Wyoming Gray Wolf Monitoring and Management: 2021 Annual Report

Prepared by the Wyoming Game and Fish Department in cooperation with the National Park Service, U.S. Fish and Wildlife Service, USDA-APHIS-Wildlife Services, and Eastern Shoshone and Northern Arapahoe Tribal Fish and Game Department to report the status and management of the gray wolf population in Wyoming from January 1, 2021 through December 31, 2021.

EXECUTIVE SUMMARY

At the end of 2021, the gray wolf (wolf) population in Wyoming remained above minimum recovery criteria, making 2021 the 20th consecutive year Wyoming has exceeded the numerical, distributional, and temporal recovery criteria established for wolves by the U.S. Fish and Wildlife Service. At least 314 wolves in ≥40 packs (including ≥23 breeding pairs) inhabited Wyoming statewide on December 31, 2021. Of the total, there were ≥161 wolves and ≥24 packs (including ≥14 breeding pairs) in the Wolf Trophy Game Management Area (WTGMA), ≥97 wolves and ≥8 packs (including ≥6 breeding pairs) in Yellowstone National Park, ≥17 wolves and ≥3 packs (including ≥2 breeding pairs) in the Wind River Reservation, and ≥39 wolves and ≥5 packs (including ≥1 breeding pair) resided in areas where wolves are designated primarily as predatory animals in Wyoming. A total of 107 wolf mortalities were documented statewide in Wyoming in 2021: 62 in the WTGMA, 38 in areas where wolves are primarily designated as predatory animals, 6 in Yellowstone National Park, and 1 in the Wind River Reservation. Causes of mortality included: human-caused = 90 (84% of mortalities); natural = 14 (13%); and unknown = 3 (3%). Fifty-six wolves were captured and radio-collared for monitoring and research in 2021.

In 2021, the Wyoming Game and Fish Department implemented a wolf hunting season with the biological objective to stabilize the wolf population at approximately 160 wolves in the WTGMA. A mortality limit of 47 wolves was divided between 13 hunt areas in the WTGMA and 1 hunt area in the Seasonal WTGMA (hunt area 12). Wolf hunting seasons were open from September 15 to December 31, 2021 with the exception of hunt area 12 (opened on October 15, 2021) and hunt area 13 (closed March 31, 2022). The hunting season for each hunt area closed at the season end date or when the mortality limit in the hunt area was met, whichever occurred first. A total of 30 wolves were killed during the 2021 wolf hunting season. In addition, the 2020 wolf hunting season extended from January 1 to March 31, 2021 in hunt area 13, during which 2 wolves were taken.

Wolves were confirmed to have killed or injured 109 head of livestock (50 cattle, 53 sheep, 5 livestock guarding dogs, and 1 horse) statewide in Wyoming in 2021. Wolf-livestock conflicts in the WTGMA were the lowest recorded since 2010 while conflicts in the Seasonal WTGMA and year-round predatory animal area increased. Nineteen packs were involved in ≥1 livestock conflict statewide. Thirty-two wolves were lethally and legally removed by agencies or the public in an effort to reduce livestock losses to wolves (17 in the WTGMA, 15 in predatory animal areas in WYO).

Suggested Citation: Wyoming Game and Fish Department, U.S. Fish and Wildlife Service, National Park Service, USDA-APHIS-Wildlife Services, and Eastern Shoshone and Northern Arapahoe Tribal Fish and Game Department. 2022. Wyoming Gray Wolf Monitoring and Management 2021 Annual Report. K.J. Mills, *ed*. Wyoming Game and Fish Department, 5400 Bishop Blvd. Cheyenne, WY 82006.

Available for download at:
https://wgfd.wyo.gov/WGFD/media/content/PDF/Wildlife/Large%20Carnivore/WYWOLF_ANNUALREPORT_2021.pdf

COVER PHOTO: The Lava Mountain pack observed during a monitoring flight on January 25, 2021.

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BACKGROUND

Beginning in 1995, the U.S. Fish and Wildlife Service reintroduced 41 gray wolves (wolves) into Yellowstone National Park, Wyoming as a nonessential experimental population under the Endangered Species Act with the goal of reestablishing a recovered gray wolf population in the northern Rocky Mountains. The U.S. Fish and Wildlife Service 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 ("delisting"). The wolf population expanded quickly in number and distribution throughout northwest Wyoming. The population met the required recovery criteria by late 2002 and has exceeded the recovery criteria every year since. More information on wolves and the history of the wolf reintroduction program can be found on the U.S. Fish and Wildlife Service website and the Wyoming Game and Fish Department website at the following links:

https://www.fws.gov/species/gray-wolf-canis-lupus
https://wgfd.wyo.gov/Wildlife-in-Wyoming/Large-Carnivore/Wolves-in-Wyoming

Endangered Species Act protections were removed for wolves (i.e., "delisting") in Wyoming in September 2012 following the approval of the Wyoming Gray Wolf Management Plan, Wyoming Game and Fish Commission regulations, and Wyoming Statutes by the U.S. Fish and Wildlife Service (Wyoming Game and Fish Commission 2011, U.S. Fish and Wildlife Service 2012). This delisting decision was challenged in U.S. District Court in Washington, D.C., which overturned the delisting and relinquished management authority for wolves in Wyoming back to the U.S. Fish and Wildlife Service in September 2014. The District Court decision was subsequently appealed by the U.S. Fish and Wildlife Service and State of Wyoming in the U.S. Court of Appeals in Washington, D.C., which ruled in favor of the U.S. Fish and Wildlife Service and State and returned management of wolves to the State of Wyoming on April 25, 2017. Since delisting, wolves have been monitored and managed by the National Park Service in Yellowstone National Park and Grand Teton National Park, the Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department in cooperation with the U.S. Fish and Wildlife Service Lander Fish and Wildlife Conservation Office on tribal lands in the Wind River Reservation, the U.S. Fish and Wildlife Service on the National Elk Refuge, and the State of Wyoming in all remaining areas of Wyoming outside these jurisdictions. 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 wolf 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 National Park Service wolf programs in Wyoming can be found at the following links:

https://www.nps.gov/yell/learn/nature/wolves.htm
https://www.nps.gov/grte/index.htm

Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department

The Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department, in cooperation with the U.S. Fish and Wildlife Service Lander Fish and Wildlife Conservation Office, is responsible for monitoring and management of wolves on tribal lands within the boundary of the Wind River Reservation. The Wind River Reservation Wolf Management Plan designates wolves as a trophy game animal on tribal lands within the Reservation. For more information, see the Wind River Reservation Wolf Management Plan at:

https://fws.gov/media/wind-river-wolf-plan

National Elk Refuge

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

https://www.fws.gov/refuge/national_elk_refuge/

Wyoming Game and Fish Department

The Wyoming Game and Fish Department'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 statute [W.S. 23-1-101(a)(xii)(B)(I) and (II)] and Wyoming Game and Fish Commission Regulation Chapter 21 Gray Wolf Management (Chapter 21), wolves in areas under the State's jurisdiction are managed under the dual classifications of trophy game animal and predatory animal as outlined in the Wyoming Gray Wolf Management Plan and approved by the U.S. Fish and Wildlife Service (Wyoming Game and Fish Commission 2011, U.S. Fish and Wildlife Service 2012). According to the regulatory documents listed above, there are 3 wolf management zones outside Yellowstone National Park and tribal lands within the Wind River Reservation (this area is referred to as WYO throughout the report), as follows:

1. *Wolf Trophy Game Management Area (WTGMA):* Wolves are designated as trophy game animals year-round within the WTGMA and are actively monitored and managed by the Wyoming Game and Fish Department with the goal of maintaining the state's commitment of ≥100 wolves and ≥10 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) solely within this area. 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 the public when in the act of doing damage to private property, in self-defense, under the authority of a lethal take permit, or by licensed hunters during an open wolf hunting season. Livestock owners who have confirmed livestock damage caused by wolves in the WTGMA may qualify for compensation from the Wyoming Game and Fish Department.
2. *Seasonal WTGMA:* Wolves are designated as trophy game animals in the Seasonal WTGMA from October 15 through the last day 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 livestock damage caused by wolves in the Seasonal WTGMA may qualify for compensation from the Wyoming Game and Fish Department on a year-round basis regardless of the date damage occurred.

3. *Areas when and where wolves are designated as predatory animals:* Wolves are designated year-round as predatory animals in areas outside the WTGMA and also within the Seasonal WTGMA from March 1 to October 14 (see above). Predatory animals are not managed under the jurisdiction of the Wyoming Game and Fish Department and may be taken anytime in any legal manner. Livestock owners who have confirmed wolf depredation on livestock outside the WTGMA/Seasonal WTGMA do not qualify for compensation from the Wyoming Game and Fish Department unless their private land is bisected by the WTMGA or Seasonal WTGMA boundary.

The Wyoming Game and Fish Department wolf management objective is to maintain a recovered wolf population in the WTGMA while balancing the need to minimize wolf conflicts with livestock and maintain wild ungulate herds. Wyoming's Gray Wolf Management Plan also seeks to incorporate public hunting opportunity into its wolf population management strategy (Wyoming Game and Fish Commission 2011). Wolves are not actively monitored or managed where designated as predatory animals, including the Seasonal WTGMA. Therefore, data presented in this report will focus primarily on the WTGMA, with data presented for predatory animals if available and/or applicable.

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

https://wgfd.wyo.gov/Wildlife-in-Wyoming/Large-Carnivore/Wolves-in-Wyoming

Wolf Population Delisting Criteria and Post-Delisting Monitoring

The U.S. Fish and Wildlife Service set specific recovery criteria for wolves in the northern Rocky Mountains that were required to be met prior to delisting. The wolf population in the northern Rocky Mountains must also continue to meet or exceed the U.S. Fish and Wildlife Service's recovery criteria into the foreseeable future post-delisting to ensure the population remains recovered. The U.S. Fish and Wildlife Service required a minimum recovery criteria of ≥300 wolves and ≥30 breeding pairs in the northern Rocky Mountains for 3 consecutive years. These criteria were developed using input from many wolf experts from around the world.

Additionally, the U.S. Fish and Wildlife Service developed additional recovery criteria that required the states to maintain a 50% safeguard above minimum recovery criteria (i.e., ≥450 wolves and ≥45 breeding pairs in the northern Rocky Mountains) to qualify for delisting and further ensure the population did not drop below minimum recovery 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 each state at the end of the calendar year. Under the terms of the delisting agreement between Wyoming and the U.S. Fish and Wildlife Service, the state of Wyoming committed to maintain wolves at or above the minimum delisting criteria of ≥100 wolves and ≥10 breeding pairs in WYO, with Yellowstone National Park and the Wind River Reservation providing the additional ≥50 wolves and ≥5

breeding pairs necessary to meet the ≥150 wolf and ≥15 breeding pair requirement for the state (U.S. Fish and Wildlife Service 2012).

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, the U.S. Fish and Wildlife Service is required, in cooperation with the states, to monitor the status of delisted species for a minimum of 5 years, set to conclude at the publication of the 2021 annual report in April 2022. The primary goal of post-delisting monitoring is to provide the U.S. Fish and Wildlife Service 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 provides the U.S. Fish and Wildlife Service with the required information for their post-delisting monitoring evaluation for the 2021 calendar year.

Reporting Wolf Population Data by Jurisdiction

Generally, states are solely responsible for monitoring and managing delisted species. In Wyoming, however, multiple jurisdictions contain significant portions of the wolf population and/or suitable wolf habitat, primarily Yellowstone National Park and tribal lands on the Wind River Reservation, where the state does not have management authority. This sharing of large portions of the wolf population adds complexity to 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) as follows:

1. The Wyoming Game and Fish Department committed to maintain ≥100 wolves and ≥10 breeding pairs in the WTGMA in northwest Wyoming. While the state does not have management authority over wolves in all areas in the WTGMA such as Grand Teton National Park and the National Elk Refuge, these areas are small and the wolf packs using them are not solely contained within their boundaries. Therefore, wolves in Grand Teton National Park and the National Elk Refuge are included in the WTGMA.
2. Combined, Yellowstone National Park and Wind River Reservation are expected to contribute the remaining ≥50 wolves and ≥5 breeding pairs necessary to meet the total ≥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 three primary jurisdictions to allow for proper evaluation of the wolf population both statewide and by individual jurisdiction.

WYOMING GRAY WOLF MONITORING AND MANAGEMENT: 2021 ANNUAL REPORT

WOLF POPULATION MONITORING

SUMMARY OF WOLF POPULATION MONITORING STATEWIDE

At the end of 2021, the wolf population in Wyoming remained above minimum recovery criteria, making 2021 the 20th consecutive year Wyoming has exceeded the numerical, distributional, and temporal recovery criteria established for wolves by the U.S. Fish and Wildlife Service. At least 314 wolves in ≥40 packs (including ≥23 breeding pairs) inhabited Wyoming statewide on December 31, 2021. Of the total, there were ≥161 wolves and ≥24 packs (including ≥14 breeding pairs) in the Wolf Trophy Game Management Area (WTGMA), ≥97 wolves and ≥8 packs (including ≥6 breeding pairs) in Yellowstone National Park, ≥17 wolves and ≥3 packs (including ≥2 breeding pairs) in the Wind River Reservation, and ≥39 wolves and ≥5 packs (including ≥1 breeding pair) resided in areas where wolves are designated primarily as predatory animals in Wyoming. A total of 107 wolf mortalities were documented statewide in Wyoming in 2021: 62 in the WTGMA, 38 in areas where wolves are primarily designated as predatory animals, 6 in Yellowstone National Park, and 1 in the Wind River Reservation. Causes of mortality included: human-caused = 90 (84% of mortalities); natural = 14 (13%); and unknown = 3 (3%). Fifty-six wolves were captured and radio-collared for monitoring and research in 2021.

Wolf Population Monitoring in the WTGMA

Population and Breeding Pair Status

The minimum number of wolves in the Wolf Trophy Game Management Area (WTGMA; see map in Figure 1) on December 31, 2021 was determined using standard wolf monitoring methods used since reintroduction. The number of wolves in individual packs was estimated at the end of the year by counting wolves during telemetry flights and capture operations, observations by, or confirmed by, qualified agency personnel, or pictures of known packs taken with remote cameras. Only pack observations obtained by agency personnel from December 2021 through March 2022 were included to ensure they were reflective of the minimum number of wolves present on December 31, 2021. Miscellaneous, mostly solitary, wolves were included in the estimate only if the animal was not a member of a known pack. Packs formed in late 2021 and early 2022 are included in the miscellaneous wolf category if they had not established a stable territory. Packs with territories overlapping jurisdictional boundaries (e.g., state, national park, tribal boundaries, etc.) and packs overlapping the WTGMA boundary were assigned to the area which held the majority of their documented locations during 2021. The final minimum population census was the sum of all pack counts and miscellaneous wolves known to be present on December 31, 2021 (see Table 1).

Breeding pair status for packs in the WTGMA was also determined using the same methods since wolves were reintroduced to the northern Rocky Mountains. 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

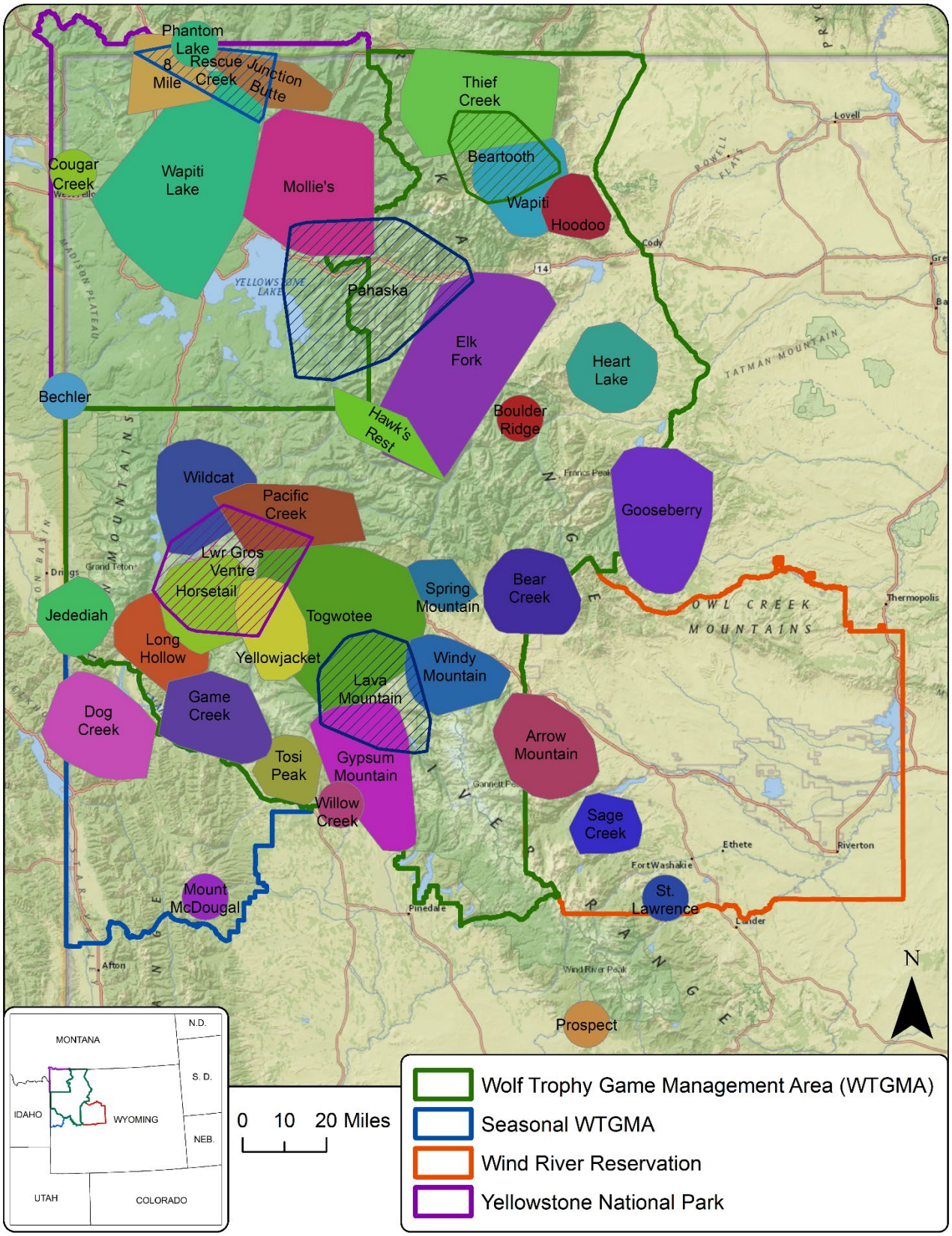

Figure 1. Wolf management areas and home ranges of wolf packs in Wyoming in 2021.

Table 1. Wolf packs, minimum pack size at the end of the calendar year, wolf mortality, and wolf-livestock conflicts in Wyoming in 2021.

WOLF PACK[1,2]	MINIMUM PACK SIZE	DOCUMENTED MORTALITIES						KNOWN		CONFIRMED CONFLICTS[9]			
		NATURAL	HUMAN[3]	UNKN[4]	HUNTING[5]	PRED. ANIMAL[6]	CONTROL[7]	DISPERSED	MISSING[8]	CATTLE	SHEEP	DOGS	OTHER
WOLF TROPHY GAME MANAGEMENT AREA													
Bear Creek^	9				1			1		2			
Beartooth	10	1								3			
~~Big Chief Butte~~							2			6			
Boulder Ridge	4												
~~Doll Creek~~								2					
Elk Fork Creek	3												
Game Creek	4							3		1			
Gypsum Mountain	4	1			1					2			
Hawk's Rest^	11												
Heart Lake	9				1			1		5			
Hoodoo	3		1		1					2			
Horsetail Creek	10		1		1								
~~Huckleberry~~								3					
Jedediah	2												
Lava Mountain	6				1			1					
Long Hollow	2							2		1			
Lower Gros Ventre	13	1		1	2					1			
Pacific Creek	12				3								1
Pahaska^	7		1		2								
~~Rattlesnake~~							8	1		1			
Spring Mountain	9				2								
Thief Creek	2	1											
Togwotee	9				3		6	1	1	3			
Tosi Peak	3												
Wapiti	6				5			1		2			
Wildcat Ridge	5	2	1		1								
Windy Mountain	4	1			2								
Yellowjacket	9				2					1			
Misc. wolves	5		2		2		1			8			
WTGMA TOTAL	**161**	7	6	1	30	0	17	16	1	38	0	0	1
PREDATORY ANIMAL AREAS													
Seasonal Wolf Trophy Game Management Area													
Dog Creek^	4					3					13	5	
~~Monument Ridge~~						3							
Mount McDougal	3					3							
Misc. wolves	4										19		
Year-round Predatory Animal Area													
~~Burnt Lake~~						1							
Gooseberry	4	1				1	7			1			
~~Jones Flat^~~						1	2				16		
Prospect	4					1	4			2	1		
Willow Creek	2					2							
Misc. wolves	18		1			6	2			9	4		
PRED. AREAS TOTAL	**39**	1	1	0	0	21	15	0	0	12	53	5	0
WYO Total	**200**	**8**	**7**	**1**	**30**	**21**	**32**	**16**	**1**	**50**	**53**	**5**	**1**
YNP Total	97	4	0	2	0	0	0	9	5	0	0	0	0
WRR Total	17	1	0	0	0	0	0	0	2	0	0	0	0
WYOMING TOTAL	**314**	**13**	**7**	**3**	**30**	**21**	**32**	**25**	**8**	**50**	**53**	**5**	**1**

1 Underlined packs are counted as breeding pairs on December 31, 2021.
2 Strikethough packs were not documented during 2021 and/or did not exist on Dec. 31, 2021 and are not displayed in Figure 1.
3 Excludes wolves killed in control actions and legal hunting.
4 Number of wolves that died of unknown causes.
5 Number of wolves legally taken during the regulated hunting season.
6 Number of wolves taken by the public as predatory animals.
7 Number of wolves killed in lethal control actions, including agency-directed control, defense of private property and on lethal take permits.
8 Collared wolves that became missing.
9 Number of conflicts between wolves and livestock/domestic animals confirmed in WYO. "OTHER" includes one horse injured by the Pacific Creek pack.
^ Border pack shared with Idaho, Yellowstone National Park or the Wind River Reservation; assigned to WYO.

ground monitoring efforts, investigations of potential den and rendezvous sites, howling surveys, 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. The Wyoming Game and Fish Department will continue using approved methods for monitoring the wolf population while also investigating alternative methods for future wolf monitoring and management.

As of December 31, 2021, ≥161 wolves in ≥24 packs, including ≥14 breeding pairs, were documented in the WTGMA (Figures 1, 2, and 3; Table 1). Pack size ranged from 2 to 13 and averaged 6.5 wolves per pack (Figure 4; Table 1).

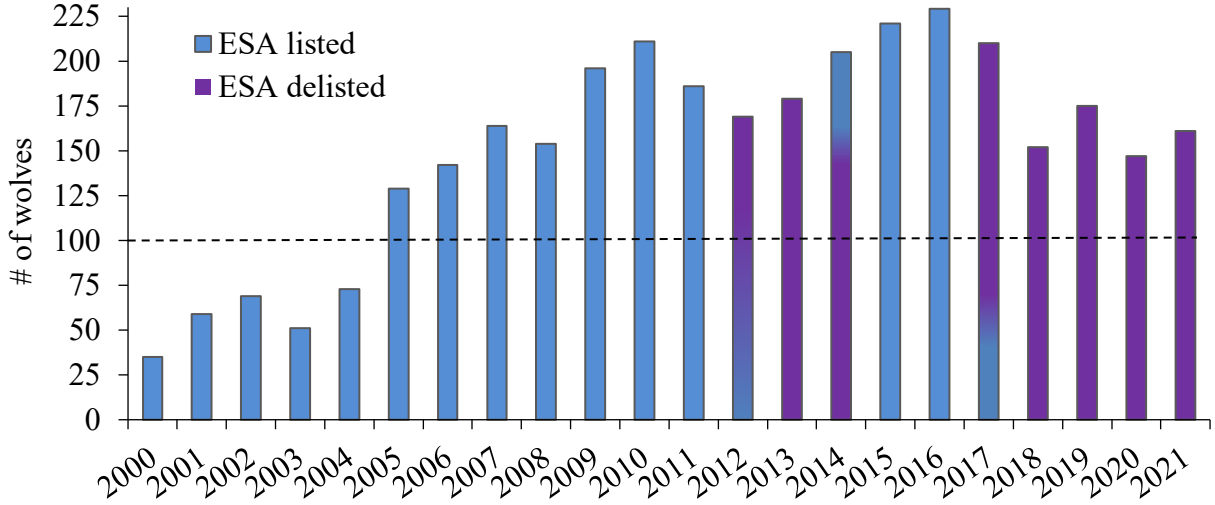

Figure 2. Minimum number of wolves in the WTGMA at the end of the calendar year. (The dashed line indicates the ≥100 wolf minimum recovery criterion)

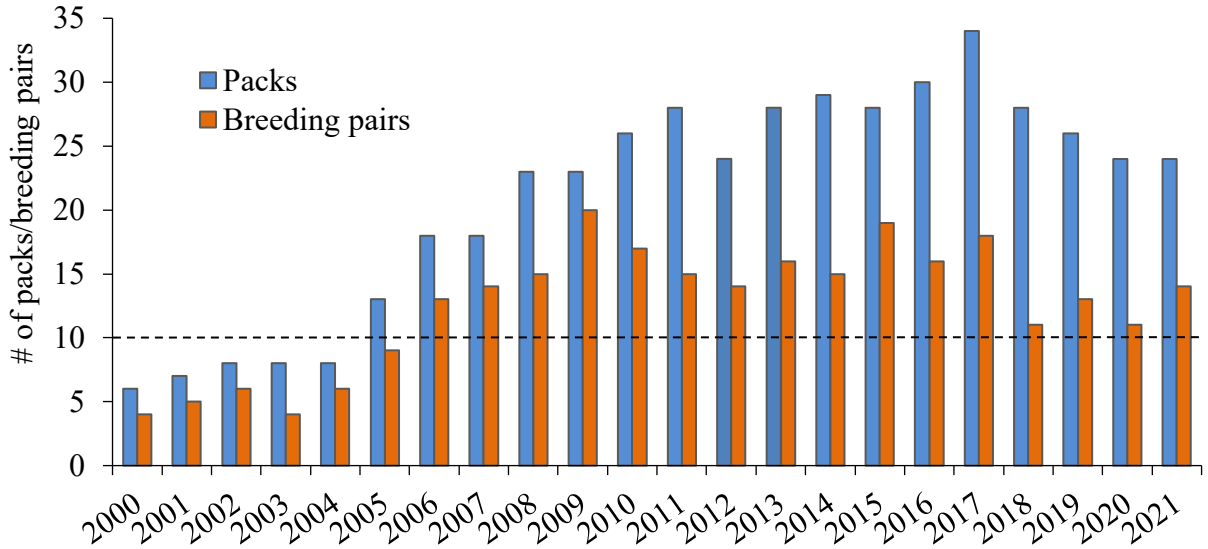

Figure 3. Minimum number of wolf packs and breeding pairs in the WTGMA at the end of the calendar year. (The dashed line indicates the ≥10 breeding pair minimum recovery criterion)

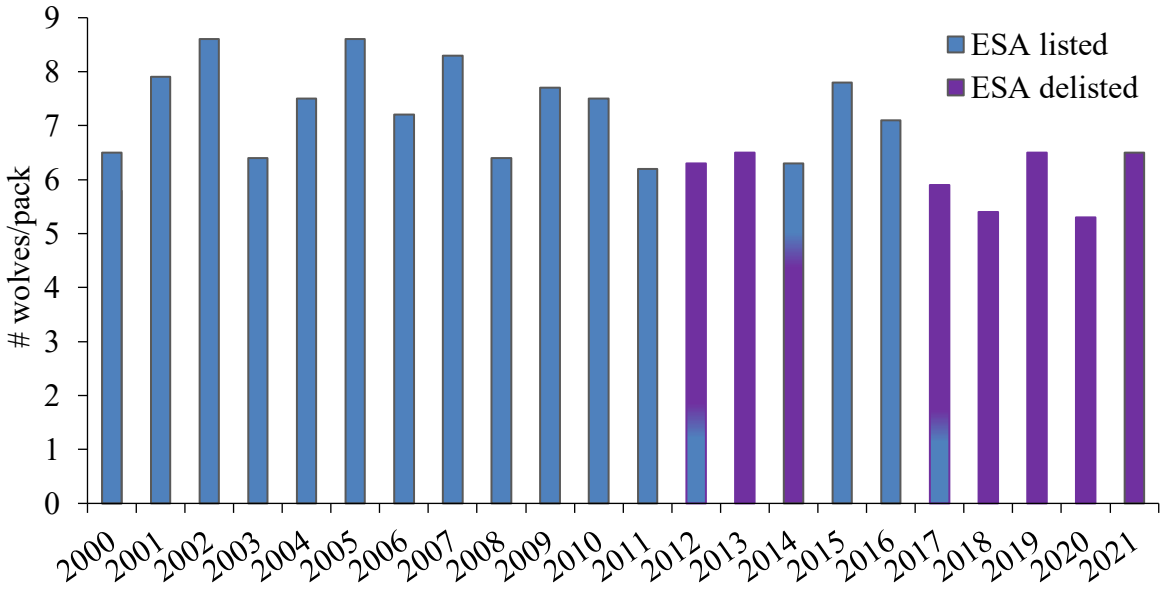

Figure 4. Average pack size for wolf packs in the WTGMA at the end of the calendar year.

Mortality

Wolf mortality was monitored in the WTGMA using multiple methods. The primary method used to identify wolf mortalities not associated with hunting was through the tracking of radio-collared wolves. The information provided by tracking collars allows managers to monitor collared wolves for mortality status and investigate the site to evaluate cause-specific mortality and collect carcasses for further evaluation through necropsy. Wolf hunting mortality in the WTMGA was monitored via mandatory reporting and registration by successful hunters as required in the Wyoming Game and Fish Commission Chapter 47 Gray Wolf Hunting Season (Chapter 47) regulation and Wyoming Statute 23-1-304(d). This requirement allowed Wyoming Game and Fish Department personnel to document mortality, collect information on wolves taken during the hunt, update mortality limits in the WTGMA/Seasonal WTGMA, and close wolf hunting seasons if the mortality limit was met. Cooperating agencies also provided information on wolf mortalities, including wolves killed in control actions by USDA Wildlife Services. Wolf mortalities from all causes were documented and confirmed, including those found by the public, cooperating agencies, and Wyoming Game and Fish Department personnel.

In 2021, 62 wolves were known to have died in the WTGMA (Figure 5; Tables 1 and 2). Causes of mortality included: hunting = 30; conflict control = 17; other human causes = 6; natural = 8; and unknown causes = 1 (Figure 5; Tables 1 and 2). Of the 30 wolves taken during hunting seasons, 2 were taken during the extended 2020 wolf hunting season in January 2021 in hunt area 13 and 28 were taken during the normal wolf hunting season in autumn 2021. Conflict control mortalities included 15 from agency-directed lethal control actions, 1 taken under the authority of a lethal take permit, and 1 taken for defense of private property as authorized by the Wyoming Game and Fish Commission Chapter 21 regulation. The 6 wolf deaths from other human causes included 4 illegal kills (2 counted toward the wolf hunt mortality limit), 1 road kill, and 1 wounding loss during the hunting season. Natural mortalities included 5 wolves killed by other wolves, 1 that died after falling from a cliff, and 2 that died of other natural, but not

specifically identified, causes. The number of wolves that died in the WTGMA in 2021 (62 wolves; Figure 5) was less than the average number of mortalities from 2012-2021 (average = 74 wolves).

Table 2. Summary of wolf mortality by cause of death in the WTGMA in 2021.

Cause of death	Total	% of mortality	% of wolves
Hunting	30	48.4	13.5
Conflict control	17	27.4	7.6
Other human causes	6	9.7	2.7
All Human Causes	53	85.5	23.8
Natural	8	12.9	3.6
Unknown	1	1.6	0.4
Total Mortality	62	100.0	27.8

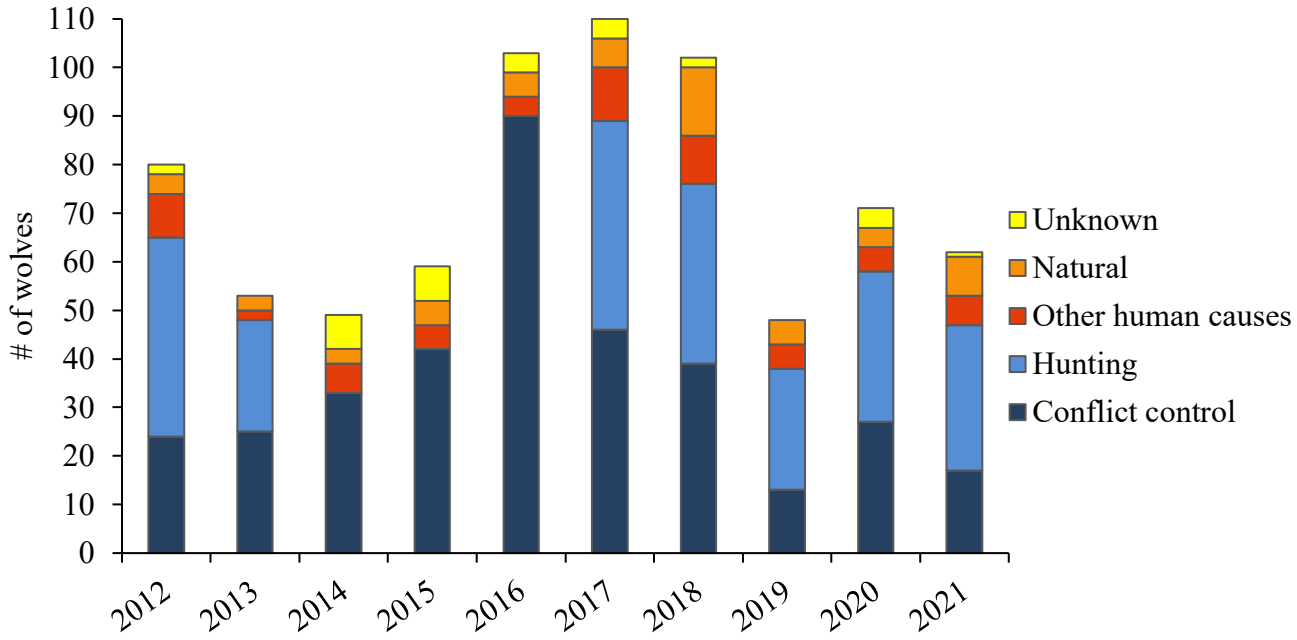

Figure 5. Number of wolf mortalities by cause of death in the WTGMA during the calendar year. (Wolves were listed under the Endangered Species Act in portions of 2014-2017)

Disease Monitoring

Disease presence and prevalence in wildlife populations is generally density-dependent, meaning the risk of a particular disease impacting a population increases as population density increases. Wolves are no exception, with evidence that the presence and prevalence of both sarcoptic mange (*Sarcoptes scabiei*: mange) and canine distemper virus (distemper) infections in wolf populations are most common at high population and wolf pack densities (Almberg et al. 2010, 2012). Both diseases may kill adult and juvenile wolves, but primarily manifest population declines through increased pup mortality and low pup recruitment (Almberg et al. 2009). While

evidence for mange and distemper has been present in the wolf population in Wyoming, they have had little impact in most years on wolf population dynamics outside Yellowstone National Park (Jimenez et al. 2010, Almberg et al. 2012). Management actions such as hunting and conflict control in the WTGMA appears to have held the population below the threshold where disease outbreaks are more likely, however, the WTGMA wolf population increased rapidly following the reinstatement of Endangered Species Act protections in 2014 and remained at relatively high density from 2015 through early 2018 (Figures 2 and 3). This increase in population density in WTGMA was correlated with an increase in detection of distemper (Figure 6) and mange in the wolf population through 2018. Documentation of disease in the WTGMA wolf population has remained low since 2018 when wolf density in the WTGMA was reduced following Endangered Species Act delisting and return to state management in 2017 (Figures 2, 3 and 6). The Wyoming Game and Fish Department will continue to monitor disease in the WTGMA wolf population and whether reduced population density continues to correlate with reduced disease.

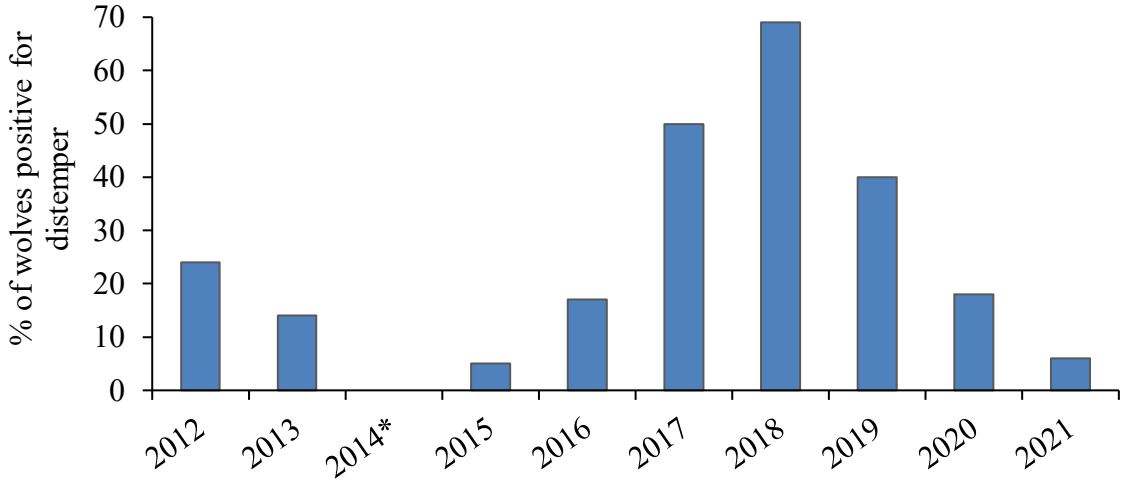

Figure 6. Proportion (%) of wolves captured in winter (November through March) that tested positive for canine distemper virus in WTGMA. (*Too few wolves were captured following Endangered Species Act relisting of the wolf population to allow for an adequate sample)

Mange: Mange is a highly contagious skin disease caused by mites and is commonly found in wolf populations throughout the world. Mange was first detected in Wyoming outside Yellowstone National Park in 2002 (Jimenez et al. 2010). As expected, documentation of mange continued to remain low in the WTGMA in 2021. The Game Creek pack continued to use the same territory and homesites used formerly by the Horse Creek pack, which was mostly killed by mange in 2018. Two wolves from the Game Creek pack were captured and collared in February 2021, each showed symptoms of mange infection. Despite producing ≥2 pups, the number of wolves in the Game Creek pack declined from 7 to 3 during the course of 2021 through dispersal (≥3 wolves) and possibly from mange infection, though no mortality was documented (Table 1). Mange was not a factor affecting broader wolf survival or population dynamics in the WTGMA in 2021.

Distemper: Distemper is a highly contagious disease that infects species such as domestic dogs, coyotes, foxes, raccoons, skunks, and wolves. Based on other areas of the world that have

experienced epizootic distemper 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. The proportion of wolves captured during winter that tested positive for distemper infection increased from 2015 through 2018 (Figure 6) and was correlated with increasing wolf population and wolf pack density in the WTGMA (Figures 2 and 3). Decreasing prevalence of distemper has been correlated with a reduction in wolf population and wolf pack density in the WTGMA and subsequent stability around the population objective from 2018-2021 (Figures 2, 3 and 6). The trend continued during winter 2021, with only 2 of 33 wolves (6%) captured testing positive for distemper exposure (Figure 6). Both wolves were ≥5 years old and were born or lived through the peak in distemper from 2017-2018 (Figure 6).

Canine Parvovirus: Canine parvovirus is a highly contagious disease that caused significant population level impacts for wolf populations throughout North America, primarily in the 1980s (Kreeger 2003). The U.S. Fish and Wildlife Service and Yellowstone National Park have surveyed for evidence of canine parvovirus while managing Wyoming wolf populations and found a high rate of infection (>80% of wolves exposed) with no apparent deleterious effects to individual wolves or the population (Almberg et al. 2009, Jimenez et al. 2012). The Wyoming Game and Fish Department has not tested samples for canine parvovirus to date, but continues to retain samples from all captured wolves that could be tested for canine parvovirus or other diseases if the need arises in the future.

Population Trend

The Wyoming Game and Fish Department closely monitors and manages the wolf population in the WTGMA because this is the area determined to have the suitable habitat required for long-term viability of wolves and would, therefore, maintain the number of wolves and breeding pairs required to meet population commitments outlined in the Wyoming Gray Wolf Management Plan (Wyoming Game and Fish Commission 2012). The WTGMA end of year wolf population increased 9% from ≥147 wolves at the end of 2020 to ≥161 wolves at the end of 2021 and remained above the minimum population commitment of ≥100 wolves (Figure 2; Table 1). Further, Wyoming Game and Fish Department management has yielded a wolf population within 10% of the 160 wolf population objective for 4 consecutive years (Figure 2), which has stabilized the wolf population and reduced wolf-livestock conflict (see the "*Wolf-Livestock conflict*" section below). Breeding pairs increased 27% from ≥11 in 2020 to ≥14 in 2021 and remained above the minimum breeding pair commitment of ≥10 breeding pairs (Figure 3; Table 1). The number of wolf packs in the WTGMA held stable at ≥24 packs from 2020 to 2021 (Figure 3). Three packs established in 2021, mostly recolonizing vacant territories of packs that dissolved (Gypsum Mountain, Jedediah, and Tosi Peak: Figure 1; Table 1). In addition, the Heart Lake pack relocated out of Yellowstone National Park from a marginal territory in winter 2020 to a prey-rich territory in the WTGMA in early 2021. Four packs documented at the end of 2020 did not exist on December 31, 2021 (Big Chief Butte, Dell Creek, Huckleberry, and Rattlesnake: Table 1). There was no evidence suggesting the presence of any wolf packs in the WTGMA that were not documented. Average pack size at the end of 2021 (6.5 wolves per pack) was higher than 2020 (5.3 wolves per pack) and was reflective of the increased population and number of breeding pairs in the WTGMA wolf population (Figures 2, 3, and 4).

Wolf population dynamics largely followed long-term trends in the WTGMA in 2021, yielding an end of year population at the population objective of 160 wolves (Figures 7 and 8; see also Figures 13 and 14). In particular, recruitment returned to levels predicted by previous trends after being around 17% below average the previous 3 calendar years (Figures 7 and 8). Lower than expected mortality during the wolf hunting season was offset by higher than expected non-hunting human causes, allowing the population to remain at objective (Tables 1 and 2; Figure 5). Lower wolf population density in the WTGMA from 2019-2021 correlated with continued larger litter sizes in summer (5.4 pups per pack from 2019-2021 vs. 4.2 pups per pack from 2012-2018). Evidence of disease has declined in the WTGMA as wolf population density declined and stabilized around the population objective and did not factor in wolf population dynamics in the WTGMA in 2021 (Figure 6).

The wolf population in the WTGMA has largely followed basic tenets of population theory over the course of recolonization and transfer to state management (e.g., density-dependence as seen in Figure 7). Predictable population responses to natural and human-caused perturbations allow for more precise estimation of the impact of management decisions. In addition, the dual population objectives of wolf numbers and breeding pairs incorporates an added level of complexity for managing the wolf population in the WTGMA. However, throughout wolf recolonization in the WTGMA, the minimum number of breeding pairs has remained highly correlated to the minimum number of wolves in the WTGMA (Figure 8). This strong correlation allows for a high level of confidence in predicting how management actions, such as wolf hunting seasons, may impact both wolf and breeding pair numbers and may provide a mechanism for indirectly estimating the number of breeding pairs in the population with less invasive approaches if wolves in Wyoming can remain delisted (Figure 8).

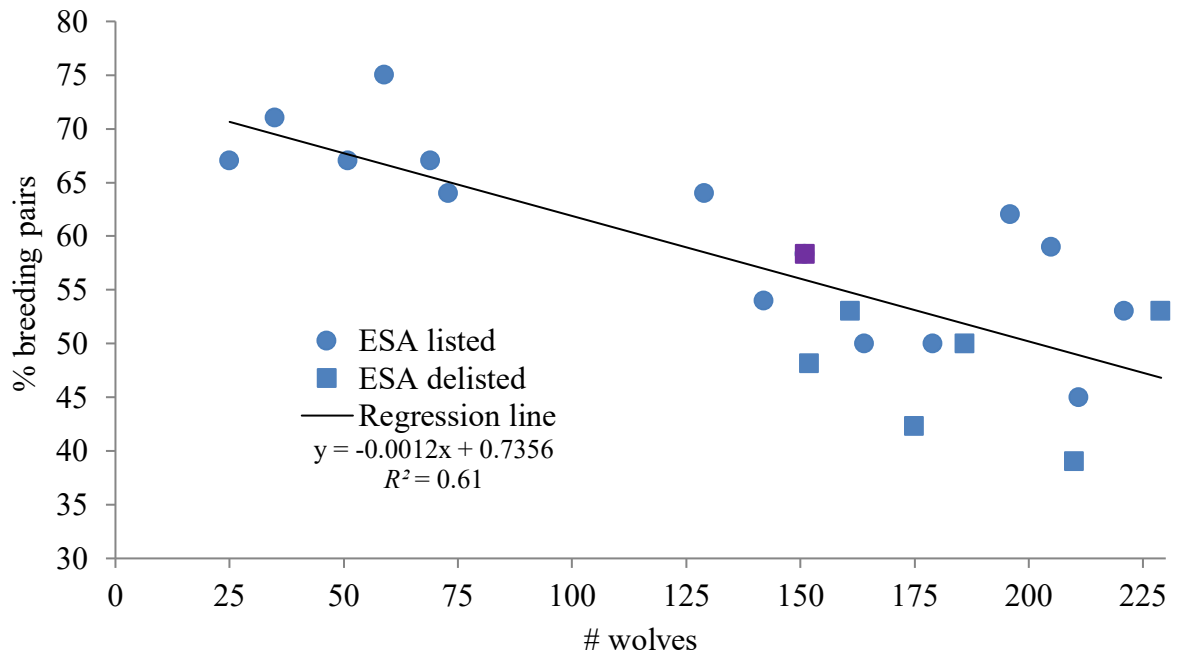

Figure 7. Minimum number of wolves present in the WTGMA at the beginning of the calendar year compared to the proportion (%) of packs that qualified as a breeding pair in the WTGMA at the end of the calendar year from 2000-2021. ("■" indicates the 2021 data point)

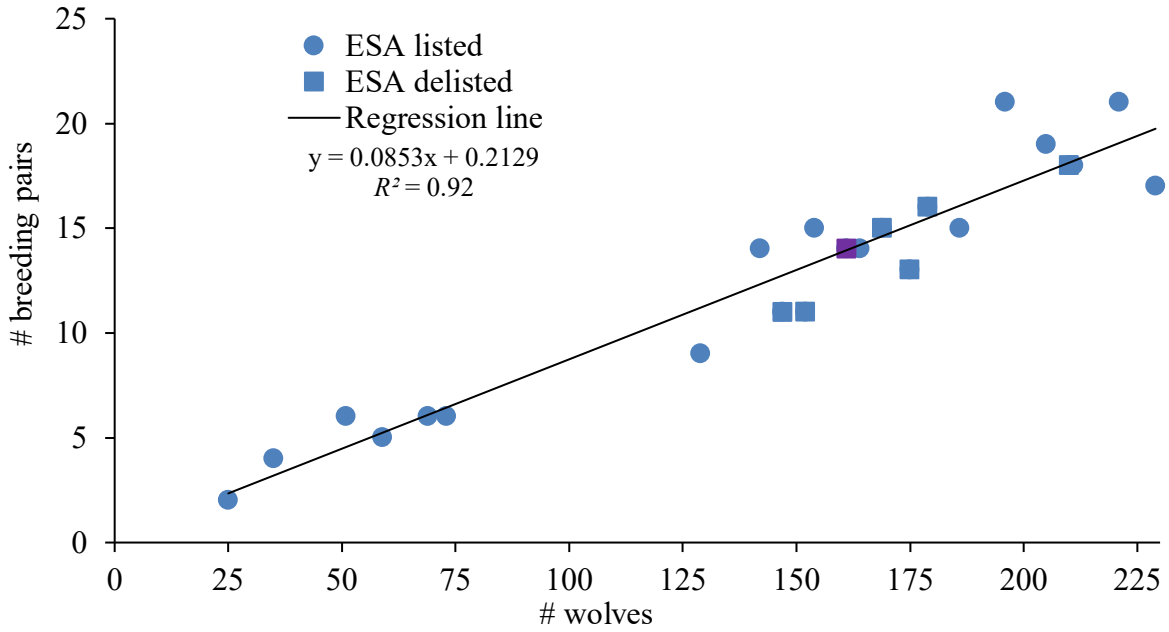

Figure 8. Minimum number of wolves and breeding pairs in the WTGMA at the end of the calendar year from 1999-2021. ("■" indicates the 2021 data point)

Genetic Monitoring

The U.S. Fish and Wildlife Service determined that, in addition to minimum population criteria, genetic interchange must also occur between the 3 wolf recovery areas in the northern Rocky Mountains. To monitor whether this delisting criterion is met, the U.S. Fish and Wildlife Service requires that all states collect and analyze genetic samples from wolf populations in the northern Rocky Mountains. Analysis of genetic interchange will be conducted cooperatively between the U.S. Fish and Wildlife Service and the states of Wyoming, Montana, and Idaho on a periodic basis (possibly every 12-20 years following 3-5 wolf generations: Wyoming Game and Fish Commission 2011). Genetic samples will continue to be collected from wolves in the WTGMA to ensure enough genetic information is available to determine whether genetic interchange is occurring in the northern Rocky Mountains.

In 2021, genetic samples were collected from 88 wolves in the WTGMA that will be used in analysis of genetic interchange. Genetic samples were collected from 44 wolves that died and 44 wolves captured for monitoring purposes. As required by Chapter 47, 29 samples were acquired from wolves taken during authorized wolf hunting seasons in the WTGMA in 2021.

In accordance with the commitment by states in the northern Rocky Mountains to analyze genetic interchange, a cooperative analysis of wolf genetics in the northern Rocky Mountains from 2010-2018 was completed in May 2021 (Wildlife Genetics International, in preparation). The analysis concluded there continues to exist a high level of genetic diversity within each wolf recovery area in the northern Rocky Mountains. In addition, individuals with ancestry representing each recovery area were present in each wolf recovery area in the northern Rocky Mountains, indicating sufficient genetic interchange to maintain genetic diversity into the foreseeable future.

Capture and Telemetry Collaring

Very high frequency (VHF) and global position system (GPS) telemetry collars are the primary tools used for monitoring wolf populations in the WTGMA. VHF collars were used for general monitoring purposes and GPS collars provided more fine-scale data for specific monitoring or research projects. Wolves were captured using ground or aerial capture techniques. Collars were affixed to captured wolves and personnel collected morphological information, genetic samples, and blood for disease testing. Collared wolves were released on site and monitored to document territories, movements (including dispersal), pack size, pack composition, breeding status and success, survival, to mitigate livestock conflicts, and to aid in law enforcement investigations.

Forty-six wolves from 18 packs in the WTGMA were collared through aerial capture techniques in 2021, including 6 recaptures. At the end of 2021, there were 50 wolves in 21 packs and 3 single wolves being monitored with telemetry collars in the WTGMA (53 wolves total; 33% of the year-end population). Winter wolf capture efforts continued through March 2022 in conjunction with the year-end population census, at which point a total of 69 wolves in 22 packs and 5 single wolves were being monitored via telemetry collars in the WTGMA (74 wolves total; approximately 46% of the WTGMA population in March 2022). The proportion of collared individuals is generally highest at the end of winter following aerial capture efforts in March and decreases throughout the remainder of the year as pups are born in April and collared wolves die, disperse, or when collars fail. Twenty-five collared wolves died in the WTGMA in 2021 (40% of total documented wolf mortalities).

Predatory Animal Areas

As of December 31, 2021, there were ≥39 wolves in ≥5 packs, including ≥1 breeding pair, in the predatory animal areas (including the Seasonal WTGMA) in Wyoming (Figure 1; Table 1). Wolves listed in the "miscellaneous" category include a group of 3 wolves detected at the north end of the Rattlesnake Hills, 5 wolves at South Pass near the southern end of the Wind River Range, and 6 wolves in the Bighorn Mountains (Table 1). Thirty-eight wolf mortalities were documented in predatory animal areas in 2021, including: 21 taken by the public as predatory animals, 15 taken by USDA Wildlife Services, 1 from other human-causes and 1 from natural causes (Table 1). Of the 21 wolves taken by the public, 18 were taken with a firearm and 3 were trapped. Wolf captures included 1 wolf from 1 pack in the Seasonal WTGMA and 1 wolf from 1 pack in the predatory animal area. At the end of 2021, 5 wolves from 4 packs and 2 single wolves were being monitored via telemetry collars in predatory animal areas in Wyoming. Twenty-four genetic samples were collected from wolves that died in predatory animal areas 2021.

Wolf Population Monitoring on the Wind River Reservation

Population and Breeding Pair Status

The Wind River Reservation minimum wolf population and breeding pair estimates were determined using analogous methods as described for the WTGMA. Wolves first recolonized the Wind River Reservation in 2003 and are currently distributed across the Wind River and Owl

Creek Mountain ranges (Figures 1 and 9). The wolf subpopulation in the Wind River Reservation slowly increased through 2013 and has since fluctuated between 10 and 20 wolves (Figure 9). As of December 31, 2021, ≥17 wolves in ≥3 packs, including ≥2 breeding pairs, were documented on the Wind River Reservation (Figures 1 and 9; Table 3). All confirmed packs existed along the eastern front of the Wind River Range (Figure 1). The wolf reported in the miscellaneous wolf category was a lone remnant of the Jones Creek pack residing in the Owl Creek Mountains in the Wind River Reservation.

Capture and Telemetry Collaring

Three wolves from 2 packs were captured and telemetry-collared in the Wind River Reservation in 2021.

Mortality

One wolf was killed by other wolves in the Wind River Reservation in 2021 (Table 3).

Wolf Population Monitoring in Yellowstone National Park

Population and Breeding Pair Status

As of December 31, 2021, there were ≥97 wolves in ≥8 packs, including ≥6 breeding pairs, living primarily in Yellowstone National Park (Figures 1 and 9; Table 3). This count marks a decrease of 21% from the end of 2020 but is close to the previous decade's average end of the year count (2010-2019 average = 94.5). Pack size ranged from 3 to 21, averaging 12 members (Table 3). The number of packs in Yellowstone National Park has been decreasing slowly since 2009 when there were approximately 16 packs, while the number of breeding pairs has changed little, and average pack size increased (Figure 1; Table 3). Small packs have always had difficulty persisting in Yellowstone because of intraspecific competition. A small number of wide-ranging, large packs may prevent small groups of wolves from even trying to establish territories in the study area. Prey availability and vulnerability and seasonal movements, wolf hunting seasons in the states surrounding Yellowstone, and radio-collar distribution may also play a role in the apparent drop in the number of packs primarily living in the park.

Prior to the 2021 pups being born, there were 110 adult wolves alive in April, the beginning of the wolf biological year. At least 47 pups were born to 7 different packs. Three packs produced multiple litters this year: 8 Mile (at least 8 pups from 2 litters), Junction Butte (at least 9 pups from 2 litters and 2 litters of unknown size), and Wapiti Lake (at least 10 pups from 2 litters). The Phantom Lake, Mollies, Cougar Creek, and Bechler packs had 1 litter each. Both the Rescue Creek and Carnelian Creek packs denned but the pups died before counts were conducted. Of the minimum 47 pups produced, 29 (62%) survived to the end of the year. At the end of 2021, pups comprised 30% of the park population, lower than in 2019 and 2020 (44%), but similar to the last decade average of 34%.

Table 3. Wolf packs, minimum pack size at the end of the calendar year, wolf mortality, and wolf-livestock conflicts in Yellowstone National Park and the Wind River Reservation in 2021.

WOLF PACK[1,2]	MINIMUM PACK SIZE	DOCUMENTED MORTALITY[3]					KNOWN		CONFIRMED CONFLICTS[6]			
		NATURAL	HUMAN[4]	UNKN	HUNTING	CONTROL	DISPERSED	MISSING[5]	CATTLE	SHEEP	DOGS	OTHER
YELLOWSTONE NATIONAL PARK NORTHERN RANGE												
8 Mile^	21	1					1	1				
~~Carnelian Creek^~~					1							
Junction Butte	17						6	1				
Phantom Lake^	3											
Rescue Creek	13	2										
Misc. wolves	1											
YELLOWSTONE NATIONAL PARK NON-NORTHERN RANGE												
Bechler %	4											
Cougar Creek^	10	1					1					
Mollie's	7						1	2				
Wapiti Lake	21							1				
Misc. wolves	0				1							
Yellowstone National Park Total[7]	**97**	**4**	**0**	**2**	**0**	**0**	**9**	**5**	**0**	**0**	**0**	**0**
WIND RIVER RESERVATION												
Arrow Mountain*	9							1				
~~Owl Creek*~~												
Sage Creek	5							1				
St. Lawrence*	2											
Misc. wolves	1	1										
Wind River Reservation Total[8]	**17**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**
Total in Yellowstone N.P. and Wind River I	**114**	**5**	**0**	**2**	**0**	**0**	**9**	**7**	**0**	**0**	**0**	**0**

1 Underlined packs qualified as breeding pairs on December 31, 2021.
2 Strikethough packs were not documented during 2021 and/or did not exist on Dec. 31, 2021 and are not displayed in Figure 1.
3 Excludes wolves assigned to Yellowstone National Park that were killed outside Yellowstone National Park.
4 Excludes wolves killed in control actions and legal hunting.
5 Collared wolves that became missing in 2021.
6 Includeslivestock and domestic animals confirmed killed or injured by wolves.
7 Mortality and confirmed livestock conflicts by wolf packs assigned to Yellowstone National Park that occured in WYO are reported in Table 1.
8 Mortality and conflicts with livestock by wolf packs assigned to the Wind River Reservation that occured in WYO are reported in Table 1.
% Border pack with ID, assigned to Yellowstone National Park.
^ Border pack with MT, assigned to Yellowstone National Park.
* Border pack with WYO, assigned to the Wind River Reservation.

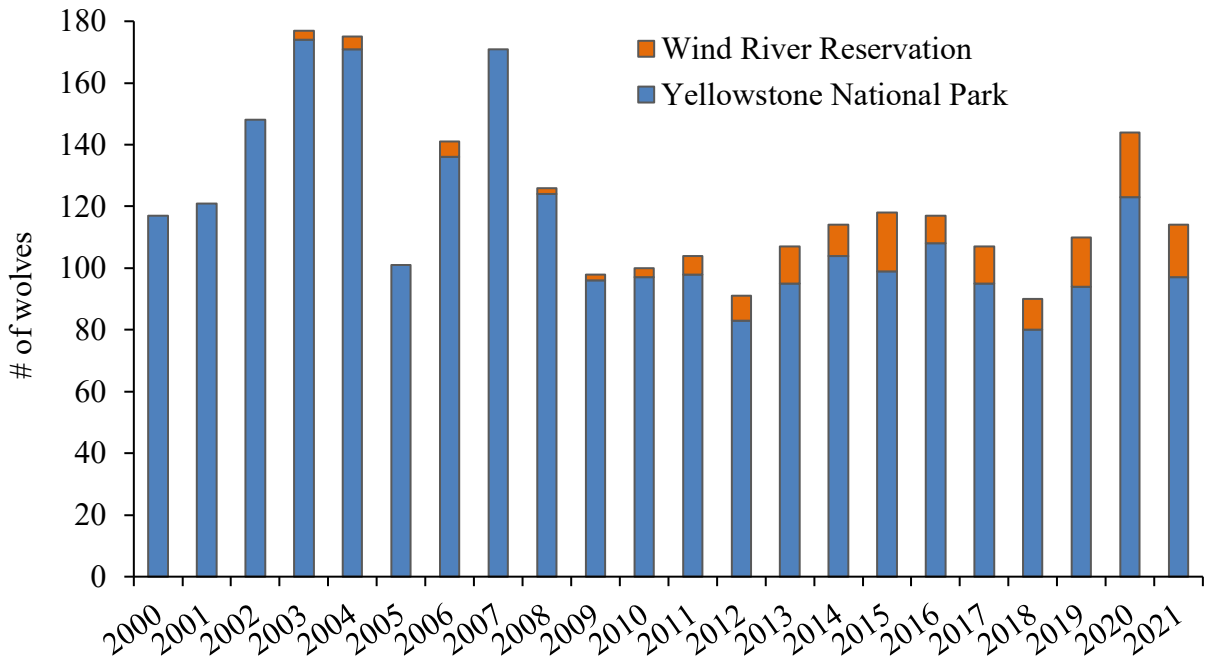

Figure 9. Minimum number of wolves in Yellowstone National Park and the Wind River Reservation at the end of the calendar year.

Capture and Telemetry collaring

Seven wolves in 2 packs were captured and collared in 2021. New collars were deployed on 2 pups, 3 yearlings, and 2 adults. The sex ratio of captured wolves was split between males (3) and females (4). In addition to fitting the radio collar, staff took blood samples for genetic and hormone analysis, serum samples for disease screening, a whisker for isotopic analysis, body and tooth measurements, and weights. A uniquely identifying pit-tag was inserted under the skin near the shoulder in case a collar is dropped or chewed off and the wolf is recaptured in the future. These collars are the basis of the monitoring and tracking of wolves from the ground or the plane to determine pack size, composition, reproduction, etc.

Mortality

Six wolves died in Yellowstone National Park in 2021, including 3 wolves killed by other wolves, 1 that died of unknown natural causes, and 2 wolves that died of unknown causes (Table 3). An additional 19 wolves assigned to packs in Yellowstone were killed during wolf hunting seasons in the states surrounding the Park in 2021 (2 in Wyoming [included in this report for the WTGMA], 2 in Idaho, and 15 in Montana). Three wolves killed in hunts were collared, including 1155M (in a pair) in Montana, and 1109F (a loner) and 1238M (from Mollie's pack) in Wyoming. Fourteen uncollared wolves were also killed in wolf hunts outside Yellowstone in Montana (6 Junction Butte wolves, 7 Phantom Lake pack wolves, 1 wolf from the Rescue Creek pack). Two wolves from the Bechler pack were also killed during wolf hunts in Idaho. One collared wolf was killed illegally: 1266M of the Wapiti Lake pack was shot with birdshot along the highway outside of Grand Teton National Park when the pack made an extra-territorial foray south. His death counted towards the Wyoming wolf hunting limit in the area.

Disease Monitoring

In early 2021, some members of the Junction Butte pack showed signs of mild to moderate mange infection. Mange infection seems to be correlated with overall health and may have been an indication that some of the youngest members of the Junction Butte pack (over 30 wolves) were experiencing food stress. This may have also led to the dispersal of many of the male pups (at 10 months old) to join their older siblings in forming the Rescue Creek pack (Figure 1; Table 3). Instead of 1 large pack trying to find enough food, the pack essentially split into 2 with the main pack of about 22 and the new pack with about 10 members. Every wolf that showed signs of mange in early 2021 seemed to be recovered by summer.

Two of the 4 denning females from Junction Butte localized around separate dens but stopped attending their dens after 1 week (uncollared alpha female) and 3 weeks (1276F). Both likely gave birth to litters but lost their pups to unknown causes. Wolf 1154F of the Rescue Creek pack also denned but 3 weeks later her pups died. Scat samples indicated the pups were infected with cryptosporidium (a parasite found in water and soil that causes diarrhea); however, canines rarely die of cryptosporidiosis alone, indicating possible coinfection with an undetected bacteria or virus. Conversely, the pups may have been killed by other wolves as both the 8 Mile and Wapiti Lake packs travelled very close to the Rescue Creek pack den in early May. All other packs had normal pup production and survival with no indication of widespread disease outbreak.

WOLF MANAGEMENT

SUMMARY OF WOLF MANAGEMENT STATEWIDE

In 2021, the Wyoming Game and Fish Department implemented a wolf hunting season with the biological objective to stabilize the wolf population at approximately 160 wolves in the WTGMA. A mortality limit of 47 wolves was divided between 13 hunt areas in the WTGMA and 1 hunt area in the Seasonal WTGMA (hunt area 12). Wolf hunting seasons were open from September 15 to December 31, 2021 with the exception of hunt area 12 (opened on October 15, 2021) and hunt area 13 (closed March 31, 2022). The hunting season for each hunt area closed at the season end date or when the mortality limit in the hunt area was met, whichever occurred first. A total of 30 wolves were killed during the 2021 wolf hunting season. In addition, the 2020 wolf hunting season extended from January 1 to March 31, 2021 in hunt area 13, during which 2 wolves were taken.

Wolves were confirmed to have killed or injured 109 head of livestock (50 cattle, 53 sheep, 5 livestock guarding dogs, and 1 horse) statewide in Wyoming in 2021. Wolf-livestock conflicts in the WTGMA were the lowest recorded since 2010 while conflicts in the Seasonal WTGMA and year-round predatory animal area increased. Nineteen packs were involved in ≥1 livestock conflict statewide. Thirty-two wolves were lethally and legally removed by agencies or the public in an effort to reduce livestock losses to wolves (17 in the WTGMA, 15 in predatory animal areas in WYO).

Wolf Management in the WTGMA

Hunting

Wolf Hunting Season Background: Chapter 47 governs wolf hunting in the WTGMA and was part of the management framework evaluated and approved by the U.S. Fish and Wildlife Service during the delisting process. Wolf hunting regulations for 2020 and 2021 were authorized by the Wyoming Game and Fish Commission and outlined specific hunt areas, mortality limits, season dates, and other wolf hunting regulations in the WTGMA and Seasonal WTGMA. As reported in the 2020 annual wolf report, the 2020 wolf hunting season included season dates for hunt area 13 that extended from January 1 to March 31, 2021. Take occurring during this extended season is included in this report. For the 2021 wolf hunting season, the Wyoming Game and Fish Department delineated 14 wolf hunt areas in the WTGMA and Seasonal WTGMA (Figure 10). Some hunt areas were combined under one mortality limit to accommodate specific wolf pack movements and management objectives (Table 4). As outlined in the Wyoming Gray Wolf Management Plan, the Wyoming Game and Fish Commission-approved wolf hunting seasons were in conjunction with big game hunting seasons and ran primarily from September 15th to December 31st (Table 4). The wolf hunting season opening date was shifted from September 1st in 2018-2019 to September 15th in 2020-2021 to reduce the proportion of juveniles taken in the hunt. The season in hunt area 13 was extended to end March 31st to allow greater opportunity to harvest wolves in areas used by the wintering Whiskey Mountain bighorn sheep herd (Figure 10; Table 4). The wolf hunting season in hunt area 12 (the Seasonal WTGMA) differed from the other 13 hunt areas by opening on October 15 (the date wolves changed from predatory animal to trophy game animal designation as prescribed by

Wyoming Statute 23-1-101(a)(xii)(B)(II)) and closed on December 31, 2021 (Figure 10; Table 4). Wolf hunting mortality was regulated by mortality limits established for each hunt area using a general license hunting structure. Hunters could purchase up to 2 wolf hunting licenses for the 2021 season. Legal and illegal wolf mortality that occurred during the open hunting season counted toward these mortality limits. The season for each hunt area closed when the mortality limit was met or at the season end date, whichever occurred first.

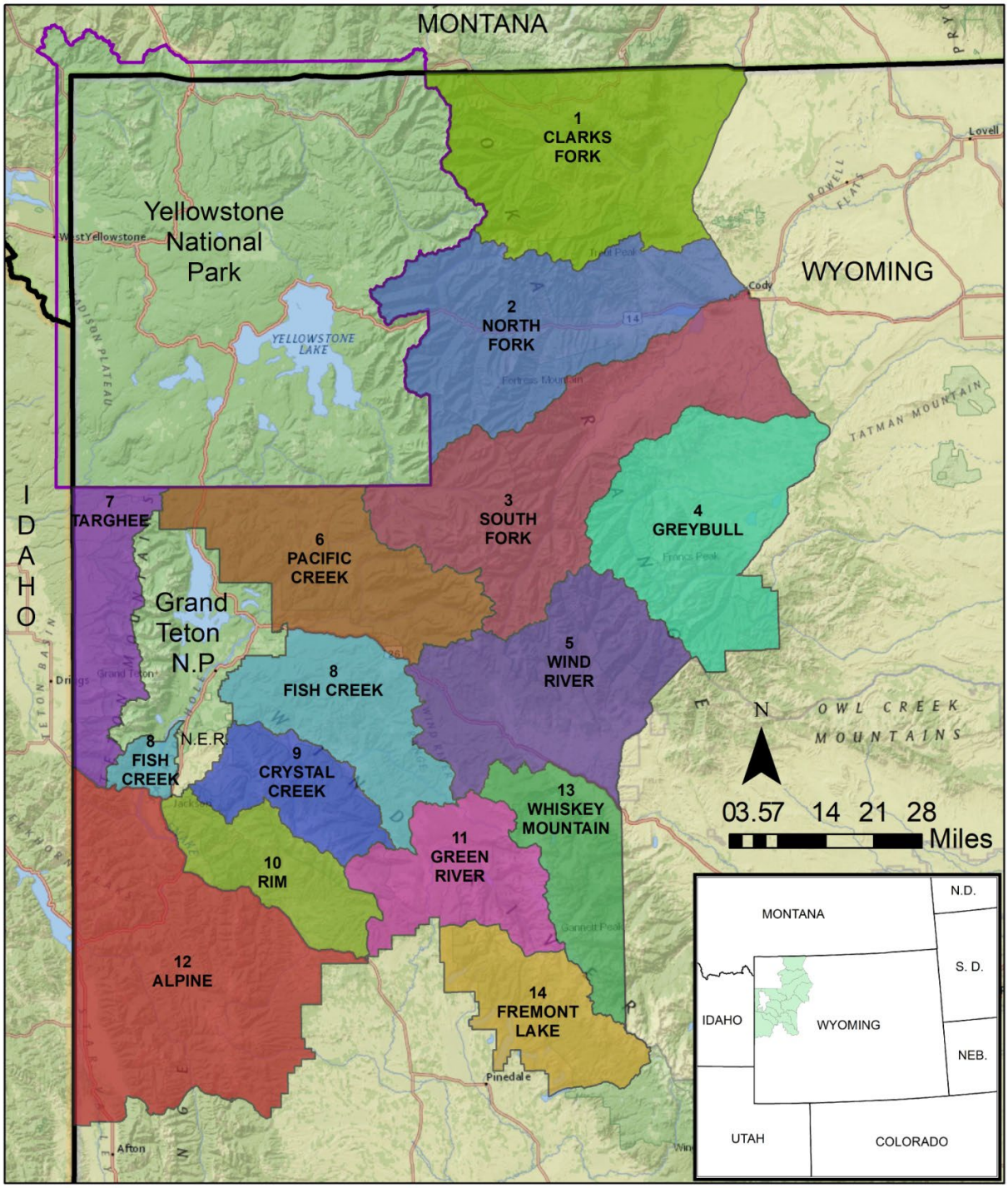

Figure 10. Wolf hunt areas for the 2021 wolf hunting season in northwest Wyoming.

Wolf mortality limits were determined using data collected annually on wolf population dynamics and human-caused mortality in the WTGMA. All forms of mortality, in addition to estimates of recruitment and wolf population demographics, were considered in the mortality limit calculation. The Wyoming Game and Fish Department predicted the population would be slightly increased in the WTGMA from ≥151 wolves at the beginning of 2021 to approximately 160 wolves at the end of 2021 if 42.4% of the wolves present at the beginning of 2021 died from all human-caused mortality. The predicted non-hunting human-caused mortality rate (12.5%) was then subtracted from 42.4% to obtain a 29.9% wolf hunting mortality rate, which equaled a total mortality limit of 45 wolves when applied to the minimum wolf population estimate of ≥151 wolves present in the WTGMA at the beginning of 2021 (i.e., the end of 2020 minimum wolf population [147 wolves] + the Heart Lake pack – 2 wolves taken in hunt area 13 in January 2021). The total mortality limit of 45 wolves was sub-divided among 13 hunt areas in the WTGMA (Table 4). An additional 2 wolves were included in the total mortality limit to be applied to hunt area 12 (the Seasonal WTGMA), for a total mortality limit of 47 wolves (Table 4).

Wolf Hunting in the WTGMA and Seasonal WTGMA: The 2020 wolf hunting season in hunt area 13 extended from January 1 through March 31, 2021, during which time 2 wolves were taken from one pack (Windy Mountain; Table 1). For the 2021 wolf hunting season, a total of 2,325 wolf hunting licenses were sold to 2,146 individuals (1,918 residents and 228 nonresidents), equal to the average sold from 2017-2020 (average = 2,322 licenses). One hundred seventy-nine individuals purchased 2 wolf hunting licenses. A total of 30 wolves (28 legal, 2 illegal) were taken during open wolf hunting seasons in the 14 hunt areas during the wolf hunting season in autumn 2021 (Tables 1, 2 and 4). Seven of the 14 hunt areas closed prior to the established December 31, 2021 closing date due to the mortality limit being met (Table 4). The mortality limit for combined hunt areas 6 and 7 was exceeded by 1 wolf because 2 wolves were killed the same day when only 1 wolf remained on the mortality limit (Table 4). All hunters who legally killed a wolf complied with reporting and registration requirements.

Table 4. Summary of the 2021 wolf hunting season in the WTGMA and Seasonal WTGMA (hunt area 12).

WGFD WOLF HUNTING SEASON SUMMARY 2021					1/1/2022
HUNT AREA(s)	HARVEST LIMIT FROM REGULATIONS	SEASON DATES GENERAL	HARVEST COUNTED TOWARDS LIMIT*	AREA STATUS	DATE/TIME AREA CLOSED
1	8	Sep. 15 - Dec. 31	8	CLOSED	Dec 10 @ 8:35 AM
2	7		3	CLOSED	Jan 1 per regulation
3,4	4		1	CLOSED	Jan 1 per regulation
5	3		3	CLOSED	Oct. 7/8:46 AM
6, 7	4		5	CLOSED	Dec 16 @5:30 AM
8, 9, 11	10		10	CLOSED	Nov. 29 @ 2:00 PM
10	5		0	CLOSED	Jan 1 per regulation
12	2	Oct. 15 - Dec. 31	0	CLOSED	Jan 1 per regulation
13	3	Sep.15 - Mar. 31	0	OPEN	
14	1	Sep. 15 - Dec. 31	0	CLOSED	Jan 1 per regulation
Total 2021 Trophy Limit	47	Total 2021 Trophy Harvest	30		

* Gray wolf trophy hunting quotas and season dates will be determined at the July Wyoming Game and Fish Commission meeting.

* All legal harvest or illegal human-caused gray wolf deaths that occur during an open hunting season will apply to the limit.

Hunting mortality during the wolf hunting season in autumn 2021 was recorded in 14 of 26 packs (54%) that regularly used the WTGMA (includes Arrow Mountain assigned to the Wind River Reservation and Coyote Meadows assigned to Idaho; Table 1). Two additional wolves were taken that did not belong to established packs, both of which had dispersed from Yellowstone National Park (Table 1). Hunting mortality occurred during each month of the season, with most occurring in October (Figure 11). More females than males (16 females:11 males) and equal proportions of black and gray colored wolves were taken during the hunt (13 gray:14 black). Wolves taken during the hunting season in autumn 2021 were primarily adults and subadults (4 juveniles:14 subadults:9 adults). For all wolf hunting seasons combined, a higher proportion of young wolves (juveniles and subadults) have been taken in earlier months with the ratio shifting toward adults through the end of the hunting season in December (Figure 12). The Department moved wolf hunting season openers from September 1st in 2018-2019 to September 15th in 2020-2021 to reduce the proportion of juveniles taken during the hunt. This management decision has, among other possible factors, reduced the proportion of juvenile wolves taken in September from 50% during years when the season opened September 1st to 14% during seasons which opened September 15th. The Department will continue to monitor the results of wolf hunting seasons to determine the long-term results of later season-opening dates to assist in making management decisions in the future.

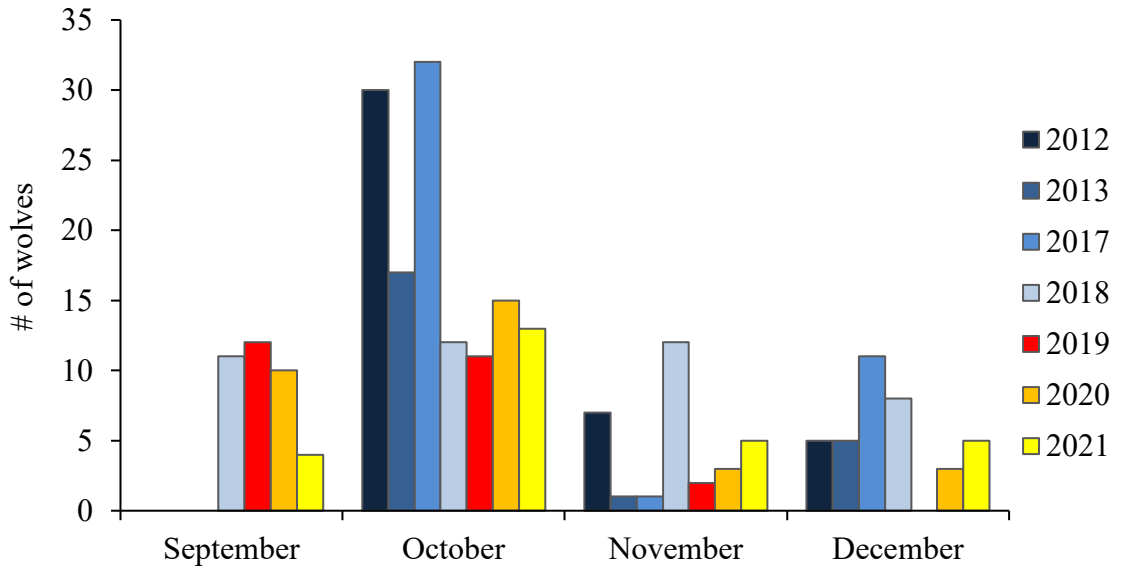

Figure 11. Number of wolves taken during wolf hunting seasons by month and year in the WTGMA and Seasonal WTGMA in northwest Wyoming. (2012, 2013 and 2017 had Oct. 1st openers; 2018-2019 had Sept. 1st openers; 2020-2021 had Sept. 15th openers)

Development of 2022 Wolf Hunting Seasons: The 2021 end of year wolf population in the WTGMA was one wolf above the population objective of 160 wolves and was at the corresponding breeding pair objective of 14 breeding pairs set during the wolf hunting season setting process (Figures 2 and 3; Table 1). Wyoming Game and Fish Department wolf management has consistently produced an end of year wolf population within 10% of the population objective since 2018 (1% above in 2021, 8% below in 2020, 9% above in 2019 and 5% below in 2018). The efficacy of the season-setting process employed is dependent on

analysis of long-term wolf population trend data for the WTGMA, including recruitment (i.e., breeding pairs: Figures 7 and 8) and mortality (Figures 13 and 14). The Department will continue to take an adaptive management approach for setting 2022 wolf hunting seasons as outlined in the Wyoming Gray Wolf Management Plan (Wyoming Game and Fish Commission 2011).

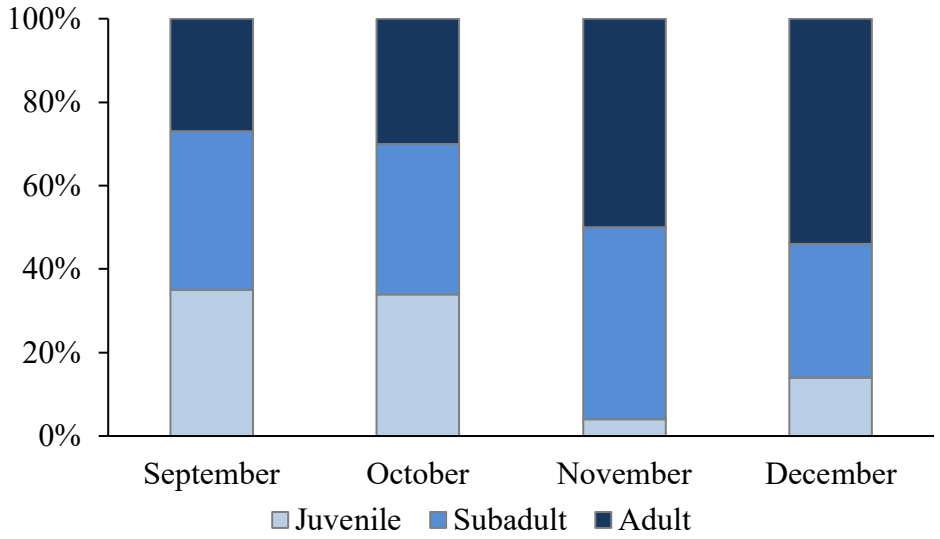

Figure 12. Proportion (%) of adult (>2 years of age), subadult (1-2 years of age), and juvenile (<1 year of age) wolves taken during wolf hunting seasons by month in the WTGMA and Seasonal WTGMA in northwest Wyoming during all wolf hunting seasons: 2012, 2013, 2017-2021. (Seasons started October 1st in 2012, 2013 and 2017, September 1st in 2018-2019, and September 15th in 2020-2021)

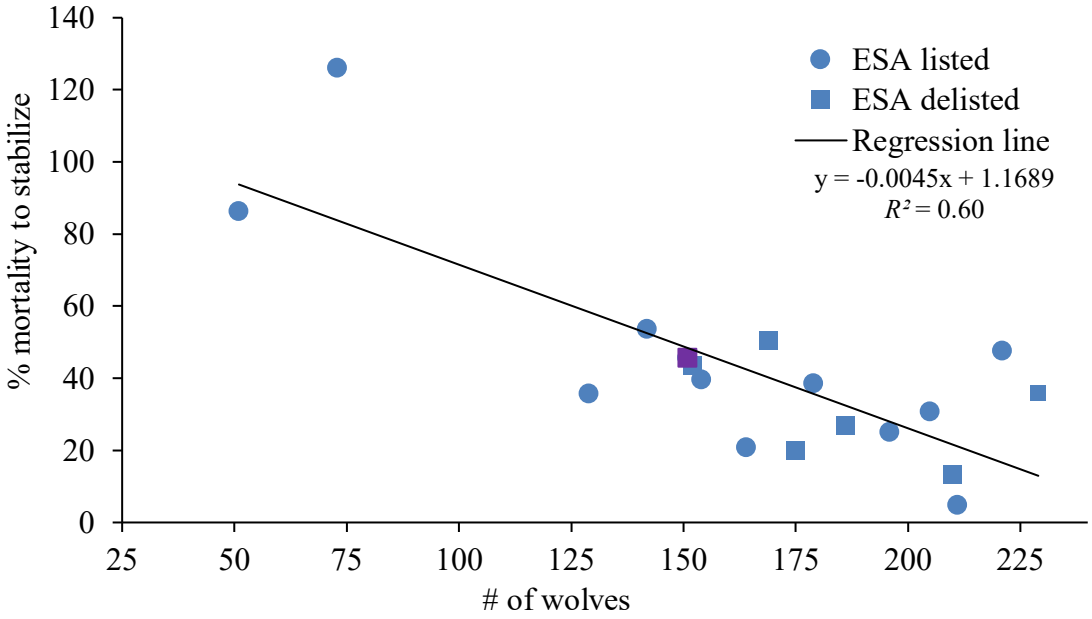

Figure 13. Minimum number of wolves at the beginning of the calendar year and the proportion (%) human-caused mortality that would have been required to stabilize wolf population growth during the calendar year in the WTGMA from 2004-2021. ("■" indicates the 2021 data point)

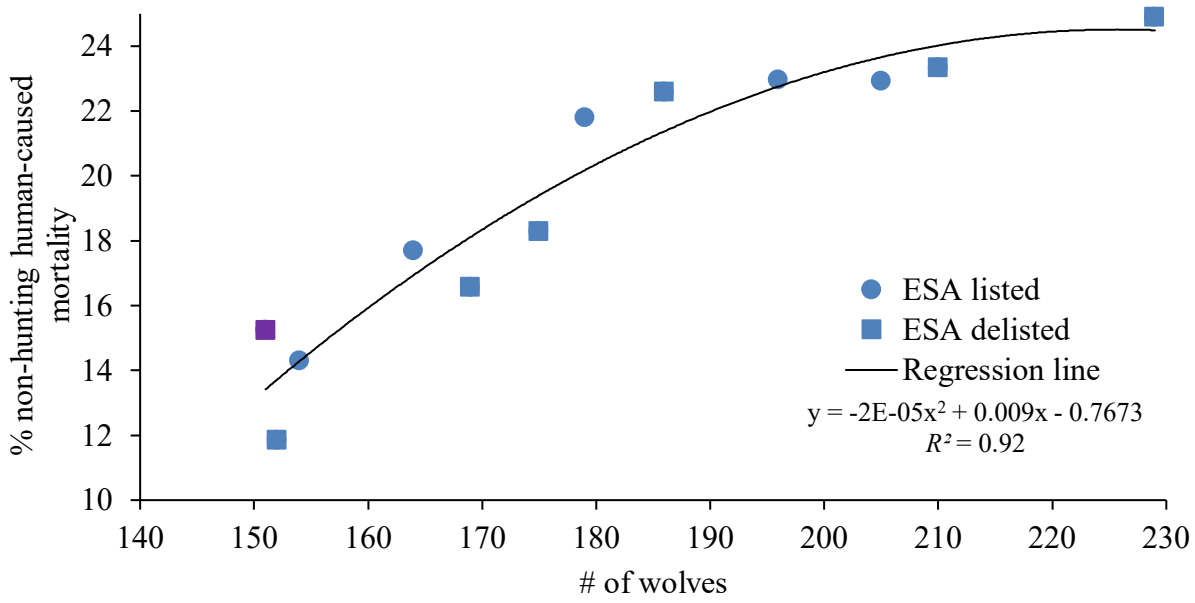

Figure 14. Minimum number of wolves at the beginning of the calendar year and proportion (%) of wolves present in the WTGMA at the beginning of the calendar year that were killed by non-hunting human-causes during the calendar year from 2008-2021. (Statistical outliers from 2011 and 2016 are excluded; "■" indicates the 2021 data point)

Wolf-Livestock Conflicts

During 2021, reported livestock that were killed or injured by wolves (i.e., conflicts) in the WTGMA and Seasonal WTGMA were investigated by the Wyoming Game and Fish Department (Figure 1). Only confirmed livestock conflicts are documented in this report consistent with Wyoming Game and Fish Commission Chapter 28: Regulation Governing Big or Trophy Game Animal or Game Bird or Gray Wolf Damage Claims (Chapter 28), which requires confirmed evidence at the scene or on the livestock carcass indicating wolves were more likely than not responsible for the death or injury of the individual livestock. All suspected conflicts between livestock and wolves are expected to be reported in the WTGMA and Seasonal WTGMA because verification is required to qualify for damage compensation and/or for wolf management actions to be initiated.

In 2021, wolves were responsible for killing or injuring 39 head of livestock (38 cattle and 1 horse) in the WTGMA and 37 head of livestock (32 sheep and 5 livestock guarding dogs) in the Seasonal WTGMA (76 head total: Figure 15; Tables 1 and 5). Livestock confirmed to have been killed or injured by wolves included 38 cattle (29 calves and 9 cows/yearlings), 32 sheep, 5 dogs, and 1 horse (Figure 15; Tables 1, 5 and 6). The total number of wolf-livestock conflicts in 2021 was similar to 2020 with increasing conflict in the Seasonal WTGMA and decreasing conflict in the WTGMA (Tables 5 and 6; Figure 15). Wolves in the Seasonal WTGMA are designated as predatory animals during the summer grazing season and, therefore, are not actively managed by the Wyoming Game and Fish Department. The number of cattle killed by wolves declined compared to previous years, and was the least recorded since 2010 (Figure 15; Table 5). Management actions included collaring wolves, intensive monitoring, lethal removal, non-lethal depredation prevention measures, and issuance of 14 lethal take permits to livestock producers

(11 initial permits, 3 of which were renewed due to continued livestock conflict). Seventeen wolves were killed in response to livestock conflicts in the WTGMA and Seasonal WTGMA; 15 in agency-directed lethal control actions, 1 under authority of lethal take permits, and 1 in defense of private property (Figures 5 and 15; Tables 1, 2 and 5).

Table 5. Confirmed wolf-livestock conflicts and wolves killed in conflict control actions in the WTGMA and Seasonal WTGMA by calendar year.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cattle	38	15	26	41	46	44	60	81	141	87	55	48	51	38
Sheep	16	40	1	0	69	19	3	36	47	22	7	0	12	32
Dogs	0	0	0	0	4	1	0	0	0	1	0	0	1	5
Horses/other	0	1	1	0	0	2	0	1	0	0	2	2	10	1
Total livestock killed/injured	54	56	28	41	119	66	63	118	188	110	64	50	74	76
Wolves killed	32	26	32	32	26	25	29	25	89	46	39	12	27	17

Number of Packs Involved in Confirmed Livestock Conflicts: Sixteen packs (50% of 32 packs that existed in 2021) that use the WTGMA and Seasonal WTGMA were involved in ≥1 livestock conflict in 2021 (includes the Coyote Meadows pack assigned to Idaho: Figure 16; Table 1). Six packs were responsible for 1 confirmed conflict with livestock (37.5% of conflict packs; 19% of all packs), 4 packs were responsible for 2 confirmed conflicts with livestock (25% of conflict packs; 12% of all packs), and 6 packs were responsible for ≥3 confirmed conflicts with livestock (37.5% of conflict packs; 19% of packs; Table 1).

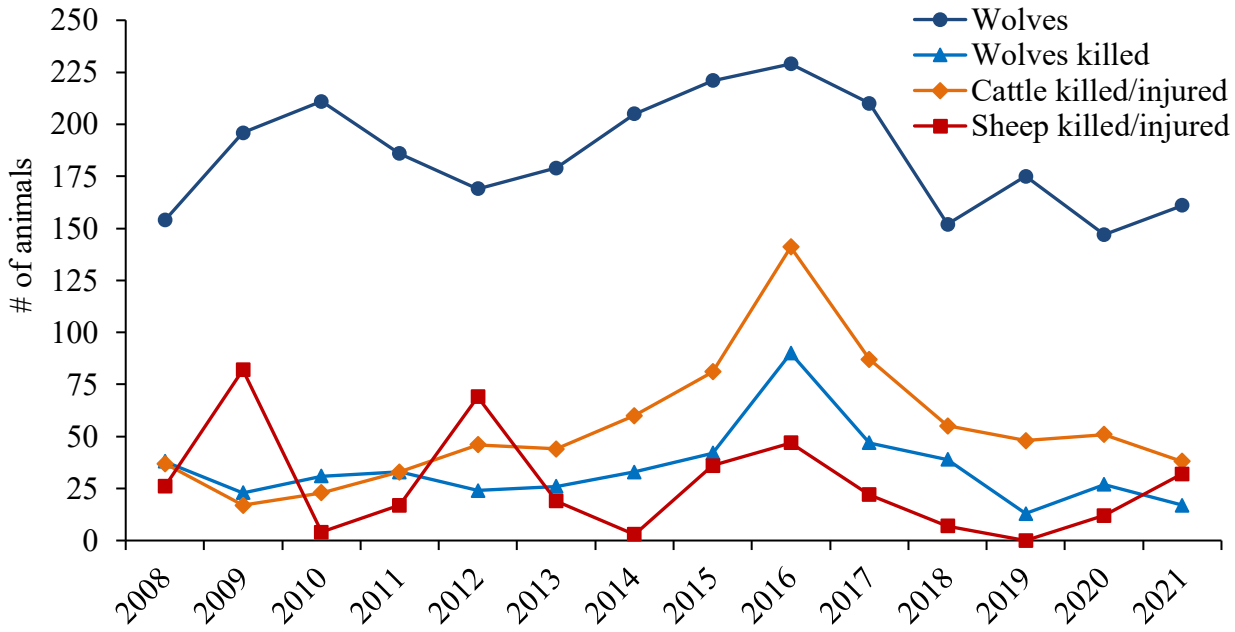

Figure 15. Number of wolves in the WTGMA, confirmed wolf-livestock conflicts and wolves killed in conflict control actions in the WTGMA and Seasonal WTGMA by calendar year.

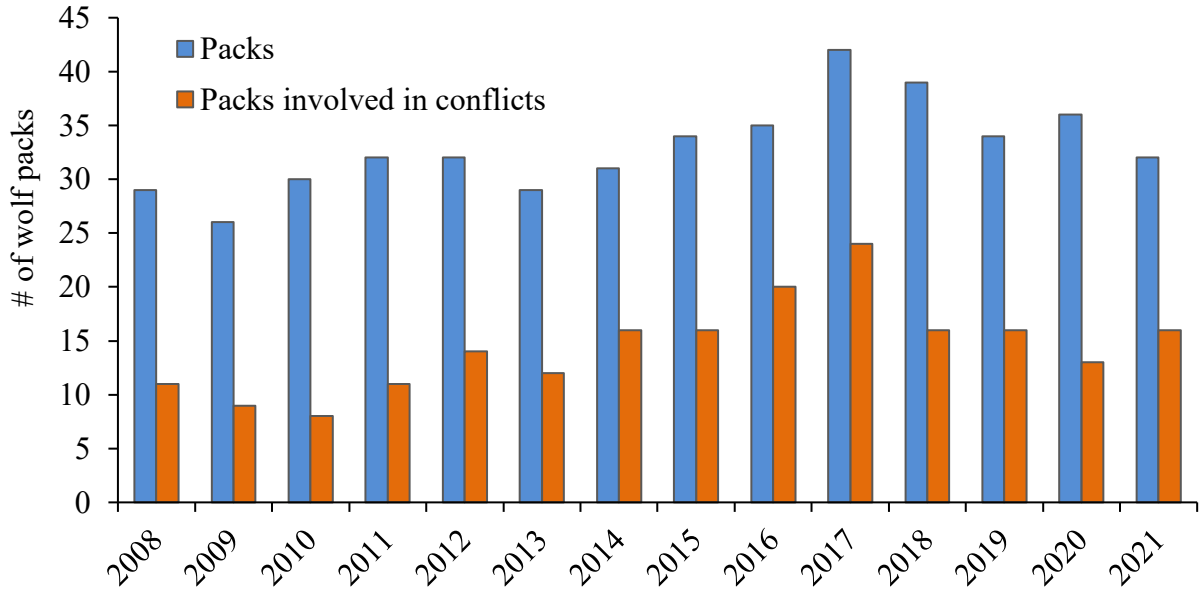

Figure 16. Minimum number of wolf packs present during the calendar year and number of wolf packs that were involved in ≥1 confirmed wolf-livestock conflict in the WTGMA and Seasonal WTGMA by calendar year.

Location of Livestock Conflicts: Land ownership is recorded for all instances of confirmed wolf-livestock conflict in the WTGMA and Seasonal WTGMA as part of routine investigation of reported conflicts. In 2021, 72% of all confirmed wolf-livestock conflicts in the WTMGA and Seasonal WTGMA were on public land (18 cattle, 32 sheep and 5 livestock guarding dogs) and 28% were on private land (20 cattle and 1 horse: Figure 17). All sheep conflicts in the Seasonal WTGMA occurred on public lands, while cattle conflicts were more evenly split between public (47%) and private (53%) lands. The lone horse conflict occurred on private lands (Table 1)

In 2021, hunt area 3 had the highest confirmed wolf-cattle conflicts while hunt area 12 (the Seasonal WTGMA) was the only area with conflicts involving sheep and livestock guarding dogs (Table 6).

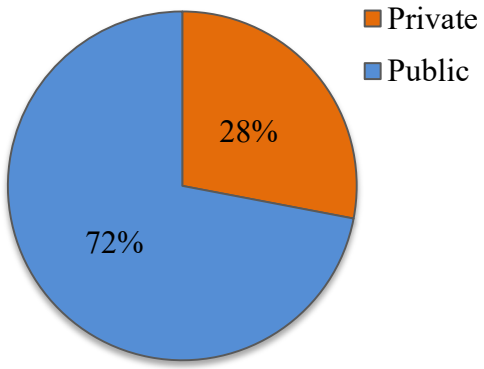

Figure 17. Land status where confirmed wolf-livestock conflict events occurred in the WTGMA and Seasonal WTGMA in 2021.

Table 6. Confirmed wolf-livestock conflicts in the WTGMA (Hunt areas 1-11, 13 & 14) and Seasonal WTGMA (Hunt area 12) by wolf hunt area in 2021.

Hunt area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Cattle	6	2	10	5	6	0	3	2	1	1	2	0	0	0	38
Sheep	0	0	0	0	0	0	0	0	0	0	0	32	0	0	32
Other	0	0	0	0	0	1	0	0	0	0	0	5	0	0	6
Total	6	2	10	5	6	1	3	2	1	1	2	37	0	0	76

Seasonal Trend in Livestock Conflicts: Wolf-cattle conflict patterns in 2021 were similar to previous years but were less frequent (Figure 18). Confirmed conflicts began in April, peaked in September, and then declined toward the end of the calendar year (Figure 18). All wolf-sheep conflicts occurred in August in the Seasonal WTGMA (wolf hunt area 12) during the portion of the year the Wyoming Game and Fish Department does not have wolf management authority in this area (Table 1 and 6; Figure 15). Conflicts between wolves and sheep usually occur in the summer months while sheep are present on public-lands grazing allotments, but do not follow other predictable seasonal patterns similar to cattle.

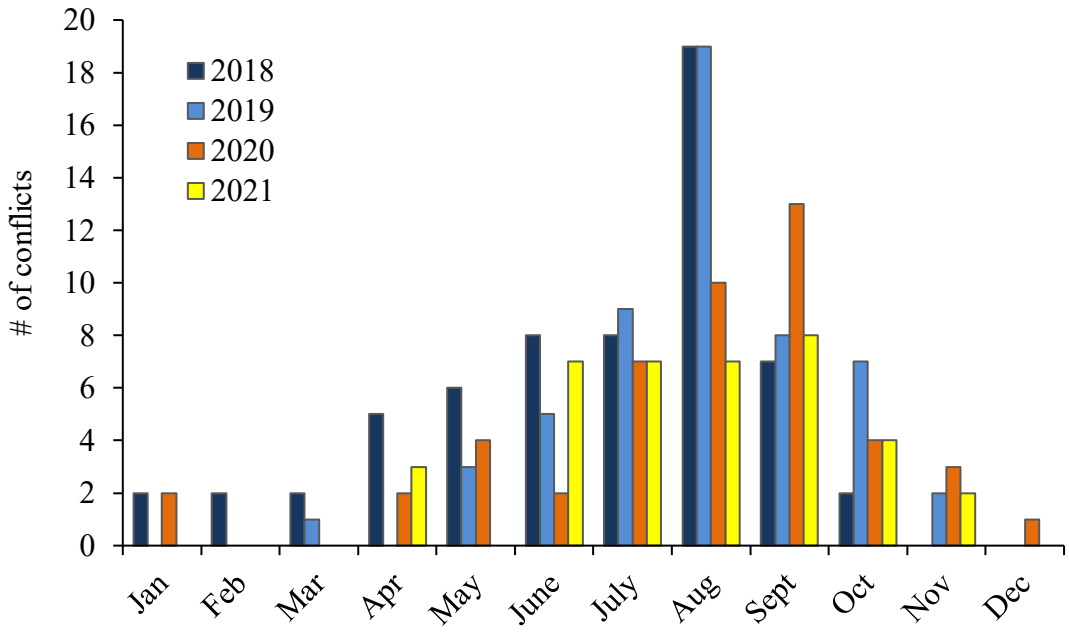

Figure 18. Number of wolf-cattle conflicts per month in the WTGMA and Seasonal WTGMA from 2018-2021.

Compensation for Livestock Damage Caused by Wolves: In 2021, the Wyoming Game and Fish Department paid $208,124 to compensate 18 livestock producers for livestock killed or injured by wolves in the WTGMA and Seasonal WTGMA (Figure 19). Compensation payments declined from >$300,000 from 2014-2017 to ~$200,000 or less from 2018-2021, mirroring synchronous declines in conflict between wolves and livestock following removal of Endangered Species Act protections in 2017 (Figures 15 and 19). Confirmed sheep conflicts, which are compensated using a multiplier of 7 (i.e., 7 sheep compensated for every one confirmed),

increased in the Seasonal WTGMA from 2019-2021 causing overall compensation amounts to increase during that timeframe despite stable to decreasing conflicts with cattle in the WTGMA (Figures 2, 15 and 19; Table 5). Wolf-sheep conflicts in the Seasonal WTGMA occur during the summer when sheep graze on public allotments and wolves are designated as predatory animals and are not under management jurisdiction of the Wyoming Game and Fish Department.

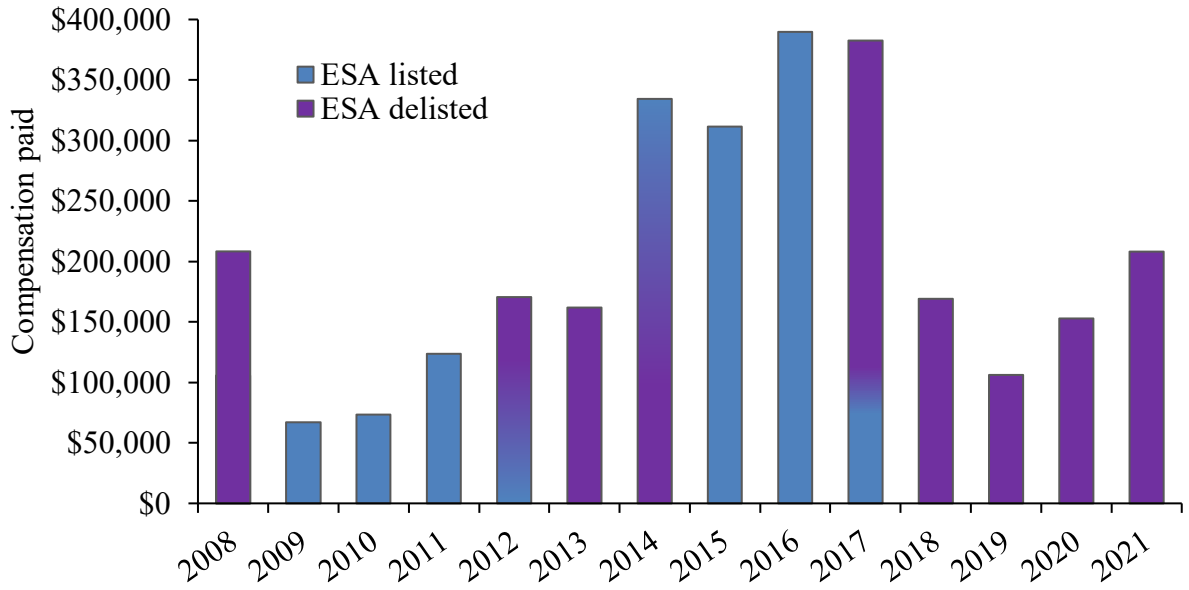

Figure 19. Compensation paid for confirmed livestock damage caused by wolves in the WTGMA (all years) and Seasonal WTGMA (from 2012-2021) by calendar year.

Unacceptable Impacts to Ungulates or Elk Feedgrounds

Under the Wyoming Gray Wolf Management Plan, Wyoming Statute 23-1-304(j), and Chapter 21 regulation, the Wyoming Game and Fish Department 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" (Wyoming Game and Fish Commission 2011). 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.

The Wyoming Game and Fish Department did not conduct any lethal removal actions as a result of unacceptable impacts to ungulates or elk feedgrounds caused by wolves in 2021. Monitoring and analyses of potential impacts to ungulate populations remain an integral part of ongoing management of wolves and their prey in the WTGMA.

Predatory animal areas

A total of 21 wolves were taken by the public under predatory animal designation and an additional 15 wolves were taken by USDA Wildlife Services to prevent conflicts with livestock in predatory animal areas in 2021 (Table 1). Three known packs and other miscellaneous wolves were responsible for killing 12 cattle (11 calves, 1 adult) and 21 sheep (4 lambs, 17 adults) in the year-round predatory animal area in 2021 (Table 1).

Wolf Management on the Wind River Reservation

In 2021, wolves were classed as a trophy game animal on the Wind River Reservation. Legal take could occur for wolves during regulated hunting seasons and for defense of life and property. Reported livestock conflicts with wolves on the Wind River Reservation are investigated by the U.S. Fish and Wildlife Service Lander Fish and Wildlife Conservation Office or the Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department.

Two wolf hunting seasons were implemented from December 1, 2020 through February 28, 2021 and December 1, 2021 through February 28, 2022 on the Wind River Reservation. Season dates were chosen to correspond with the period of the year when wolf pelts are prime. A total quota of 6 wolves was split evenly between 2 hunt areas in the Owl Creek and Wind River Mountains during both seasons. Mandatory reporting was required within 48 hours to allow for seasons to be closed once the quota was met. No wolves were taken during portions of either hunt in 2021 (Table 3).

No wolf-livestock conflicts were verified in 2021 (Table 3). At least 10 cattle were reportedly killed within the Jones Creek pack's territory in May 2021, but U.S. Fish and Wildlife Service and Tribal personnel were not informed in a timely manner to allow investigation or verification.

Wolf Management in Yellowstone National Park

Wolf management in Yellowstone National Park included temporary closures around the Junction Butte and Wapiti Lake den areas to protect the young pups from disturbance and allow the adult wolves to travel to and from the den unimpeded. For the second year in a row the Junction Butte pack was visible nearly every day of the summer and most of the fall, using Slough Creek and Lamar Valley to raise their pups. By early summer, the Wapiti Lake pack moved their pups deeper into the backcountry and the original closure was lifted. Several wolves exhibited habituated behavior and were aversively conditioned. Other wolves that had been habituated in previous years did not cause any management issues in 2021.

OUTREACH

WYO

In person and virtual presentations were conducted by Wyoming Game and Fish Department personnel to multiple school and community groups in 2021. Personnel continued to provide interviews for numerous magazine, newspaper, and television feature stories. As part of normal wolf monitoring and management activities, Wyoming Game and Fish Department personnel interacted with members of the public and made every effort to make these interactions positive and informative to increase the public's involvement and understanding of wolf biology, monitoring, and management throughout Wyoming. The Wyoming Game and Fish Department also conducted 8 public meetings during the wolf hunting season-setting process in May 2021.

Yellowstone National Park

Yellowstone Wolf Project staff gave 105 formal talks, 50 interviews, presented 1 conference poster, and led 16 field trips. During the summer months, staff helped educate at least 20,190 people while viewing wolves and gave 164 informal talks in the field. One of the interviews with Project Leader Doug Smith highlighted gray wolves for CBS Mornings. In addition, collaborating University of Montana PhD candidate Brenna Cassidy taught a 3-day course about wolves through Yellowstone Forever. The book synthesizing the first 25 years of wolf research after reintroduction, Y*ellowstone Wolves: Science and Discovery in the World's First National Park*, was released in the last few days of 2020 and by early 2021 was already in a second printing.

EXPENDITURES

WYO

During the 2021 calendar year, the Wyoming Game and Fish Department conducted annual population monitoring, responsive conflict management, internal and external education and information, and other statutory and regulatory obligations in regards to damage compensation and law enforcement for wolves. The Department directed approximately $598,699 of wolf program funds toward wolf management in 2021. Program expenditures are reported by primary work activities conducted below, but do not represent all Department expenses incurred:

- Monitoring and management program: $337,289
- Conflict prevention and management: $19,589
- Internal and external information and education: $26,760
- Equipment and administration: $6,937
- Compensation for verified wolf-livestock conflict: $208,124

Cooperating agencies in WYO also expended funds directed toward wolf monitoring and management in 2021 as follows:

- Grand Teton National Park: $121,000
- USDA Wildlife Services: $60,045 (including $1,317 for nonlethal projects and $58,728 from the Wyoming Animal Damage Management Board)

Wind River Reservation

A total of $4,150 was spent on wolf monitoring and management in the Wind River Reservation in 2021 ($2,150 by the U.S. Fish and Wildlife Service Lander Fish and Wildlife Conservation Office and $2,000 by the Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department).

Yellowstone National Park

About $550,000 was spent on monitoring and managing wolves in Yellowstone National Park in 2021; $250,000 from federal funding and $300,000 from private sources.

CONTRIBUTORS

Many personnel contributed to the content of the 2021 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:

- Wyoming Game and Fish Department: Ken Mills analyzed data, drafted, and edited the report. Large Carnivore Section: Clint Atkinson, Dan Bjornlie, Mike Boyce, Justin Clapp, Brian DeBolt, Luke Ellsbury, Kyle Garrett, Zach Gregory, Andy Johnson, Ryan Kindermann, Dusty Lasseter, Rebecca Lyon, Gage Metzen, Phil Quick, Sean Ryder, Scott Stingley, Dan Thompson, and Zach Turnbull. Fiscal information: Kindra Brown, Casi Crites, and Tracey Kupec.
- Wyoming Game and Fish Wildlife Health Laboratory: Hank Edwards, Jessica Jennings-Gaines, Katie Luukkonen, and Kara Robbins.
- University of California, Berkeley: Kristin Barker, Arthur Middleton, and Avery Shawler.
- Wyoming State Veterinary Laboratory: Joan Edwards and Jacqueline Kurz.
- Grand Teton National Park: John Stephenson and Sarah Dewey.
- Wildlife Services: Mike Burrell, Mike Foster, Vivian Meek, Rod Merrell, and Melissa Walker.

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

- U.S. Fish and Wildlife Service Lander Fish and Wildlife Conservation Office: Pat Hnilicka.

- Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department: Art Lawson.

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

- National Park Service: Kira Cassidy, Douglas Smith, Daniel Stahler, Erin Stahler, Matthew Metz, Jeremy SunderRaj, Maddy Jackson, Wes Binder, Connor Meyer, Taylor Bland, Brenna Cassidy, Jack Rabe, and Nikki Tatton.

ACKNOWLEDGEMENTS

WYO

We appreciate safe and outstanding piloting from Mark Packila of Wildlife Air, without whom the Wyoming Game and Fish Department's wolf program would not be successful. We also thank Native Range Capture Services for their wolf capture expertise. Ron Blanchard has volunteered many weeks of field effort assisting the wolf monitoring program and provided valuable data for over a decade. We thank numerous regional Wyoming Game and Fish Department biologists and wardens who were instrumental in collecting wolf monitoring data. We also thank staff at the Wyoming Game and Fish Department Wildlife Forensic Laboratory for their assistance with wolf genetic samples. We thank additional personnel at the following agencies for their assistance in wolf monitoring and management: U.S. Forest Service; National Elk Refuge; and Bureau of Land Management. We also thank members of the public and private landowners who assisted the Wyoming Game and Fish Department wolf monitoring and management program in Wyoming. We recognize a successful program needs a strong base of support and to all of the above we continue to be greatly indebted.

Wind River Reservation

We gratefully acknowledge the following for their assistance with wolf conservation: Mike Mazur and Scott Becker (U.S. Fish and Wildlife Service); Justin Friday, Ervin Brown, Ben Snyder, Mirah Snyder, and Wilma Wagon (Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department).

Yellowstone National Park

We thank the many interested people who come forward every year to study and support wolves in YNP. First and foremost, we thank the Wolf Project volunteers, without whom we would not be able to complete this research. We thank Yellowstone Forever for their support of this program. We also thank the many generous individuals, foundations, and organizations that have provided funding for the Wolf Project (through Yellowstone Forever). We deeply appreciate the safe piloting from Mark Packila of Wildlife Air, Jim Pope and team of Leading Edge, and Stephan Robinson and Grayson Sperry of Ridgeline Aviation. We would not be able to learn and teach about wolves without this support.

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