 2013, with an expected completion date of 2014.

Title: Wolf predation on ungulates in the Upper Gros Ventre River drainage.
Collaborators: Wyoming Game and Fish Department
Description: This research is aimed at measuring wolf kill rates and predation characteristics on ungulates in the Upper Gros Ventre River drainage. The WGFD captured 4 wolves in packs present in the Upper Gros Ventre River drainage in March 2014 and fitted them with GPS collars to study specific wolf predation characteristics and their potential impacts on ungulate prey populations. Information will be used to guide management of wolves and ungulates, specifically elk, in the region. This project will occur in conjunction with a study evaluating predation by mountain lions in the same area in order to further understand predator-prey relationships in multiple predator/prey systems and how this information can be used to better manage overlapping conspecific species.

Title: Comparative Demography of Two Moose Populations with Contrasting Predator Densities.
Collaborators: B. Oates, M. Kauffman, K. Monteith, University of Wyoming and Wyoming Cooperative Fish and Wildlife Research Unit; J. Goheen, University of Wyoming; G. Fralick, A. Courtemanch, S. Smith, WGFD; G. Hanvey, United States Forest Service-Bridger-Teton National Forest.
Description: Quantifying the relative influence of wolf and grizzly bear density on the demography of two moose herds (Sublette and Jackson) in the southern GYE, while accounting for the influence of winter severity, spring green-up of vegetation, summer drought, habitat quality, and the effect of the 1988 Yellowstone fires. Project is expected to be completed by summer of 2015.

Title: Evaluating moose behavioral response to wolf presence in the southern Greater Yellowstone Ecosystem.
Collaborators: B. Oates, J. Goheen, M. Kauffman, and K. Monteith, Wyoming Cooperative Fish and Wildlife Research Unit; S. Dewey, S. Cain, and J. Stephenson, Grand Teton; M. Jimenez, USFWS.
Description: Planned research will use existing datasets to test how wolf presence influences Shiras moose habitat selection and movement rates. An enhanced understanding of such indirect risk effects will improve predictions about the potential demographic effects moose experience

as a function of predation risk by wolves in the Greater Yellowstone Ecosystem (GYE). Project is expected to be completed by end of 2015.

Wolf Research in Yellowstone

Research Completed in 2013

Cassidy, K. 2013. Group composition effects on interpack aggressive interactions of gray wolves in Yellowstone National Park. M.S. Thesis, University of Minnesota, pp. 59

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

Ongoing 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 18 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.

Elk Research. As part of a NSF – LTREB awarded to the Yellowstone Wolf Project in 2012, a long-term study of wolf impacts on the Northern Range elk population continues in collaboration with Dr. Dan MacNulty (Utah State), Dr. John Vucetich (Michigan Tech), and Dr Tim Coulson (Oxford). This work has developed into a large-scale project consisting of two objectives: 1) to determine the influence of wolf predation on the survival, recruitment, and age structure of NR elk herd, and 2) determine the relative influence of top-down and bottom-up factors on the movement of elk in Northern Yellowstone, and to evaluate the influence of these movement patterns on elk survival and reproduction. We are now tracking over 75 elk instrumented with both satellite GPS and VHF radio-collars. Collared elk are monitored for survival and calf recruitment throughout the year.

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

Pelican Valley Wolf, Grizzly Bear, and Bison. Starting in 1999, the 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 is 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 monitor Yellowstone packs for courtship and breeding behaviors. The opportunity to study breeding behavior in wild wolves is unprecedented, and this study is designed to investigate the role of interacting social and ecological factors influencing individuals' attempts to breed and their relative fitness consequences.

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 10-20 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 regional population genetic structure, evolutionary history and selection for coat color, evolution of life history traits, effect of kinship on breeding strategies, territoriality and strife. Additionally, whole genome sequencing on Yellowstone wolves is underway 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 Yellowstone 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.
Wolf-Prey Relationships

Collaborative Research

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

Title: Elucidating evolutionary processes in North American gray wolves: demographic history, coat coloration, and ecotype-specific selection.
Graduate Student: Rena M Schweizer, PhD Candidate

Committee Chair and University: Dr. Robert K Wayne, Department of Ecology and Evolutionary Biology, University of California, Los Angeles

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

Title: Survival of Northern Rocky Mountain wolves: Phase II
Graduate Student: Jack Massey, PhD student
Committee Chair and University: Dr. Tim Coulson, Department of Zoology, University of Oxford.

Title: Groups and mortality: their effects on cooperative behavior and population growth in a social carnivore
Graduate student: David Ausband, PhD student
Committee Chair and University: Dr. Michael S. Mitchell, Advisor, University of Montana, Wildlife Biology Program

Title: Influence of top-down and bottom-up forces on movement and habitat use of northern Yellowstone elk.
Graduate Student: Michel T. Kohl, PhD student
Committee Chair and University: Dr. Daniel R. MacNulty, Department of Wildland Resources, Utah State University.

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

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

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

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

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

OUTREACH

Outreach in WYO

In 2013 WGFD, personnel gave numerous formal presentations on wolf biology, monitoring, and management to the general public, special interest groups, civic organizations, and other agencies and associations, including 9 public information gathering meetings discussing proposed regulatory changes for wolves in WYO. The WGFD also met with multiple conservation and sportsmen's non-government organizations and several interested members of the public to discuss the status of the wolf population in Wyoming and wolf hunting season proposals. The WGFD conducted 9 Living in Lion, Bear, and Wolf Country Workshops attended by almost 400 people across western Wyoming where information on wolf biology and ecology and safety, primarily in regards to dogs and other pets was presented. WGFD personnel were also interviewed for many magazine, newspaper, and television feature stories. As part of normal wolf monitoring and management activities, WGFD personnel interacted with members of the public on a daily basis and made every effort to make these interactions positive and informative to increase the public's involvement and understanding of wolf monitoring and management throughout Wyoming.

In 2012, the WGFD, in cooperation with the Wyoming Animal Damage Management Board, produced a brochure titled, "Wolves in Wyoming: A Guide for Livestock Producers". This brochure continues to provide important and accessible guidance for livestock producers who experience damage to livestock caused by wolves. The brochure is available at WGFD regional offices or by download at the following link:

http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/WOLF_LIVESTOCK_BROCHURE0003179.pdf

Outreach on the Wind River Reservation

One school presentation to 20 5th graders and 5 adults was conducted by USFWS Lander Fish and Wildlife Conservation Office and TFG personnel on ecology of wolves and other wildlife on a field trip to the Dinwoody Lakes area.

Outreach in Yellowstone

Yellowstone Wolf Project staff gave 265 formal talks and 82 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 an estimated 18,000 people view wolves, making 18,822 visitor contacts and giving over 600 informal talks in the field.

CONTRIBUTORS

Many personnel contributed to the content of the 2013 Wyoming Wolf Population Monitoring and Management Annual Report. Thanks go to all those who contributed.

Information presented in this report for the wolf population in WYO:

- WGFD: Ken Mills and Robert Trebelcock
- Grand Teton: Sarah Dewey and John Stephenson
- Wildlife Services: Rod Krischke, Craig Acres, Rod Merrell, and Jim Pehringer

Information presented in this report for the wolf population on the Wind River Reservation:

- USFWS Lander Fish and Wildlife Conservation Office: Pat Hnilicka
- Tribal Fish and Game: Ben Snyder

Information presented in this report for the wolf population in Yellowstone:

- National Park Service: Doug Smith, Dan Stahler, Erin Stahler, Matthew Metz, Kira Quimby, Rick McIntyre, Caitlin Ruhl, and Molly McDevitt

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WYO

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Wind River Reservation

We gratefully acknowledge the following for their assistance with wolf conservation: Mike Mazur, Courtney Grantham, and Laurie Connell (USFWS), Western Thayer, Ken Smith, Ben Warren and Lynelle Shakespeare (Tribal Fish and Game), Bob Trebelcock and Ken Mills (WGFD). We gratefully appreciate the WGFD for conducting and financing aerial telemetry surveys on the Wind River Reservation and Mike Jimenez of USFWS for providing trapping expertise and trap transmitters.

Yellowstone

We thank the paid and volunteer staff who assisted in monitoring Yellowstone wolves in 2013, including Charly Arney, Aidan Beers, Cheyenne Burnett, Brenna Cassidy, Lizzie Cato, Sara Eno, Cayley Faurot-Daniels, Elizabeth Flesch, Shannon Forshee, Dane Horowski, Lisa Koitzsch, Ky Koitzsch, Peter Mumford, Brandon Navratil, Kameron Perensovich, Daniel Perret, Kersten Schnurle, Yasaman Shakeri, Aimee Tallian, Eric Torvinen, Jamie Walton, Ryan Wilber, and Travis Wyman. Both paid and volunteer technicians were supported by funding provided by the Yellowstone Park Foundation.

We continue to be impressed by and thank the many interested people who come forward every year to work with and help Yellowstone wolves. First and foremost are the Wolf Project staff including volunteers, whom without we would accomplish much less. The Yellowstone wolf watching community over the years has always helped when they can and to them we are appreciative. We also thank the many generous individuals, foundations and organizations that have provided approximately $5 million in grants through the Yellowstone Park Foundation to the Wolf Project since 1996. Continued support from Canon U.S.A, Inc., and anonymous donor, The Tapeats Fund, the Twin Spruce Foundation, the Perkin-Prothro Foundation, the participants in the wolf collar sponsorship program, and the National Science Foundation grants DEB-0613730 and DEB-1245373 are also critical to our success and we thank all of those mentioned above.

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