This report presents information on the status, distribution, and management of wolves in the State of Montana, from January 1, 2021 to December 31, 2021.

This report is also available at: http://fwp.mt.gov/fishAndWildlife/management/wolf/

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Montana Gray Wolf Program
2021 Annual Report

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EXECUTIVE SUMMARY

Wolf recovery in Montana began in the early 1980s. The federal wolf recovery goal of 30 breeding pairs for 3 consecutive years in the Northern Rocky Mountains (NRM) of Montana, Idaho and Wyoming was met by 2002. Montana's state Wolf Conservation and Management Plan of 2004 was based on the work of a citizen's advisory council and was approved by the United States Fish and Wildlife Service (USFWS). The wolf population in the NRM tripled between the time recovery goals were met and when wolves were ultimately delisted by congressional action during 2011. At present, Montana Fish, Wildlife & Parks implements the 2004 state management plan using a combination of sportsman license dollars and federal Pittman-Robertson funds (excise tax on firearms, ammunition, and hunting equipment) to monitor the wolf population, regulate harvest, collar packs in livestock areas, coordinate and authorize research, and direct problem wolf control under certain circumstances.

The primary means of monitoring wolf distribution, numbers, and trends in Montana is now Integrated Patch Occupancy Modeling, or "iPOM." The iPOM method uses annual hunter effort surveys, known wolf locations, habitat covariates, and estimates of wolf territory size and pack size to estimate wolf distribution and population size across the state. iPOM estimates of wolf population size are the preferred monitoring method due to accuracy, confidence intervals, and cost efficiency. The 2021 iPOM estimate of wolf population size was 1,144 wolves (95% C.I. = 1,043 – 1,258; Fig. 1).

Wolf hunting was recommended as a management tool in the 2004 Montana Wolf Conservation and Management Plan. Calendar year 2021 included parts of two hunting/trapping seasons for wolves. During calendar year 2021, 160 wolves were harvested during the spring, and 139 wolves were harvested during the fall for a total of 299 (Fig. 1). Sales of license year 2020/21 wolf hunting licenses generated $339,338 for wolf monitoring and management in Montana.

Wildlife Services (WS) confirmed the loss of 96 livestock to wolves during 2021, including 67 cattle and 29 sheep; and 3 livestock guard dogs were also killed by wolves (Fig. 1). This total was similar to numbers during 2011-2020. During 2021 the Montana Livestock Loss Board paid $103,815.95 for livestock that were confirmed by WS as killed by wolves or probable wolf kills. Thirty-nine wolves were killed in response to depredation or to reduce the potential for further depredation. Of the 39 wolves, 38 were killed by WS and 1 was lawfully taken by a private citizen. FWP's wolf specialists radio-collared 15 wolves during 2021 to meet the legislative requirement for collaring livestock packs and to aid in population monitoring and research efforts.

Montana's wolf population grew steadily from the early 1980's when there were less than 10 in the state. After wolf numbers approached 1,250 in 2011 and wolves were delisted, the wolf population has decreased slightly and may be stabilizing at about 1,160 wolves (Fig. 1). Stabilization of population size may be related to the onset of wolf hunting and trapping seasons, whereas reduced livestock depredation in recent years is most likely related to more aggressive depredation control actions (DeCesare et al. 2018). Montana's wolf population remains well above requirements (7 – 8x). Wolf license sales have generated $4.8 million for wolf management and monitoring since 2009.

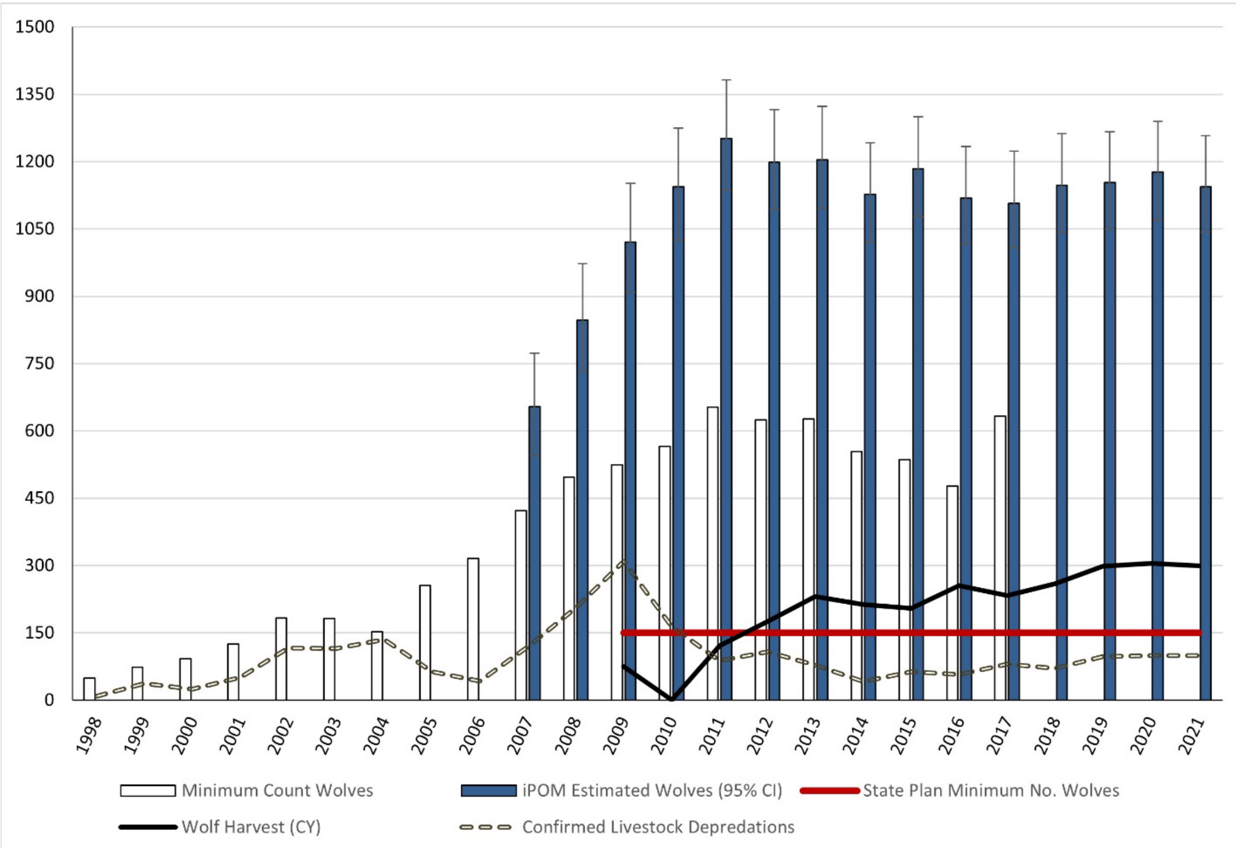

Figure 1. Integrated Patch Occupancy Modeling (iPOM) estimated number of wolves in Montana (including 95% confidence intervals) and verified minimum number of wolves residing in Montana in relation to state wolf plan requirements along with trends in wolf harvest and confirmed livestock losses due to wolves, 1998 – 2021.

1. BACKGROUND

Wolf recovery in Montana began in the early 1980s. Wolves increased in number and distribution because of natural emigration from Canada and successful federal and tribal efforts that reintroduced wolves into Yellowstone National Park and the wilderness areas of central Idaho. The federal wolf recovery goal of 30 breeding pairs for 3 consecutive years in Montana, Idaho and Wyoming was met during 2002, and wolves were declared to have reached biological recovery by the U.S. Fish and Wildlife Service (USFWS) that year. During 2002 there were a minimum of 663 wolves and 43 breeding pairs in the Northern Rocky Mountains (NRM).

The Montana Gray Wolf Conservation and Management Plan was approved by the USFWS in 2004. Nine years after having been declared recovered and with a minimum wolf population of more than 1,600 wolves and 100 breeding pairs in the NRM, in April 2011, a congressional budget bill directed the Secretary of the Interior to reissue the final delisting rule for NRM wolves. On May 5, 2011 the USFWS published the final delisting rule designating wolves throughout the Distinct Population Segment (DPS), except Wyoming, as a delisted species.

Beginning with delisting in May 2011, the wolf was reclassified as a Species in Need of Management in Montana. Montana's laws, administrative rules, and state plan replaced the federal framework. The Montana Wolf Conservation and Management Plan is based on the work of a citizen's advisory council. The foundations of the plan are to recognize gray wolves as a native species and a part of Montana's wildlife heritage, to approach wolf management similar to other wildlife species such as mountain lions, to manage adaptively, and to address and resolve conflicts. As noted in the State Plan, "Long-term persistence of wolves in Montana depends on carefully balancing the complex biological, social, economic, and political aspects of wolf management."

At present, Montana Fish, Wildlife & Parks implements the state management plan using a combination of sportsman license dollars and federal Pittman-Robertson funds (excise tax on firearms, ammunition, and hunting equipment) to monitor the wolf population, regulate hunter harvest, coordinate and authorize research, and direct problem wolf control under certain circumstances. Several state statutes also guide FWP's wolf program. FWP and partners have placed increasing emphasis on proactive prevention of livestock depredation. USDA Wildlife Services (WS) continues to investigate injured and dead livestock, and FWP works closely with them to resolve conflicts. Montana's Livestock Loss Board compensates producers for losses to wolves and other large carnivores.

Montana wolf conservation and management has transitioned to a more fully integrated program since delisting. With wolf population level securely above requirements for over a decade, FWP continues to adapt the wolf program to match resources and needs. For years, when the population was small and wolves were listed, a "wolf weekly" report was issued, detailing all depredations, collaring, control and known mortalities. That level of detail and its associated expense is no longer warranted, and the information is now reported annually. This allows limited personnel time and conservation dollars to be allocated more effectively.

Population monitoring techniques have also changed. Wolf packs were intensively monitored year-round beginning with their return to the northwestern part of Montana in the 1980s. Objectives for monitoring during the period of recovery were driven by the USFWS's recovery criteria – 30 breeding pairs for 3 consecutive years in Montana, Idaho, and Wyoming. Similar metrics of population status were used from the time recovery criteria were met in 2002, through delisting in 2011, and for the 5 years when the USFWS retained oversight after delisting. These population monitoring criteria and methods were appropriate and achievable when the wolf population was small and recovering. For instance, in 1995, when wolves were reintroduced into Yellowstone National Park and central Idaho, the end-of-year count for wolves residing in Montana was 66. In the early years, most wolf packs had radio-collared individuals and intensive monitoring was possible to identify new packs and most individuals within packs. However, in later years, the minimum count of wolves approached or exceeded 500 individuals distributed across more than 25,000 square miles of mostly rugged and remote terrain in western Montana. Therefore, the ability to count every pack, every wolf, and every breeding pair has become expensive, unrealistic, and unnecessary. Consequently, FWP has moved to more cost-effective methods for monitoring wolves. These methods can be more accurately described as population estimates that account for uncertainty (confidence intervals), as opposed to a minimum count where the end result, at this time when populations are large, reflects total effort (and dollars spent) as much as population numbers.

FWP first began considering alternative approaches to monitoring the wolf population in 2006 through a collaborative effort with the University of Montana Cooperative Wildlife Research Unit. The primary objective was to find an alternative approach to wolf monitoring that would yield statistically reliable estimates of the number of wolves, the number of wolf packs, and the number of breeding pairs (Glenn et al. 2011). Ultimately, a method applicable to a sparsely distributed and elusive carnivore population was developed that used hunter observations as a cost-effective means of gathering biological data to estimate the area occupied by wolves in Montana - "Patch occupancy modelling" (POM; Rich et al. 2013a) and most recently "Integrated Patch Occupancy Modeling" (iPOM; Sells et al. (2020a, Sells et al. In Press).

iPOM is a modern, scientifically valid, and financially efficient means of monitoring wolves. iPOM is the best and most efficient method to document wolf population numbers and trends at this point in time. FWP is confident that the wolf population estimate and trends that iPOM provides is sufficient and scientifically valid evidence that can be used to assess wolf status relative to the criteria outlined in Montana's Wolf Conservation and Management Plan. Minimum counts and pack tables are no longer reported. Instead, the more appropriate and efficient techniques that have been in development for a decade are being used. If new and improved techniques become available in the future, those methods may be implemented when appropriate.

2. WOLF POPULATION MONITORING

2.1 Wolf Distribution and Numbers via Integrated Patch Occupancy Modeling

We used an Integrated Patch Occupancy Model (iPOM) to estimate the distribution and number of wolves in Montana (Sells et al. 2020). With iPOM, an occupancy model estimates the extent of wolf distribution in Montana, and a territory model predicts territory sizes; together, these models predict the number of packs in a given area (Fig. 2). A group size model predicts pack sizes. Total abundance estimates are derived by combining the estimated number of packs and pack sizes, while also accounting for lone and dispersing wolves.

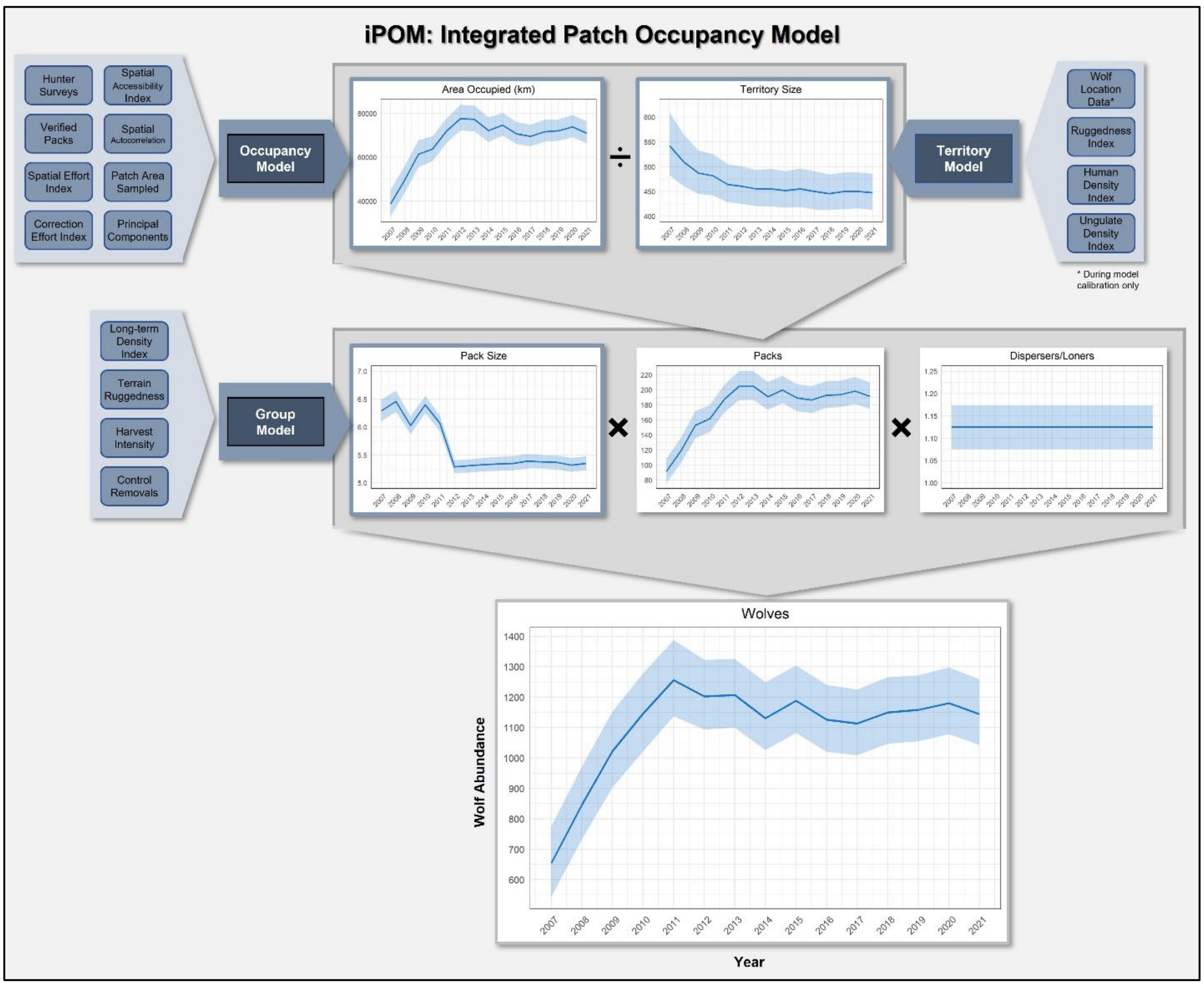

Figure 2. Schematic for method of estimating the area occupied by wolves, number of wolf packs and number of wolves in Montana, 2007 – 2021 using an Integrated Patch Model. Graphs show statewide estimates over time. Ribbons indicate 95% credible intervals.

Integrated Patch Occupancy Modeling Methods

Occupancy Model

To predict where wolves occurred in Montana each year from 2007 – 2021, we fit a multi-season false-positives occupancy model in a Bayesian context (Bassing et al. 2019). This work built on an earlier occupancy model (Miller et al. 2013, Rich et al. 2013, Inman et al. 2020). Following those authors, we created an observation “iPOM grid” for Montana as 600 km^2 cells. We assigned locations of wolves in packs to grid cells, based on monitoring effort by FWP wolf specialists and wolf sightings reported by hunters each fall. Wolf specialists monitored packs each year to verify presence using trail cameras, visual observations, and telemetry collars, and used these data to demarcate approximate territory centroids for packs. FWP conducted annual Hunter Harvest Surveys of a random sample of 50,000 – 80,000 resident deer and elk hunters annually to obtain wolf sighting reports. Hunters spent 1.8 – 2.2 million hunter days each fall pursuing deer and elk (fwp.mt.gov), providing many observers across Montana. Hunters were queried about dates and locations of any sightings of groups of 2 – 25 wolves.

To develop encounter histories, we divided the 5-week general rifle season (occurring each year around late Oct. through Nov. or early Dec.) into one-week encounter periods and mapped locations of pack centroids and hunter observations for each week. Based on past work (Miller et al. 2013, Rich et al. 2013, Inman et al. 2020), we included model covariates for detection as: 1) hunter days per km^2 in each hunting district (an index to spatial effort), 2) proportion of mapped wolf observations (a correction for effort, accounting for number of hunter observations with coordinates versus total reported, including any sightings with vague location descriptions), 3) densities of low-use forested and non-forested roads (indices of spatial accessibility), 4) a spatial autocovariate (proportion of neighboring cells with wolves seen out to a mean dispersal distance of 100 km), and 5) patch area sampled (because smaller cells on the border of Montana, parks, and tribal lands have less hunting activity and therefore less opportunity for hunters to see wolves). We also included cell size as a nuisance parameter to account for varying cell sizes. Model covariates for occupancy, colonization, and local extinction included a principal component constructed from several autocorrelated environmental covariates (percent forest cover, slope, elevation, latitude, percent low use forest roads, and human population density), and recency (number of years with verified pack locations in the previous 5 years).

Using these pack locations and model covariates, we fit the multi-season false-positives occupancy model to estimate psi, the probability of occupancy (ψ). We used pack centroids to estimate probabilities of false positives, true positives, and false negatives (Miller et al. 2013). We estimated ψ for tribal lands and national parks, where no hunter survey data were available, via modeled covariates.

We used Markov chain Monte Carlo (MCMC; Brooks 2003) methods in a Bayesian framework to fit the occupancy model using program R 3.4.1 (R Core Team 2020) and package rjags (Plummer et al. 2019) that calls on program JAGS 4.2.0 (Plummer 2003). We ran 3 chains for 10,000 iterations, after an adaptation phase of 10,000 iterations and a burn-in of 10,000 iterations. We did not thin the MCMC chains.

Territory Model

We used a recently developed mechanistic territory model to predict territory size. Full details are available in Sells and Mitchell 2020 and Sells et al. 2020, 2021. The territory model was a spatially-explicit, agent-based model representing the hypothesis that wolves are adapted to select economical territories that maximize food benefits and minimize costs of travel, competition, and mortality risk. After calibrating the model using wolf location data collected from 2014 – 2018 (Sells et al. 2020), the model provided territory size predictions through simulations in NetLogo 6.1.1 (Wilensky 1999).

The model demonstrated the strong effect of competition on resulting space use (Sells and Mitchell 2020; Sells et al. 2020, 2021). Accordingly, we applied the model to predict territory sizes at a wide range of possible pack densities and resulting levels of competition. We used a density identifier model (Sells et al. 2020) to predict levels of competition in each area of Montana for each year. We then used the territory sizes predicted at the given level of competition as estimates of territory size in each area of the state.

Group Model

We used a recently-developed group size model (Sells et al. 2020) to predict pack sizes in each 600 km^2 iPOM grid cell. The model was based on mechanisms hypothesized to influence wolf pack size and developed using 14 years of wolf pack data. The generalized linear mixed effects model included effects of pack density, terrain ruggedness, harvest intensity, and control removals. Pack density was the long-term (2005 – 2018) mean pack density in the iPOM grid cell, which served as an index to density trends (Sells et al. 2020). Ruggedness was terrain ruggedness in the iPOM grid cell. Harvest intensity was categorized as “none” when no harvest was allowed, “restricted” if 2009 and 2011 rules were followed (statewide harvest was limited by a quota, seasons were shorter, bag limits were low, and trapping was prohibited), and “liberal” if 2012 – 2021 rules were followed (statewide harvest quotas were removed, seasons were longer, bag limits were higher, and trapping was allowed; fwp.mt.gov). Control removals were reported numbers of wolves removed for depredations in the iPOM grid cell that year. Ecoregion defined in which ecoregion the iPOM grid cell fell (epa.gov). The unique identifier for the iPOM grid cell was included as a random effect to account for repeated observations among years. We applied the model to each iPOM grid cell, each year, to predict local pack size.

Model Integration

We estimated numbers of packs and wolves for each year, 2007 – 2021, by combining predictions from the 3 models (Fig. 2) using an integrated approach (Sells et al. In Press). We first calculated mean estimated occupancy ($\bar{\psi}$) across iPOM grid cells, then calculated area occupied ($area_{occupied}$) as:

$$area_{occupied} = \bar{\psi} \times \sum grid_{area}$$

where $\sum grid_{area}$ was the sum of grid cell areas. We calculated number of estimated packs as:

$$N_{packs} = area_{occupied} \div territory_{size}$$

where values for $territory_{size}$ were drawn with replacement for each iteration of the MCMC chain from the distribution of territory sizes predicted by the territory model at the specific grid cell. Values for $territory_{size}$ were therefore spatially explicit and biologically appropriate to local conditions each year and accounted for uncertainty. We then calculated number of wolves as:

$$N_{wolves} = N_{packs} \times pack_{size} \times lone_{rate}$$

where $lone_{rate}$ accounted for lone and dispersing wolves. For $pack_{size}$ we drew for each iteration of the MCMC chain a value from the distribution of group sizes predicted at the specific grid cell. This provided spatially explicit and biologically appropriate values for local conditions each year while incorporating model uncertainty about pack size. We modeled $lone_{rate}$ by drawing for each iteration of the MCMC chain values from a normal distribution assuming a mean of 1.125 and standard deviation of 0.025. This yielded a loner/disperser rate of 12.5% and incorporated variation and uncertainty around this rate, as 95% of values drawn were 7.6 – 17.4%. We selected these values based on studies documenting that 10 – 15% of wolf populations are comprised of lone or dispersing wolves (Fuller et al. 2003). This is consistent with Idaho's calculations for lone wolves (Holyan et al. 2013) and slightly more conservative than Minnesota's calculations, which add 15% (Erb et al. 2018).

To account for uncertainty and calculate credible intervals (CI's) for all parameters, we retained posterior estimates of 10,000 values for each and calculated the median value and 2.5% and 97.5% values (creating 95% CI's) for $area_{occupied}$, $territory_{size}$, $pack_{size}$, N_{packs}, and N_{wolves}. We calculated density of packs per 1,000 km^2, wolves per 1,000 km^2, and population growth (lambda, λ).

We repeated these calculations for FWP management regions by completing each step described above at each subsetted group of grid cells by region. Grid cells were categorized by the region in which the majority of their areas fell.

Integrated Patch Occupancy Modeling Results

Area Occupied

Each year (2007 – 2021), 44,690 – 82,375 hunters responded annually to the wolf sighting surveys. From their reported sightings, 669 – 3,469 locations of 2 – 25 wolves were mapped each year. Percent of hunters reporting a wolf sighting ranged from 4.0% (2021) to 7.5% (2011).

From 2007 – 2021, estimated area occupied by wolf packs in Montana ranged from 38,731 km2 (95% CI = 33,035 – 44,971) in 2007 to 77,676 km^2 (95% CI = 72,247 – 83,954) in 2012 (Fig. 3).

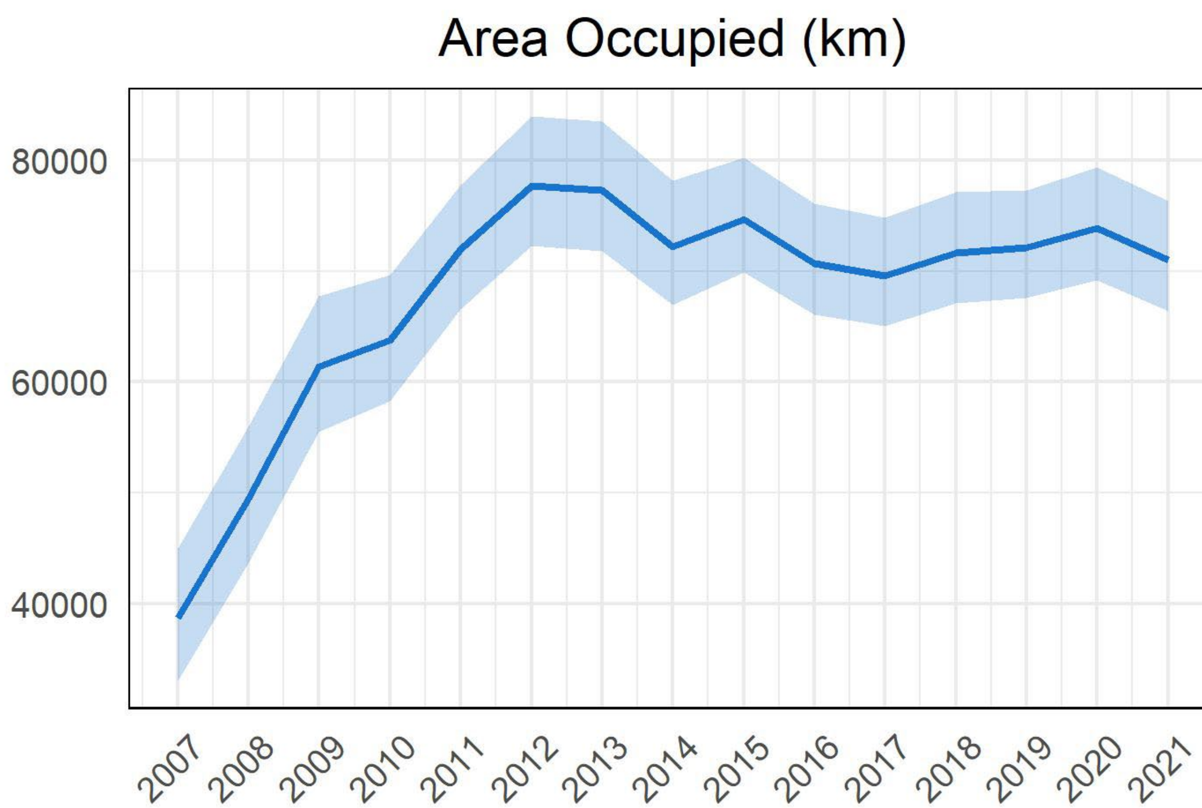

Figure 3. Estimated total area occupied (km^2) by wolves in Montana, 2007 – 2021. Ribbon indicates 95% credible interval.

Territory Size

Estimated territory size varied across time and space (Fig. 4). Overall, territory size was estimated to be largest in southwest MT and second largest in areas in and around Glacier National Park and the Bob Marshall Wilderness. Territories were estimated to be smaller in northwest MT and the Bitterroot. Territory size was greatest in 2007 and dropped thereafter, and has remained largely stable in the past decade.

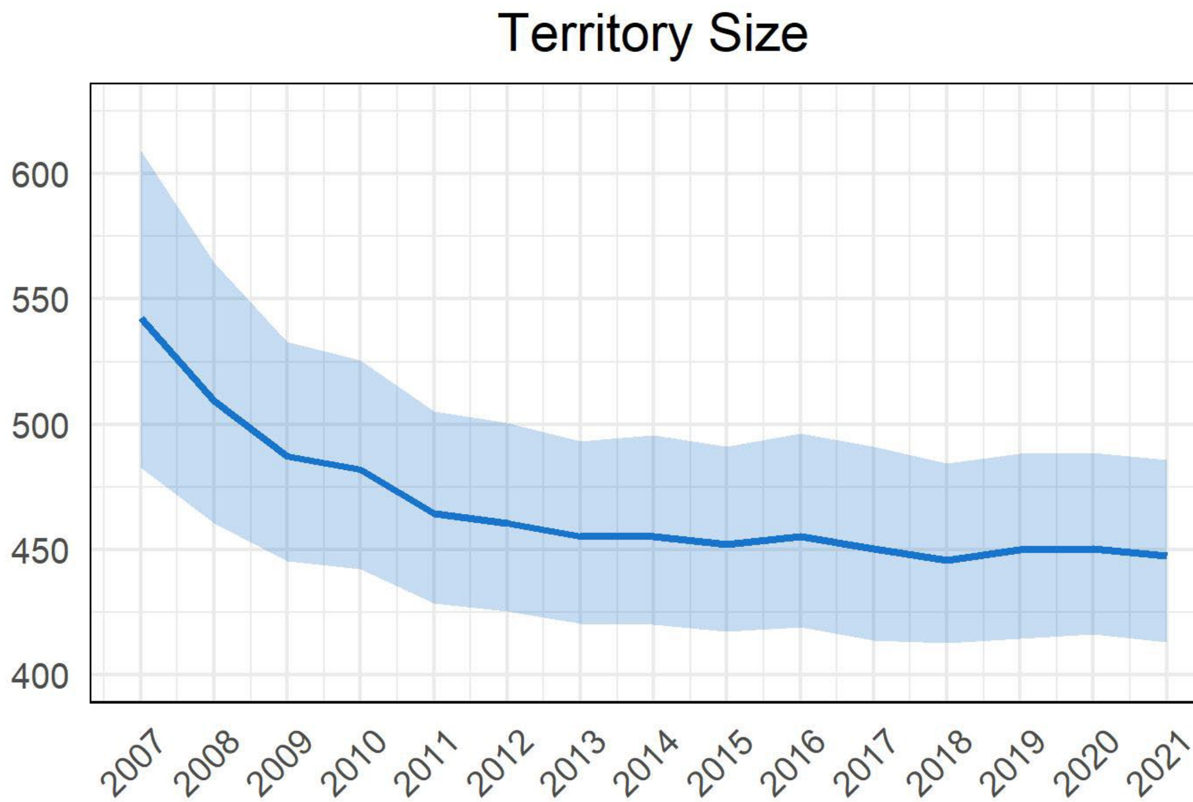

Figure 4. Estimated mean territory size (km^2) of wolves in Montana, 2007 – 2021. Ribbon indicates 95% credible interval.

Group Size

Estimated pack size also varied (Fig. 5). Mean pack sizes were larger in earlier years (prior to harvest) and have since declined by approximately 1 wolf per pack, on average. Mean pack size was estimated to be similar across Montana (an approximate difference of < 1 wolf per pack in most years).

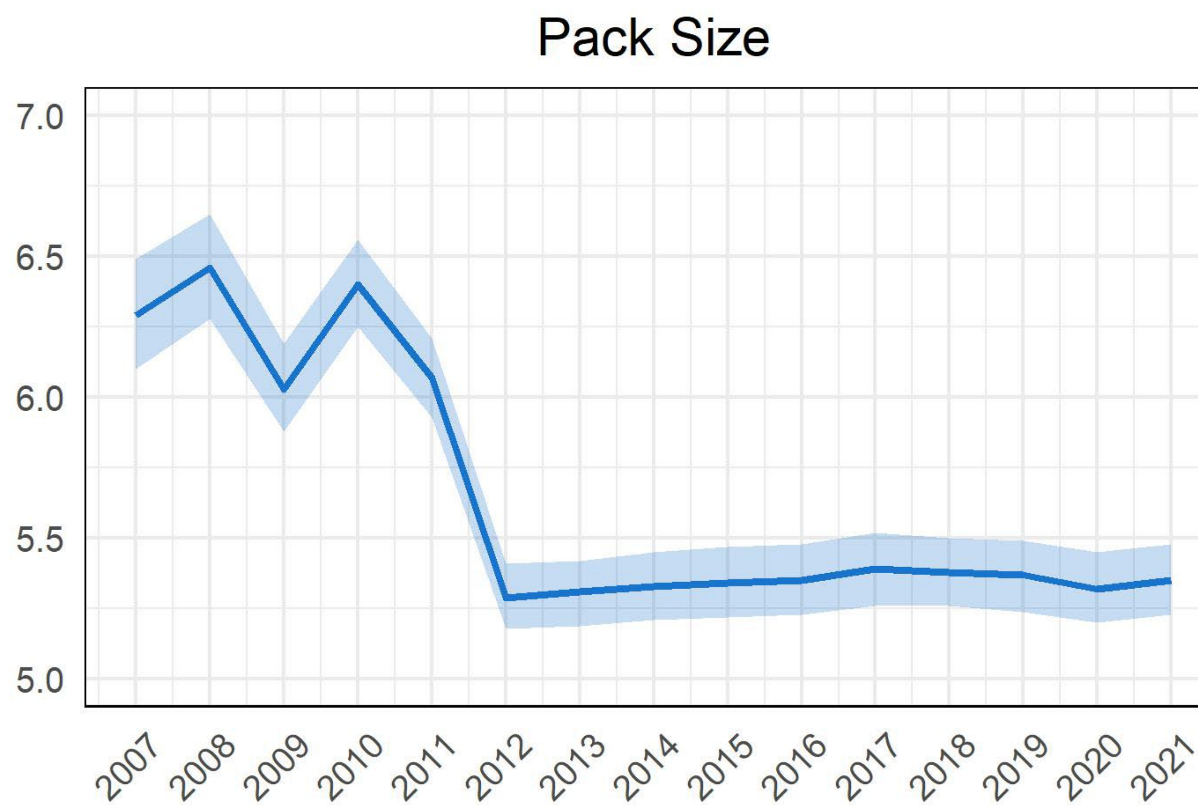

Figure 5. Estimated mean pack size of wolves in Montana, 2007 – 2021. Ribbon indicates 95% credible interval.

Estimated Number of Packs and Wolves

Estimated numbers of packs and wolves varied through time (Fig. 6; Table 1). The population was estimated to have been smallest in the first year of our analysis (2007), with 91 packs (95% CI = 76 – 108) and 654 wolves (95% CI = 545 – 776). Population growth was positive through 2011 (Fig. 6). Total wolf numbers peaked in 2011 with 188 packs (95% CI = 170 – 207) and 1,256 wolves (95% CI = 1,138 – 1,388). This peak coincided with the first years of harvest management in Montana, after which the population declined by 9.0% in total wolf abundance between 2011 and 2021.

Population growth rate alternated from slightly positive and slightly negative each year (Fig. 7). From 2016 – 2021, the population appears to have become somewhat stabilized with an average of 192 packs and 1,143 wolves per year.

Estimated numbers of packs and wolves varied spatially (Fig. 6). Pack and wolf abundances were consistently greater in FWP Region 1, followed by Regions 2 and 3. Regions 4 – 7 each contained only ≤ 1 – 9% of packs and 1 – 9% of wolves.

Wolf densities varied over space and time (Fig. 8). Densities were estimated to be greatest in FWP Region 1 (ranging 6.43 – 13.32 wolves per 1,000 km^2 from 2007 – 2021), followed by Region 2 (6.64 – 12.44) and Region 3 (3.23 – 5.09). Regions 4 – 7 had ≤ 1.42 wolves per 1,000 km^2. Maps of pack and wolf densities demonstrate close alignment between known packs, locations of wolf harvests, and predictions from iPOM (Fig. 8).

Table 1. Estimated area occupied by wolves (km^2), number of wolf packs, and number of wolves in Montana, 2007 – 2021. Annual numbers were based on best available information and were retroactively updated as integrated patch occupancy modeling incorporated more information each year.

Year	Area Occupied	LCI Area Occupied	UCI Area Occupied	Packs	LCI Packs	UCI Packs	Wolves	LCI Wolves	UCI Wolves
2007	38731	33035	44971	91	76	108	654	545	776
2008	49425	43649	55945	119	103	136	846	734	971
2009	61360	55465	67762	153	135	172	1022	903	1152
2010	63777	58274	69673	162	144	180	1146	1022	1279
2011	71932	66569	77758	188	170	207	1256	1138	1388
2012	77676	72247	83954	205	186	225	1203	1093	1323
2013	77316	71815	83502	205	187	225	1208	1100	1326
2014	72172	66957	78149	191	173	210	1131	1027	1249
2015	74666	69897	80199	200	183	219	1188	1083	1304
2016	70710	66055	76103	189	172	208	1126	1020	1241
2017	69554	65032	74823	186	169	205	1113	1010	1226
2018	71625	67073	77088	193	176	211	1150	1048	1266
2019	72107	67563	77255	194	177	212	1158	1056	1272
2020	73897	69140	79375	198	181	217	1181	1079	1298
2021	71035	66413	76353	192	175	210	1144	1043	1258

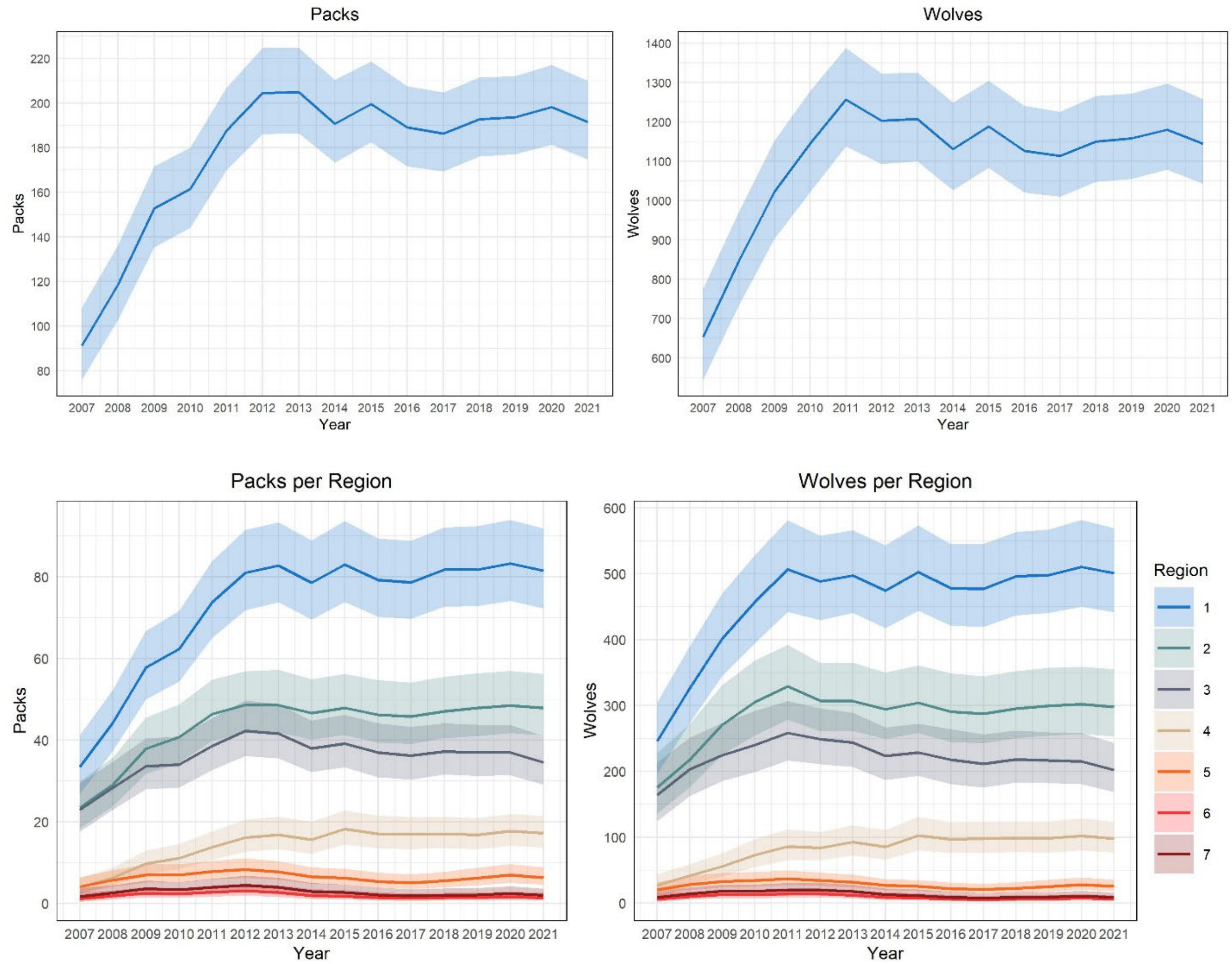

Figure 6. Estimated number of packs and wolves in Montana and by FWP Administrative Region, 2007 – 2021. Ribbons indicate 95% credible intervals.

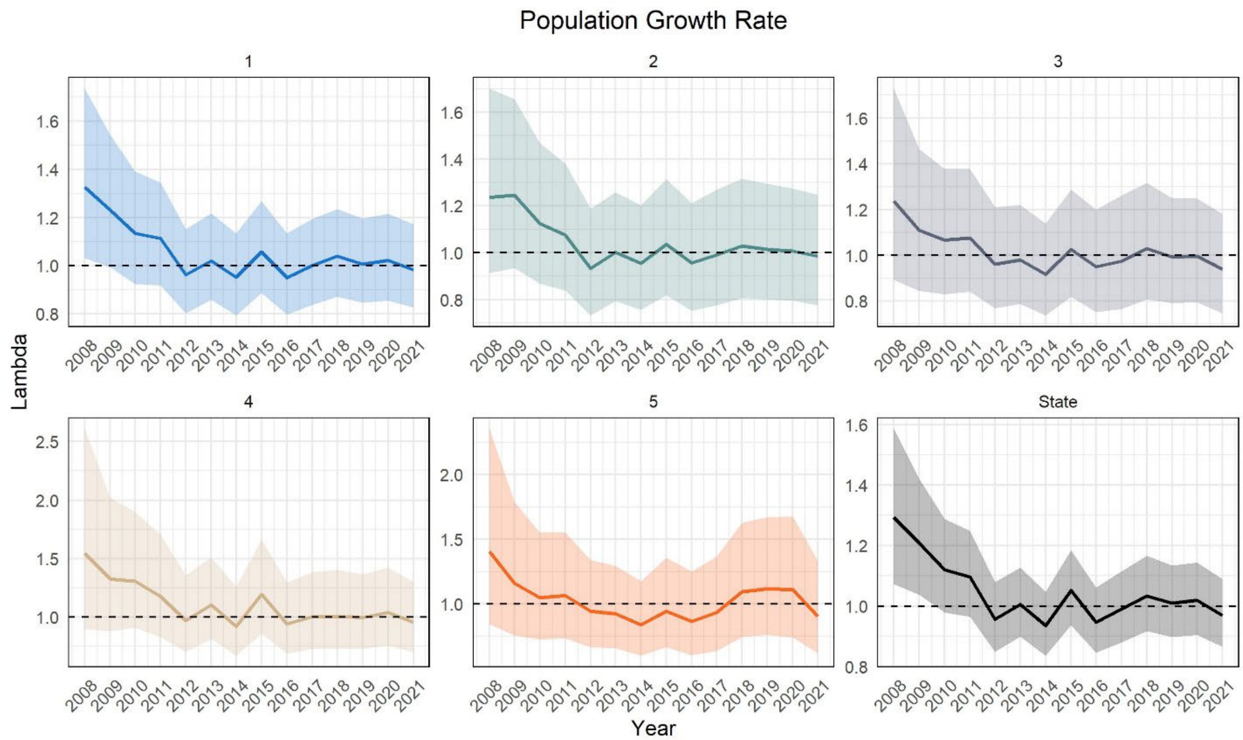

Figure 7. Population growth rate for wolves in FWP Administrative Regions 1 – 5 and the state, 2008 – 2021. Values <1 indicate a declining population, whereas values >1 indicate a growing population. Ribbons indicate 95% credible intervals.

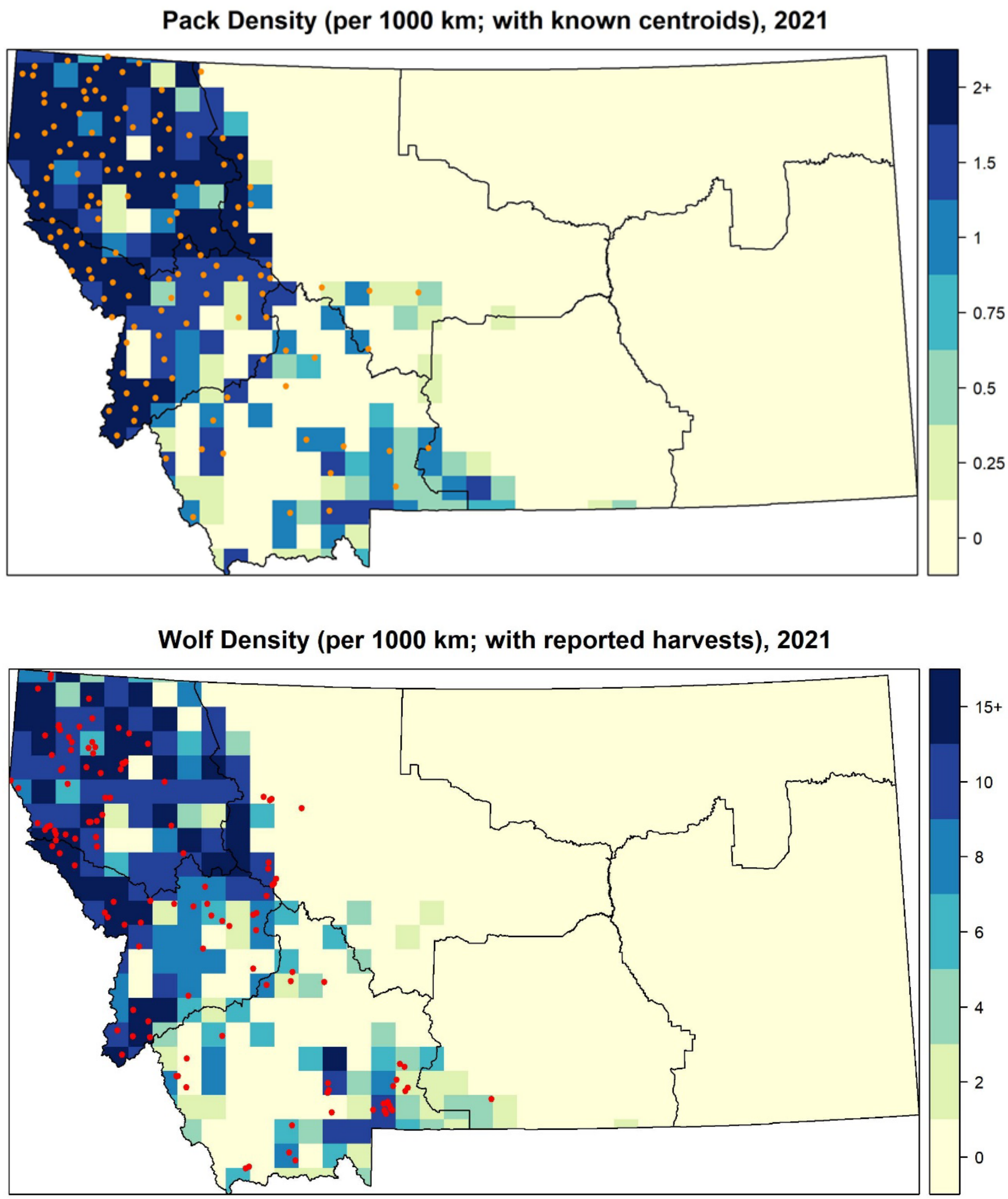

Figure 8. Estimated pack and wolf densities in Montana, 2021, per 1,000 km^2. Orange points demarcate territory centroids identified through monitoring in 2021 (pack density map), whereas red points demarcate reported harvest locations in 2021 (wolf density map).

3. WOLF MANAGEMENT

3.1 Regulated Public Hunting and Trapping

Regulated public harvest of wolves was recommended by the Governor's Wolf Advisory Council and included in Montana's Wolf Conservation and Management Plan that was approved by the USFWS during 2004. FWP has developed and implemented wolf harvest strategies that maintain a recovered and connected wolf population, reduce wolf-livestock conflicts, reduce wolf impacts on low or declining ungulate populations and ungulate hunting opportunities, and effectively communicate to all parties the relevance and credibility of the harvest while acknowledging the diversity of values among those parties. The Montana public has the opportunity for continuous and iterative input into specific decisions about wolf harvest throughout the public season-setting process. Wolf seasons are to be reviewed no less frequently than every other year by the Fish and Wildlife Commission, but in practice get reviewed annually.

Because wolf conservation and management in Montana are governed by laws enacted by the state legislature, state laws provide detailed guidance on some wolf management activities. The Montana Code Annotated (MCA) is the current law, and specific sections can be viewed at http://leg.mt.gov/bills/mca/index.html. Legislative bill language and history that has created or amended MCA sections can be accessed at http://leg.mt.gov/css/bills/Default.asp.

Several changes to wolf harvest seasons resulted from the 2021 Montana Legislative Session, providing legislative intent to increase individual harvest opportunity and to reduce the state wolf population to a lower, sustainable level. Three sections of the MCA are of primary significance to recent changes in wolf harvest and season structure.
These are:
MCA 87-1-304 Fixing of Seasons and Bag and Possession Limits
MCA 87-1-901 Gray Wolf Management – Rule Making -- Reporting
MCA 87-6-214 Unlawful Contest or Prize

MCA 87-1-304 was amended in the 2021 Montana Legislative Session in response to HB 225 to adjust the trapping wolf trapping season dates. This law now provides the Montana Fish and Wildlife Commission the authority to adjust the start of the trapping season for specific wolf management units based on regional recommendations.
MCA-87-901 was amended in response to HB 224 and SB 314. Montana statute now states trapping seasons must allow for use of snares by holders of a trapping license. This statute also provides legislative intent to reduce Montana's wolf population to a lower, sustainable level, but no lower than the number of wolves needed to maintain 15 breeding pairs. This statute further provides Commission authority to apply different management techniques depending on conditions in each administrative region to include: allowing unlimited take of wolves on a single wolf hunting or trapping license, allowing use of bait while hunting or trapping wolves, and allowing hunting of wolves on private lands outside daylight hours with use of artificial light or night vision scopes.

MCA-87-6-214 was amended in response to SB 267 to allow for reimbursements of costs incurred related to the hunting or trapping of wolves for individuals licensed to hunt or trap wolves.

In response to these new laws, the Commission adopted changes to the 2021-2022 wolf hunting and trapping regulations. Changes included eliminating quotas for specific areas, increasing the number of wolf hunting licenses allowed for individual hunters (10 per hunter), increasing the number of wolves allowed to be legally harvested on one trapping license (10 per trapper), extending the wolf trapping season and implementing a floating start date within grizzly bear occupied areas, and adding new harvest tools to include snaring, night hunting on private property, and baiting. The Commission also adopted a set of regulatory components to reduce human safety concerns, reduce risk of overharvest, and reduce probability for take of federally protected lynx and grizzly bears. Under these new regulatory components, meeting any of the following criteria would initiate a Commission review with potential for rapid in-season adjustments to hunting and trapping regulations:

1. Incidental capture of a single lynx or grizzly bear in a trap or snare and each time a lynx or grizzly bear is captured thereafter
2. Statewide harvest of 450 wolves and after every additional 50 wolves harvested thereafter
3. Meeting the following thresholds for regional wolf harvest
   - Region 1 – 195 wolves
   - Region 2 – 116 wolves
   - Region 3 – 82 wolves
   - Region 4 – 39 wolves
   - Region 5 – 11 wolves
   - Region 6 – 3 wolves
   - Region 7 – 4 wolves

The Commission had the opportunity to utilize the new regulatory components in the spring portion of the 2021-2022 License Year. On February 17, 2022, the Commission closed wolf harvest in Region 3 upon meeting the 82 wolf threshold.

At the close of the 2021-22 wolf season (2021 License Year) on March 15, 2022, the harvest totaled 273 wolves taken during the 2021-22 season, including 148 taken by hunters (54.2%) and 125 taken by trappers (45.8%). Despite the new liberalized harvest regulations, the 2021-22 season was lower than the previous three seasons. Seventeen more wolves were harvested during 2021-22 season than the average during the previous 9 wolf seasons when both hunting and trapping were allowed (2012-2020). Most of the increase over the 9-year average occurred in Regions 1, 2, and 3 via trapping (Table 2). Statewide wolf population appears to have peaked in 2011 and has declined slightly since then, appearing to stabilize at around 1160 wolves (Fig. 9). The total calendar-year 2021 wolf harvest in Montana was 299, including 160 wolves harvested during spring of the 2020-21 season and 139 wolves harvested during fall of the 2021-22 season.

Table 2. Change in level of wolf harvest in Montana between the 2012-2020 seasons and the 2021 season by FWP Region and type of harvest.

	2012-2020 Average						2021 Season						Change					
	R1	R2	R3	R4	R5	All	R1	R2	R3	R4	R5	All	R1	R2	R3	R4	R5	All
Hunt	46	34	61	10	0	**151**	43	27	69	9		**148**	-3	-7	8	-1		-3
Trap	47	32	16	9	0	**104**	65	41	16	2	1	**125**	18	9	0	-7	1	**21**
Total	**94**	**65**	**77**	**19**	**0**	**255**	**108**	**68**	**85**	**11**	**1**	**273**	**14**	**2**	**8**	**-8**	**1**	**17**

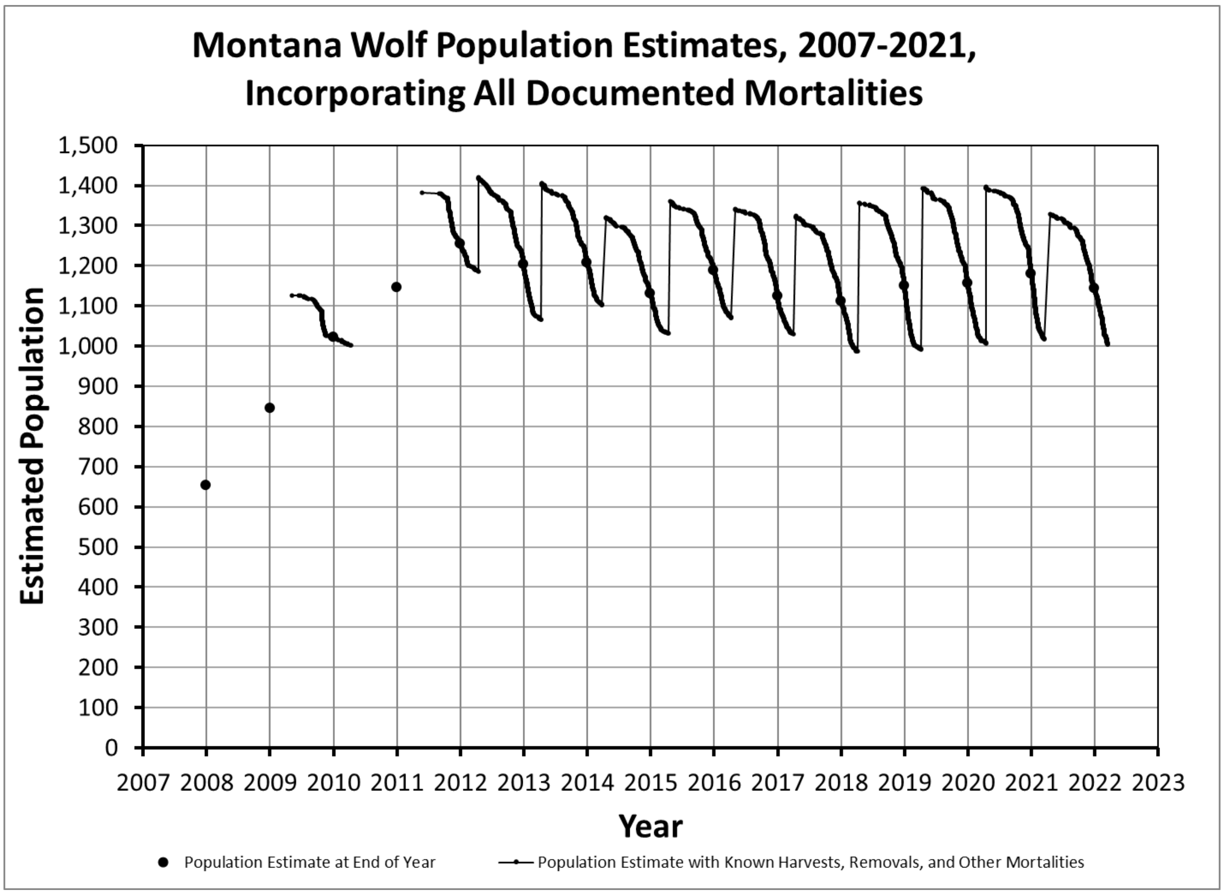

Figure 9. Estimated wolf population size based on known mortalities anchored to December 31 Patch Occupancy Modelling estimates, 2007 – 2021.

During 2021, Montana sold 17,937 resident wolf hunting licenses ($10 or $12/each) and 3,041 non-resident wolf hunting licenses ($25 or $50/each). In calendar year 2020 the price of a resident wolf hunting license dropped from $19 to $12 and a discounted $10 wolf hunting license was offered with the purchase of a sportsman's tag. A discounted nonresident wolf hunting license was offered for $25 with the purchase of a sportsman's tag. Sale of these wolf licenses generated $341,043 for wolf management and monitoring in Montana (Fig. 10). Total funding generated for wolf monitoring and management by the sale of wolf hunting licenses from 2009-2021 is nearly $4.8 million. Because trapping licenses for both residents and non-residents are not wolf-specific, FWP cannot quantify the financial contribution that wolf trapping generates.

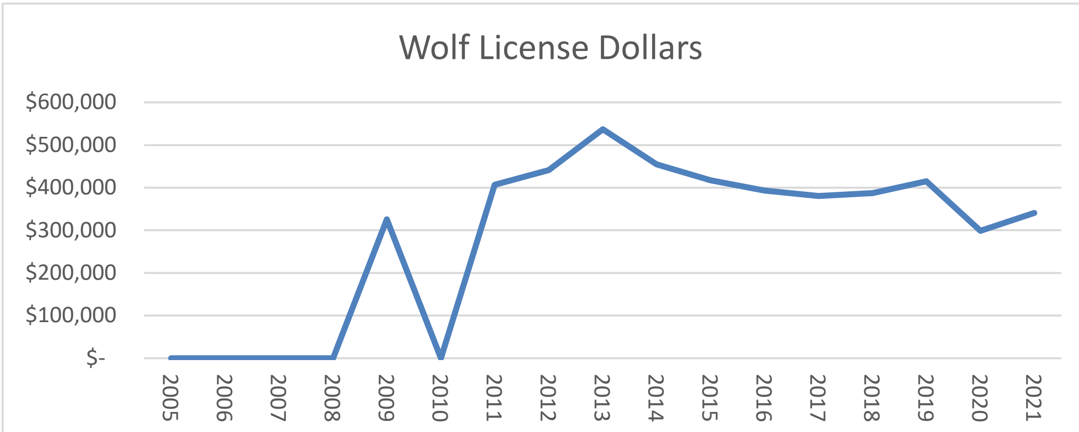

Figure 10. Dollars generated for wolf conservation and management through sales of wolf hunting licenses in Montana, 1998-2021.

3.2 Wolf – Livestock Interactions in Montana

Montana wolves routinely encounter livestock on both private land and public grazing allotments. Wolves are opportunistic predators, most often seeking wild prey. However, some wolves learn to prey on livestock and teach this behavior to other wolves. The majority of cattle and sheep wolf depredation incidents confirmed by USDA Wildlife Services (WS) occur on private lands. The likelihood of detecting injured or dead livestock is probably higher on private lands where there is greater human presence than on remote public land grazing allotments. The magnitude of under-detection of loss on public allotments is unknown. Most cattle depredations occur during the spring or fall months while sheep depredations occur more sporadically throughout the year.

Wolf Depredation Reports

Wildlife Service's workload increased through 2009 as the wolf population increased and distribution expanded (Fig. 6). The number of depredation reports received since those years has declined from 233 in FFY 2009 to approximately 100 or less from FFY14-FFY21. That trend held steady during FFY 2021, when 98 reports were received (Fig. 11). Since 1997, about 50% of wolf depredation reports received by WS have been verified as wolf-caused. During FFY 2021, 78% of reports were verified as wolf depredation, slightly higher than the long-term average.

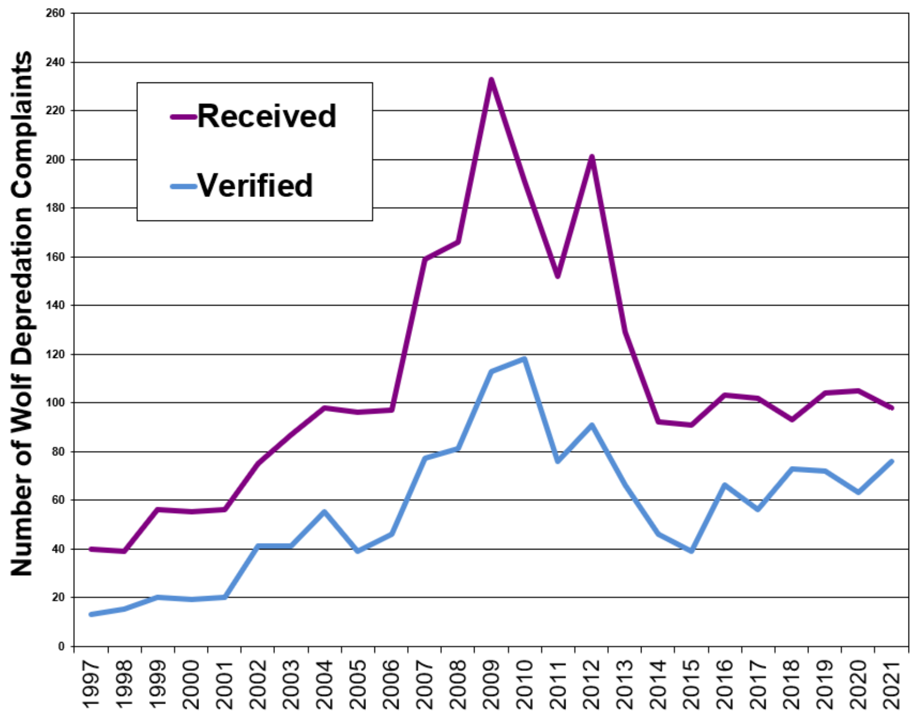

Figure 11. Number of complaints received by USDA Wildlife Services as suspected wolf damage and number of complaints verified as wolf damage, Federal Fiscal Year 1997-2021.

Wolf Depredation Incidents and Responses During 2021

Wildlife Services confirmed that, statewide, 67 cattle, 29 sheep, and 3 livestock guard dogs were killed by wolves during 2021. Wildlife Services also determined that an additional 12 cattle and 6 sheep were probable wolf kills. Total confirmed cattle and sheep losses were similar to 2011-2020 numbers (Fig. 12). Many livestock producers reported "missing" livestock and suspected wolf predation. Others reported indirect losses including poor weight gain and reduced productivity of livestock. There is no doubt that there are undocumented losses.

To address livestock conflicts and to reduce the potential for further depredations, 39 wolves were killed during 2021 (Fig. 13). This was lower than the average number of wolves removed due to depredation since meeting biological recovery goals in 2002 (Avg. = 70/year) and since delisting in 2011 (Avg. = 66/year). Federal and state regulations since 2009 have allowed private citizens to kill wolves seen in the act of attacking, killing, or threatening to kill livestock; from 2009-2020 an average of 11 wolves have been taken by private citizens each year. Thirty-eight wolves were removed in control actions by USDA Wildlife Services during 2021, one wolf was killed by a private citizen when wolves were seen chasing, killing, or threatening to kill livestock. The general decrease in livestock depredations since 2009 (Fig. 12) may be a result of several factors, primarily more aggressive wolf control in response to depredations (DeCesare et al. 2018).

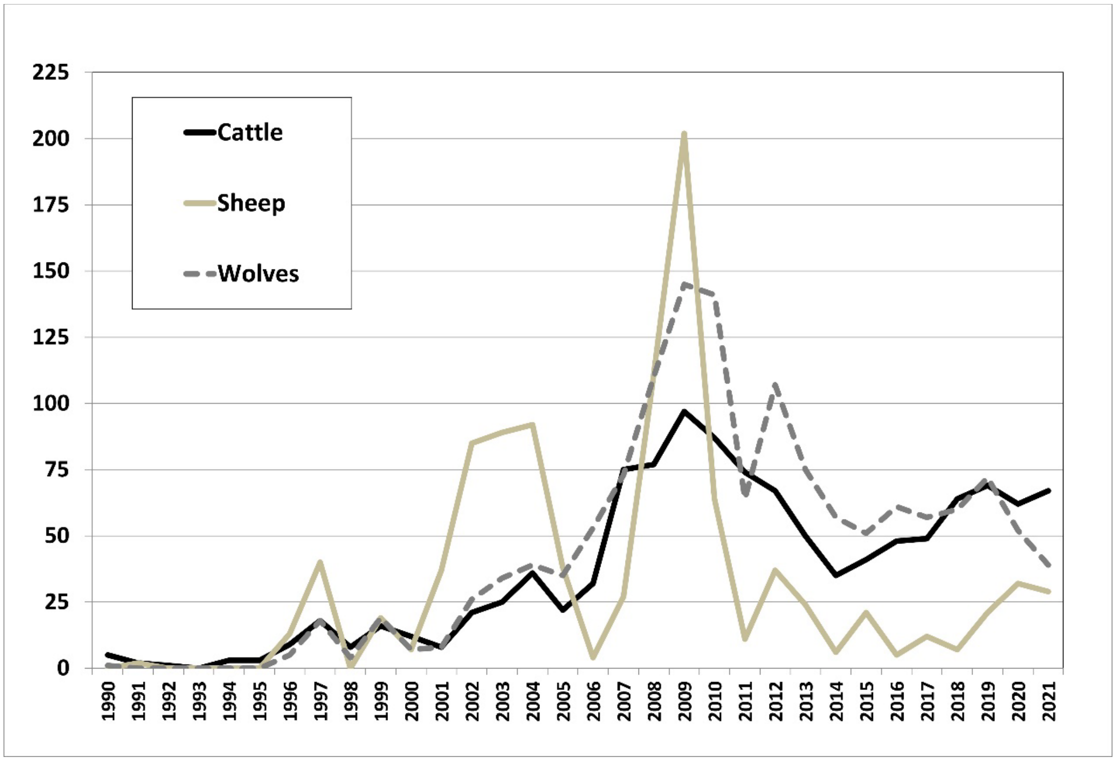

Figure 12. Number of cattle and sheep killed by wolves and number of wolves removed through agency control and legal depredation-related take by private citizens, 2000-2021.

Montana Livestock Loss Board (MLLB) Payments

The Montana Wolf Conservation and Management Plan called for creation of this Montana-based program to address the economic impacts of verified wolf-caused livestock losses. The plan identified the need for an entity independent from FWP to administer the program. The purposes of the MLLB are 1) to provide financial reimbursements to producers for losses caused by wolves based on the program criteria, and 2) to proactively apply prevention tools and incentives to decrease the risk of wolf-caused losses and minimize the number of livestock killed by wolves through proactive livestock management strategies. The Loss Mitigation element implements a reimbursement payment system for confirmed and probable losses that are verified by USDA Wildlife Services. Indirect losses and costs are not directly covered. Eligible livestock losses are cattle, calves, hogs, pigs, horses, mules, sheep, lambs, goats, llamas, and guarding animals. Confirmed and probable death losses are reimbursed at 100% of fair market value. Veterinary bills for injured livestock that are confirmed due to wolves may be covered up to 100% of fair market value of the animal when funding becomes available.

Reimbursement totals for CY2021 wolf depredations were $103,815.95 paid to 37 livestock owners on 81 head of livestock and 2 dogs. These numbers differ slightly from the WS confirmed losses due to wolves because reimbursements are also made for probable wolf depredations and tallied by calendar year rather than federal fiscal year. By comparison, confirmed and probable losses totaled $193,971.17 from grizzly bears and $42,647.70 from mountain lions during 2021.

FWP Collaring of Livestock Packs

State Statute 87-1-623 requires Montana Fish, Wildlife & Parks to allocate wolf license dollars toward collaring wolf packs in livestock areas. The purpose of these efforts is to be able to more readily understand which wolf pack may have been involved in a livestock depredation and so that USDA Wildlife Services can be more efficient and effective at controlling packs that depredate on livestock. FWP employs five wolf specialists covering Regions 1, 2, 3, 4, and 5 (Appendix 1) along with seasonal technicians in Regions 1 and 2. Wolf specialists and technicians capture wolves and deploy collars during winter helicopter capture efforts and summer/fall trapping efforts. During 2021, FWP wolf specialists captured and collared 15 wolves (Table 3). USDA Wildlife Services also captured and collared 5 additional wolves for a total of 20 statewide by both agencies.

Table 3. Wolves captured and radio-collared by FWP Wolf Specialists during 2021.

	Helicopter	Summer/Fall	**Total**
Region 1	0	1	**1**
Region 2	2	12	**14**
Region 3	0	0	**0**
Region 4	0	0	**0**
Total	**2**	**13**	**15**

Proactive Prevention of Wolf Depredation

In Northwest Montana, proactive depredation prevention work continued in the Eureka and Trego area with the fourth grazing season of the Range Rider program. The Trego Range Rider Program was collaboratively funded and staffed by Natural Resources Defense Council; Defenders of Wildlife; Vital Ground; USDA AHPIS Wildlife Services; Montana Fish, Wildlife & Parks; U.S. Forest Service; and six livestock producers. The desired outcomes were to mitigate producer-predator conflicts, reduce cattle losses, reduce wolf and grizzly bear mortalities, find livestock carcasses and remove them, document presence of predators, and alert producers of predators among the herds. Ranger Rider Maddie Nieuwenhuis covered 6 allotments in northwestern Montana on the Kootenai National Forest and Jim Creek state lease. Nieuwenhuis traveled the allotments by horseback, truck, atv and hiking, while also camping out on the allotments during the week. She notified ranchers and FWP about carnivore activity and set survey cameras to help monitor carnivore presence.

In West-Central Montana, FWP continued partnering on two collaborative proactive risk management projects in the Blackfoot Valley: the Blackfoot Challenge range rider program and carcass pickup program. 2021 marked the 14th year of the range rider program, which employed four seasonal range riders and one permanent wildlife technician to monitor livestock and predators in areas occupied by the Arrastra Creek, Belmont, Chamberlain, Morrell

Mountain, Inez, and Union Peak wolf packs. The carcass pickup program removed livestock carcasses from Blackfoot Valley ranches and transported them to the carcass compost site to reduce attractants in livestock grazing and calving areas. FWP and the Blackfoot Challenge also partnered with Wildlife Services for a fourth year to deploy fladry in the Blackfoot Valley to deter wolves from livestock calving yards.

FWP was also involved in two collaborative, proactive risk management projects in the Big Hole Valley. The first of these projects, a range rider program, completed its eleventh season in 2021. The second project, a carcass pickup and composting program, completed its seventh year of operation.

In North-Central Montana, range rider programs initiated in 2017 and 2020 continued on private land and USFS grazing allotments in the Augusta area. The programs included five livestock producers and employed two range riders for the summer grazing season. These efforts were developed and coordinated by Kyran Kunkel through the Conservation Science Collaborative, with funding from several non-governmental organizations (NGOs).

In South-West Montana, Wildlife Services continued their partnership with the Greater Yellowstone Coalition for a second season of the Gravelly Mountain range rider program. The range rider covered 19 allotments to detect predator presence, deter predation on livestock, and worked with permittees to determine the best approach to minimize further conflicts with wildlife. Federally appropriated funds will be available to continue this program in 2022 with the continued support of cooperative NGOs.

Wildlife Services also continued employment of a full-time conflict reduction specialist (Adam Baca) in Montana. Baca planned, coordinated, and implemented non-lethal predator damage management tools such as turbo fladry and electric fencing to protect livestock from predation. This position, which originated in February 2018, was funded collaboratively by Wildlife Services, U.S. Fish and Wildlife Service, Natural Resources Defense Council, Defenders of Wildlife and the American Prairie Reserve.

3.3 Total 2021 Documented Statewide Wolf Mortalities

FWP detected a total of 349 wolf mortalities during 2021 statewide due to all causes (Fig. 8). Undoubtedly, additional mortalities occurred but were not detected. Documented total wolf mortality in 2021 was 5% greater than 9-year average since 2012 (9-yr avg. = 332). The majority of the increase was due to higher levels of legal harvest with 299 occurring during calendar year 2021. Control actions were very similar to 2016-2020, and approximately one-third of peak years. Of the 39 wolves removed in 2021 for livestock depredations, 38 were removed by WS and 1 was legally killed by a private citizen under the Montana state law known as the Lawful Taking To Protect Livestock Or Person statute (87-6-106, MCA). Five wolves were documented as being killed illegally, and 4 wolves were documented as being killed by vehicle or train collision. Two wolves were documented as being killed by natural, other, or unknown causes. No wolves were reported taken under provisions of Senate Bill 200 (87-1-901, MCA) in 2021.

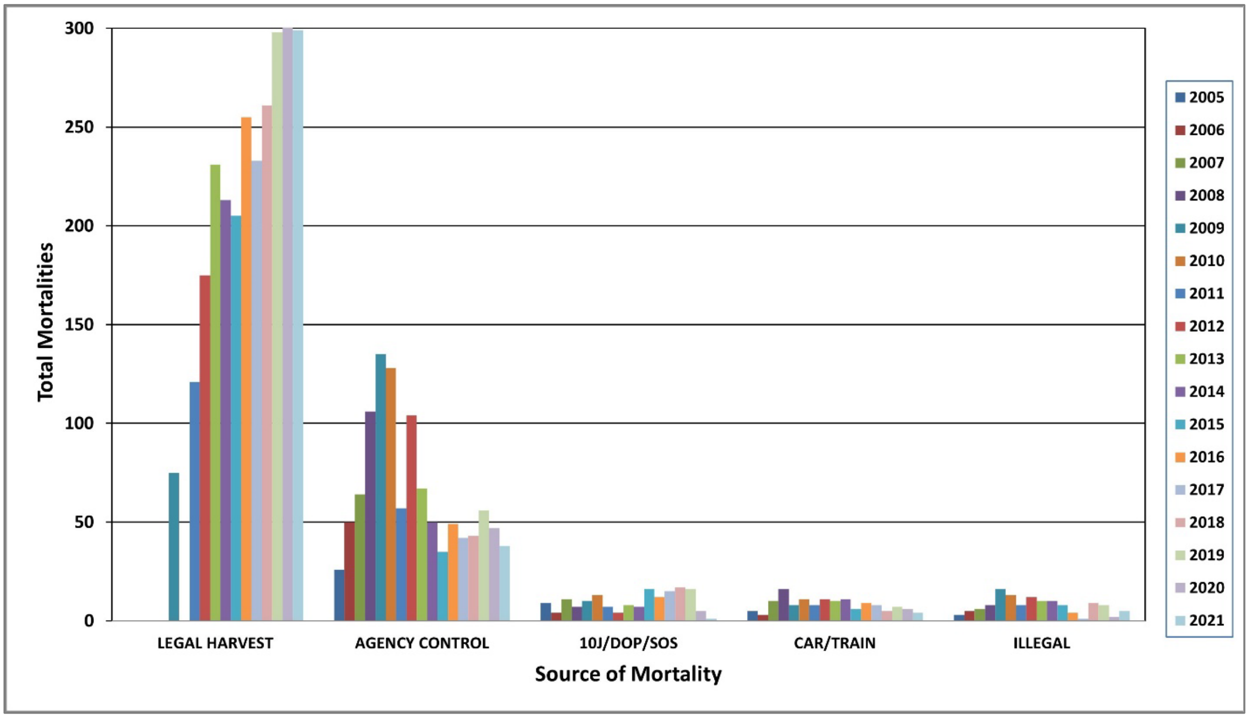

Figure 13. Minimum number of wolf mortalities documented by cause for gray wolves (2005-2021). Total number of documented wolf mortalities during 2021 was 349.

4. OUTREACH AND EDUCATION

FWP's wolf program outreach and education efforts are varied, but significant. Outreach activities take a variety of forms including field site visits, phone and email conversations to share information and answer questions, presentations to school groups and other agency personnel, media interviews, and formal and informal presentations. FWP also prepared and distributed a variety of printed outreach materials and media releases to help Montanans become more familiar with the Montana wolf population and the state plan. The "Report a Wolf" application continued to generate valuable information from the public in monitoring efforts for existing packs and documenting wolf activity in new areas. Several reports were received through the website and others via postal mail and over the phone. Most wolf program staff spent some time talking with hunters about wolves, wolf management, and their hunting experiences.

5. FUNDING

5.1 Montana Fish, Wildlife & Parks Funding

Funding for wolf conservation and management in Montana is controlled by laws enacted by the state legislature. State laws also provide detailed guidance on some wolf management activities. The Montana Code Annotated (MCA) is the current law, and specific sections can be viewed at http://leg.mt.gov/bills/mca/index.html. Legislative bill language and history that has created or amended MCA sections can be accessed at http://leg.mt.gov/css/bills/Default.asp. Three sections of the MCA are of primary significance to wolf management and funding. These are:

MCA 87-5-132 Use of Radio-tracking Collars for Monitoring Wolf Packs
MCA 87-1-623 Wolf Management Account
MCA 87-1-625 Funding for Wolf Management

MCA 87-5-132 was created during the 2005 legislative session by Senate Bill 461. It has been amended twice, both times during the 2011 legislative session, by House Bill 363 and Senate Bill 348. This law requires capturing and radio-collaring an individual within a wolf pack that is active in an area where livestock depredations are chronic or likely.

MCA 87-1-623 was created during the 2011 Legislative Session by House Bill 363. This law requires that a wolf management account be set up and that all wolf license revenue be deposited into this account for wolf collaring and control. Specifically, it states that subject to appropriation by the legislature, money deposited in the account must be used exclusively for the management of wolves and must be equally divided and allocated for the following purposes: (a) wolf-collaring activities conducted pursuant to 87-5-132; and (b) lethal action conducted pursuant to 87-1-217 to take problem wolves that attack livestock.

MCA 87-1-625 was created during the 2011 Legislative Session by Senate Bill 348. This law required FWP to allocate $900,000 annually toward wolf management. "Management" in MCA 87-1-625 is defined as in MCA 87-5-102, which includes the entire range of activities that constitute a modern scientific resource program, including but not limited to research, census, law enforcement, habitat improvement, control, and education. The term also includes the periodic protection of species or populations as well as regulated taking. During the 2015 legislative session, Senate Bill 418 reduced this amount to $500,000 of spending authority.

The wolf management budget for state fiscal year 2021 (July 1, 2020 – June 30, 2021) was $833,493.96 and consisted of $316,056.46 of federal PR funds, $492,437.50 of Montana wolf and general license dollars, and $25,000 from the Rocky Mountain Elk Foundation.

Funding was used to pay for FWP’s field presence to implement population monitoring, collaring, outreach, hunting, trapping, and livestock depredation response. During state fiscal year 2021, the wolf program had 5 base wolf specialists/full-time equivalent (FTE) dedicated to wolf management, and 1 total FTE for two 6-month technicians to increase collaring efforts in wolf packs associated with livestock. FWP also renewed the financial agreement with Wildlife Services for their role in wolf depredation management efforts. Other wolf management services provided by FWP include law enforcement, harvest/quota monitoring, legal support, public outreach, and overall program administration. Exact cost figures have not been quantified for the value of these services.

5.2 USDA Wildlife Services Funding

Wildlife Services (WS) is the federal agency that assists FWP with wolf damage management. WS personnel conduct investigations of injured or dead livestock to determine if it was a predation event and, if so, what predator species was responsible for the damage. Based on WS determination, livestock owners may be eligible to receive reimbursement through the Montana Livestock Loss Program. If WS determines that the livestock depredation was a confirmed wolf kill or was a probable wolf kill, the livestock owner is eligible for 100% reimbursement on the value of the livestock killed based on USDA market value at the time of the investigation.

Under a memorandum of understanding (MOU) with FWP, the Blackfeet Nation (BN), and the Confederated Salish and Kootenai Tribes (CSKT), WS conducts the control actions on wolves as authorized by FWP, BN, and CSKT. Control actions may include radio-collaring and/or lethal removal of wolves implicated in livestock depredation events. FWP, BN, and CSKT also authorize WS to opportunistically radio-collar wolf packs that do not have an operational radio-collar attached to a member of the pack in order to fulfill the requirements of Montana State Statute 87-5-132.

As a federal agency, WS receives federal appropriated funds for predator damage management activities but no federal funding directed specifically for wolf damage management. Prior to Federal Fiscal Year (FFY) 2011, the WS Program in Montana received approximately $250,000 through the Tri-State Predator Control Earmark, some of which was used for wolf damage management operations. However, that earmark was completely removed from the federal budget for FFY 2011 and not replaced in FFY 2012-2021.

In FFY 2021, WS spent $376,423 conducting wolf damage management in Montana (not including administrative costs). The FFY 2021 expenditure included $241,423 Federal appropriations and $135,000 from FWP.

6. PERSONNEL AND ACKNOWLEDGEMENTS

The 2021 FWP wolf specialist team comprised Wendy Cole, Tyler Parks, Nathan Lance, Mike Ross, and Ty Smucker.

Wolf specialists worked closely with regional wildlife managers in FWP Regions 1-5, including Neil Anderson, Howard Burt, Cory Loeker, Kevin Rose, Matt Ladd, and Mike Thompson, as well as Carnivore and Furbearer Coordinator Bob Inman. Wolf technicians provided seasonal assistance monitoring and trapping with the specialists in Regions 1 and 2. FWP Helena and Wildlife Health Lab staff contributed time and expertise including Caryn Dearing, Missy Erving, Justin Gude, Lauri Hanuska-Brown, Anne Howes, Xander Kennedy, Quentin Kujala, Greg Lemon, Ken McDonald, Kammi McClain, Adam Messer, Kevin Podruzny, Jennifer Ramsey, Brian

Wakeling, and Smith Wells. The wolf team is part of a much bigger team of agency professionals that make up Montana Fish, Wildlife & Parks including regional supervisors, biologists, game wardens, information officers, front desk staff, and many others who contribute their time and expertise to wolf management and administration of the program.

FWP thanks The Blackfoot Challenge and their range riders: Eric Graham, Jordan Mannix, Vicki Pocha, and Sigrid Olson. The Blackfoot Challenge worked with ranchers and landowners to reduce wildlife conflict in the Blackfoot watershed using range riders, fladry, and carcass pick-up.

USDA APHIS WS investigates all suspected wolf depredations on livestock and under the authority of FWP, carries out all livestock depredation-related wolf damage management activities in Montana. We thank them for contributing their expertise to the state's wolf program and for their willingness to complete investigations and carry out lethal and non-lethal damage management and radio-collaring activities in a timely fashion. We also thank WS for assisting with monitoring wolves in Montana. WS personnel involved in wolf management in Montana during 2021 included assistant regional director John Steuber; western district supervisor Kraig Glazier; acting state director Dalin Tidwell; western assistant district supervisor Chad Hoover; eastern assistant district supervisor Alan Brown; wildlife disease biologist Jerry Wiscomb; wildlife biologist Zack May; helicopter pilot Eric Waldorf and Keith Olsen; helicopter/airplane pilots Tim Graff and John Martin; airplane pilots Guy Terrill, Justin Ferguson, and Scott Snider; wildlife specialists Adam Baca, Glenn Hall, Micheal "Finny" Helske, Mike Hoggan, Cody Knoop, John Maetzold, Graeme McDougal, John Miedtke, Kurt Miedtke, Maddi Nieuwenhuis, Brian Noftsker, Ted North, Scott Olson, Luke Peeples, Cody Richardson, Jim Rost, Dymond Running Crane, Kirk "Skippy" Sims, Bart Smith, Brian Smith, Pat Sinclair, and Danny Thomason.

We acknowledge the work of the citizen-based Montana Livestock Loss Board (LLB) which oversees implementation of Montana's reimbursement program and the conflict prevention grant money, and we thank the LLB's coordinator, George Edwards.

We thank Northwest Connections for their avid interest and help in documenting wolf presence and outreach in the Swan River Valley. We thank Swan Ecosystem Center for their continued interest and support. We thank Kyran Kunkel of Conservation Science Collaborative, Inc. for his continued coordination of a range rider program on private and public land along the Southern Rocky Mountain Front. We also thank Kathy Robinson and Joel Keeter who were the range riders on these efforts and were instrumental in working with local producers to monitor livestock and predator activity in the area.

We thank Confederated Salish and Kootenai Tribal biologists Stacy Courville and Shannon Clairmont for capturing and monitoring wolves in and around their respective tribal reservation. We were saddened to learn of Stacy Courville's passing in early 2021 and will miss his dedication and partnership in the future.

The Montana Wolf Management Program field operations also benefited in a multitude of ways from the continued cooperation and collaboration of other state and federal agencies and private interests such as the USDA Forest Service, Montana Department of Natural Resources and Conservation ("State Lands"), U.S. Bureau of Land Management, Weyerhauser Company, Stimpson Lumber Company, Southern Pines Plantation, Glacier National Park, Yellowstone National Park, Idaho Fish and Game, Wyoming Game and Fish, Nez Perce Tribe, Canadian Provincial wildlife professionals, Turner Endangered Species Fund, People and Carnivores, Wildlife Conservation Society, Keystone Conservation, Boulder Watershed Group, Big Hole Watershed Working Group, the Madison Valley Ranchlands Group, the upper Yellowstone Watershed Group, the Blackfoot Challenge, Tom Miner Basin Association, the Granite County Headwaters Working Group, and Avista.

We deeply appreciate and thank our pilots whose unique and specialized skills, help us find wolves, get counts, and keep us safe in highly challenging, low altitude mountain flying situations. They include Joe Rahn (FWP Chief Pilot), Neil Cadwell (FWP Pilot), Ken Justus (FWP Pilot), Trever Throop (FWP Pilot), Mike Campbell (FWP Pilot), Rob Cherot (FWP Pilot), Jim Pierce (Red Eagle Aviation, Kalispell), Roger Stradley (Gallatin Flying Service, Belgrade), Steve Ard (Tracker Aviation Inc., Belgrade), Dave Horner (Red Eagle Aviation), Joe Rimensberger (Osprey Aviation, Hamilton), Mark Duffy (Central Helicopters, Bozeman), and Lowell Hansen/ Piedmont Aviation. We also thank Quicksilver Aviation for their safe and efficient helicopter capture efforts.

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APPENDICES

APPENDIX 1

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Brian Wakeling
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USDA Wildlife Services

(to request investigations of injured or dead livestock):

Dalin Tidwell
USDA WS State Director, Billings
(406) 657-6464 (w)

Kraig Glazier
USDA WS West District Supervisor, Helena
(406) 439-5943 (c)

Doug Eckberg
USDA WS East District Supervisor, Columbus
(406) 657-6464 (w)
(406) 601-9213 (c)

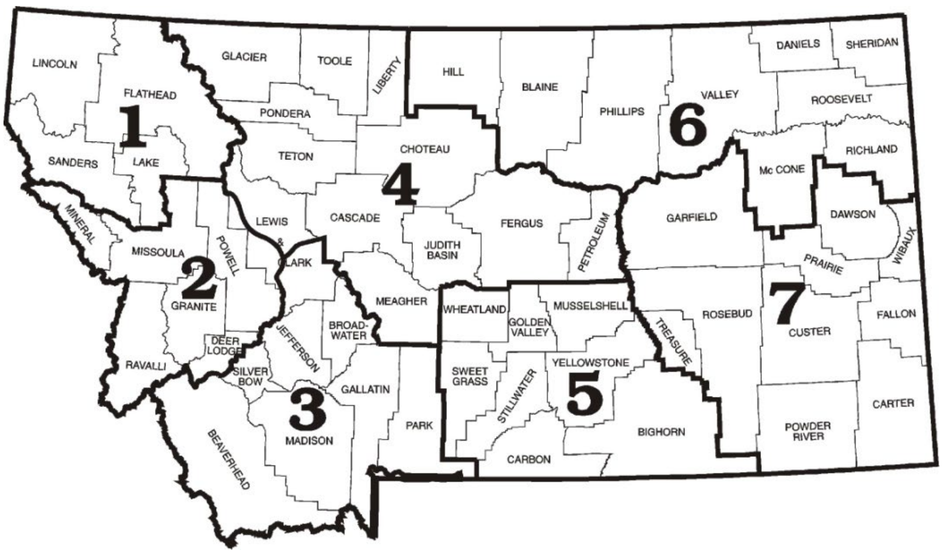
TO REPORT A DEAD WOLF OR POSSIBLE ILLEGAL ACTIVITY:

Montana Fish, Wildlife & Parks

- Dial 1-800-TIP-MONT (1-800-847-6668) or local game warden

TO SUBMIT WOLF REPORTS ELECTRONICALLY AND TO LEARN MORE ABOUT THE MONTANA WOLF PROGRAM, SEE:

MONTANA FISH WILDLIFE & PARKS
ADMINISTRATIVE REGIONS



STATE HEADQUARTERS
MT Fish, Wildlife & Parks
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PO Box 200701
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REGION 1
490 N Meridian Rd
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REGION 2
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REGION 3
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HELENA Area Res Office (HARO)
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Helena, MT 59620
(406) 495-3260

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Butte, MT 59701
(406) 494-1953

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Great Falls, MT 59405
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LEWISTOWN Area Res Office (LARO)
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PO Box 938
Lewistown, MT 59457
(406) 538-4658

REGION 5
2300 Lake Elmo Dr
Billings, MT 59105
(406) 247-2940

REGION 6
54078 US Hwy 2 W
Glasgow, MT 59230
(406) 228-3700

HAVRE Area Res Office (HvARO)
2165 Hwy 2 East
Havre, MT 59501
(406) 265-6177

REGION 7
Industrial Site West
PO Box 1630
Miles City, MT 59301
(406)234-0900

APPENDIX 2

RESEARCH, FIELD STUDIES, AND PROJECT PUBLICATIONS

Each year in Montana, there are a variety of wolf-related research projects and field studies in varying degrees of development, implementation, or completion. These efforts range from wolf ecology and predator-prey relationships to wolf-livestock relationships, policy, or wolf management. In addition, the findings of some completed projects get published in the peer-reviewed literature. The recent efforts are summarized below, with updates or project abstracts.

1. INTEGRATING BASIC AND APPLIED RESEARCH TO ESTIMATE CARIVORE ABUNDANCE

Investigators: Sarah Sells, Michael Mitchell, Kenneth Loonam, Joshua Nowak, Sarah Bassing (University of Montana) Kevin Podruzny, Ty Smucker, Tyler Parks, Diane Boyd, Abby Nelson, Nathan Lance, Bob Inman, Justin Gude (Montana Fish, Wildlife & Parks)

Status: In Press, Ecological Applications 2022

ABSTRACT: A clear connection between basic research and applied management is often missing or difficult to discern. We present a case study of integration of basic research with applied management for estimating abundance of gray wolves (Canis lupus) in Montana, USA. Estimating wolf abundance is a key component of wolf management but is costly and time intensive as wolf populations continue to grow. We developed a multi-model approach using an occupancy model, mechanistic territory model, and empirical group size model to improve abundance estimates while reducing monitoring effort. Whereas field-based wolf counts generally rely on costly, difficult-to-collect monitoring data, especially for larger areas or population sizes, our approach efficiently uses readily available wolf observation data and introduces models focused on biological mechanisms underlying territorial and social behavior. In a three-part process, the occupancy model first estimates the extent of wolf distribution in Montana, based on environmental covariates and wolf observations. The spatially explicit mechanistic territory model predicts territory sizes using simple behavioral rules and data on prey resources, terrain ruggedness, and human density. Together, these models predict the number of packs. An empirical pack size model based on 14 years of data demonstrates that pack sizes are positively related to local densities of packs, and negatively related to terrain ruggedness, local mortalities, and intensity of harvest management. Total abundance estimates for given areas are derived by combining estimated numbers of packs and pack sizes. We estimated the Montana wolf population to be smallest in the first year of our study, with 91 packs and 654 wolves in 2007, followed by a population peak in 2011 with 1,252 wolves. The population declined approximately 6% thereafter, coincident with implementation of legal harvest in Montana. Recent numbers have largely stabilized at an average of 191 packs and

1,141 wolves from 2016 – 2020. This new approach accounts for biologically based, spatially explicit predictions of behavior to provide more accurate estimates of carnivore abundance at finer spatial scales. By integrating basic and applied research, our approach can therefore better inform decision-making and meet management needs.

2. ECONOMICAL DEFENCE OF RESOURCES STRUCTURES TERRITORIAL SPACE USE IN A COOPERATIVE CARNIVORE

Investigators: Sarah Sells, Michael Mitchell, Angela Luis, Douglas Emlen (University of Montana) David Ausband (US Geological Survey), Kevin Podruzny, Justin Gude (Montana Fish, Wildlife & Parks)

Status: Published in the Proceedings of the Royal Society of London B: Biological Sciences in 2022

Link to full article: https://fwp.mt.gov/binaries/content/assets/fwp/conservation/wolf/sells-et-al.-2022.-economical-defence-of-resources-structures-territorial-space-use-in-a-cooperative-carnivore.pdf

ABSTRACT: Ecologists have long sought to understand space use and mechanisms underlying patterns observed in nature. We developed an optimality landscape and mechanistic territory model to understand mechanisms driving space use and compared model predictions to empirical reality. We demonstrate our approach using grey wolves (Canis lupus). In the model, simulated animals selected territories to economically acquire resources by selecting patches with greatest value, accounting for benefits, costs and trade-offs of defending and using space on the optimality landscape. Our approach successfully predicted and explained first- and second-order space use of wolves, including the population's distribution, territories of individual packs, and influences of prey density, competitor density, human-caused mortality risk and seasonality. It accomplished this using simple behavioural rules and limited data to inform the optimality landscape. Results contribute evidence that economical territory selection is a mechanistic bridge between space use and animal distribution on the landscape. This approach and resulting gains in knowledge enable predicting effects of a wide range of environmental conditions, contributing to both basic ecological understanding of natural systems and conservation. We expect this approach will demonstrate applicability across diverse habitats and species, and that its foundation can help continue to advance understanding of spatial behaviour.

3. COMPETITION, PREY AND MORTALITIES INFLUENCE GRAY WOLF GROUP SIZE

Investigators: Sarah Sells, Michael Mitchell, Douglas Emlen, Kenneth Loonam, (University of Montana) Kevin Podruzny, Justin Gude, Ty Smucker, Diane Boyd (Montana Fish, Wildlife & Parks) Dave Ausband (US Geological Survey)

Status: Published in the Journal of Wildlife Management in 2021, 86(3): e22193

Link to full article: https://fwp.mt.gov/binaries/content/assets/fwp/conservation/wolf/sells-et-al.-2022.-competition-prey-and-mortalities-influence-gray-wolf-group-size.pdf

ABSTRACT: Group living is found in only 10–15% of carnivorans and can shape demographic processes. Sociality is associated with benefits including increased ability to acquire resources, decreased risk of mortality, and increased reproductive success. We hypothesized that carnivore group size is influenced by conditions related to competition, prey, and mortality risk, which should affect benefits and costs of sociality and resulting demographic processes. We evaluated our hypotheses with gray wolves (Canis lupus) using a 14-year dataset from a large, heavily managed population in the northern Rocky Mountains, USA. Annual mean group size ranged 4.86–7.03 and averaged 5.92 overall. Most groups were relatively small, with 80% containing ≤8 members. Groups were larger in areas with higher densities of conspecific groups, and smaller where prey availability was low. Group sizes remained largely stable while the population was unharvested or under low-intensity harvest but declined under high-intensity harvest. Results support the hypothesis that as habitat becomes saturated, inclusive fitness may become increasingly important such that subordinates delay dispersal. In addition to direct implications for birth and deaths, conditions related to prey and mortality risk may also influence dispersal decisions. Our work also provided a model to predict group size of wolves in our system, directly fulfilling a management need.

4. EVIDENCE OF ECONOMICAL TERRITORY SELECTION IN A COOPERATIVE CARNIVORE

Investigators: Sarah Sells, Michael Mitchell, Allison Keever (University of Montana) Kevin Podruzny, Justin Gude, Diane Boyd, Ty Smucker, Abigail Nelson, Tyler Parks, Nathan Lance, Michael Ross, Robert Inman (Montana Fish, Wildlife & Parks)

Status: Proceedings of the Royal Society of London B: Biological Sciences in 2021, 228:20210108.

Link to full article: https://fwp.mt.gov/binaries/content/assets/fwp/conservation/wolf/sells-et-al.-2021.-evidence-of-economical-territory-selection.pdf

ABSTRACT: As an outcome of natural selection, animals are probably adapted to select territories economically by maximizing benefits and minimizing costs of territory ownership. Theory and empirical precedent indicate that a primary benefit of many territories is exclusive access to food resources, and primary costs of defending and using space are associated with competition, travel and mortality risk. A recently developed mechanistic model for economical territory selection provided numerous empirically testable predictions. We tested these predictions using location data from grey wolves (Canis lupus) in Montana, USA. As predicted, territories were smaller in areas with greater densities of prey, competitors and low-use roads, and for groups of greater size. Territory size increased before decreasing curvilinearly with greater terrain ruggedness and harvest mortalities. Our study provides evidence for the economical selection of territories as a causal mechanism underlying ecological patterns observed in a cooperative

carnivore. Results demonstrate how a wide range of environmental and social conditions will influence economical behaviour and resulting space use. We expect similar responses would be observed in numerous territorial species. A mechanistic approach enables understanding how and why animals select particular territories. This knowledge can be used to enhance conservation efforts and more successfully predict effects of conservation actions.

5. THE ECONOMICS OF TERRITORY SELECTION

Investigators: Sarah Sells, Michael Mitchell (University of Montana)

Status: Published in Ecological Modelling in 2020, 438:109329

Link to full article: https://fwp.mt.gov/binaries/content/assets/fwp/conservation/wolf/sells--mitchell.-2020.-the-economics-of-territory-selection.pdf

ABSTRACT: Territorial behavior is a fundamental and conspicuous behavior within numerous species, but the mechanisms driving territory selection remain uncertain. Theory and empirical precedent indicate that many animals select territories economically to satisfy resource requirements for survival and reproduction, based on benefits of food resources and costs of competition and travel. Costs of competition may vary by competitive ability, and costs of predation risk may also drive territory selection. Habitat structure, resource requirements, conspecific density, and predator distribution and abundance are likely to further influence territorial behavior. We developed a mechanistic, spatially-explicit, individual-based model to better understand how animals select particular territories. The model was based on optimal selection of individual patches for inclusion in a territory according to their net value, i.e., benefits (food resources) minus costs (travel, competition, predation risk). Simulations produced predictions for what may be observed empirically if such optimization drives placement and characteristics of territories. Simulations consisted of sequential, iterative selection of territories by simulated animals that interacted to defend and maintain territories. Results explain why certain patterns in space use are commonly observed, and when and why these patterns may differ from the norm. For example, more clumped or abundant food resources are predicted to result, on average, in smaller territories with more overlap. Strongly different resource requirements for individuals or groups in a population will directly affect space use and are predicted to cause different responses under identical conditions. Territories are predicted to decrease in size with increasing population density, which can enable a population's density of territories to change at faster rates than their spatial distribution. Due to competition, less competitive territory-holders are generally predicted to have larger territories in order to accumulate sufficient resources, which could produce an ideal despotic distribution of territories. Interestingly, territory size is predicted to often show a curvilinear response to increases in predator densities, and territories are predicted to be larger where predators are more clumped in distribution. Predictions consistent with empirical observations provide support for optimal patch selection as a mechanism for the economical territories of animals commonly observed in nature.

APPENDIX 3

2021 WOLF POPULATION FORECASTING REPORT

Aim

The FWP commission was directed by the 2021 Montana legislature (SB 314) to reduce wolf populations to a sustainable level that is not less than the number needed to support 15 breeding pairs. The

legislation emphasized and expanded the commission's authority to implement additional hunting and trapping regulations to accomplish this, including extended seasons, increased bag limits, and expanded hunting and trapping options such as snares, night-hunting, and the use of bait. To support the commission's decision-making process, FWP Wildlife Research & Technical Services Bureau was asked to provide projections of the impacts of 4 human-caused mortality scenarios (annual totals of 516, 566, 666, and 766) on wolf population sizes. These human-caused mortality scenarios represent the recent 10-year annual mean of 66 depredation removals added to public harvest levels of 450, 500, 600, and 700. These projected harvest levels represented increases from the recent 5-year mean public harvest of 270, consistent with the intent to reduce the statewide wolf population size. For example, a public harvest of 450 would be 145 more wolves than the 2020 license year and 180 more than the 2016-2020 average (when estimated wolf populations remained relatively stable). The simulation scenarios were therefore intended to represent a range of elevated public harvest levels that may have been possible with the liberalized regulations. In each simulation scenario, total human-caused mortalities were held constant each future year. Projections were generated with simulations from a population growth model that used past estimates of statewide wolf population size and an index of human-caused mortality rate (harvest and depredation removals during Jan. 1–Dec. 31 year *t* / population estimate for Dec. year *t-1*) to forecast population sizes 5 years into the future. This human-caused mortality rate is an index to facilitate forecasting based on empirical relationship with estimated growth rates.

Methods

Annual wolf population sizes –

We used mid-winter (Dec.) wolf population size estimates from an integrated patch occupancy model (iPOM) (Sells et al. 2020, Inman et al. 2020). With iPOM, an occupancy model estimates the extent of wolf distribution in Montana, and a territory model predicts territory sizes; together, these models predict the number of packs. A group size model predicts pack sizes. Total abundance estimates are derived by combining the estimated number of packs and pack sizes, while also accounting for lone and dispersing wolves. Further detail can be found in Sells et al. (2020) and the 2020 wolf annual report (Inman et al. 2020).

Modeling wolf population dynamics–

We used the mid-winter iPOM population estimates (Y_t, Dec. of year t; Figure 1A,B) and their associated measures of uncertainty ($\sigma_{t_{observation}}$) as the input for a model of annual population dynamics which estimated the effect of the human-caused mortality rate index. Human-caused mortality (Jan. 1 – Dec. 31 of year t; Figure 1C) was estimated as mandatory reported hunter harvest and lethal removal of wolves involved in livestock depredation by USDA Wildlife Services. Our model took an empirical approach, modeling past annual growth rates (λ_t; Figure 1B) as a function of the annual index of human-caused mortality rate ($\text{H}_t = human\ caused\ mortality_t \ / \ Y_{t-1}$; Figure 1D). This is similar to previous work by Gude et al. (2012), except here we use iPOM population estimates rather than minimum population

estimates, and our approach includes an observation model that accounts for uncertainty in the iPOM population estimates. It is important to note that that H_t should not be misconstrued as the actual percentage of the Dec. t-1 population (Y_{t-1}) that is removed. Harvest and removals occur throughout the calendar year, which encompasses a birth pulse in early spring. Those young of the year are available for harvest in the 2nd half of the calendar year, thus the true percent of the Y_{t-1} removed is lower than H_t. Similarly, a dispersal pulse occurs in early winter with an unknown number of wolves entering and leaving the Montana population. The population model is as follows:

$$\lambda_t = Normal(\alpha + \beta_1 \times \text{H}_t, \sigma_{process})$$

$$N_t = N_{t-1} \times \lambda_t$$

$$Y_t \sim Normal(N_t, \sigma_{t_{observation}})$$

where α is the regression intercept, β_1 is the slope of the relationship between annual human-caused mortality rate index and growth rate. N_t is the true, but unobserved population size, and $\sigma_{process}$ describes the variation in annual growth rates unaccounted for by human-caused mortality rate index and driven by environmental and demographic stochasticity. While there may be some level of density dependent regulation in Montana's wolf populations, we were unable to estimate this effect because human-caused mortality and N are confounded in our 2007-2020 dataset (they both increase over the time period) and therefore these parameters were not separately identifiable in our model. Given our charge to forecast the effect of future human-caused mortality, we included that effect and not a density dependence effect. Therefore, our projections assume that human-caused mortality rate is the primary driver of population dynamics and do not account for increases in wolf recruitment that may occur if the population is in fact reduced in the coming years.

We fit the model in a Bayesian statistical estimation framework using JAGS software (4.3.0; Plummer 2003) executed from R via the package jagsUI (Kellner 2019), a wrapper to the package rjags (Plummer 2019). The Bayesian framework simplifies the inclusion of uncertainty in past population estimates and appropriate propagation of uncertainty into future forecasts. We generated 3 chains with 500,000 iterations, a burn-in of 50,000, and a thinning rate of 10. We assessed convergence by ensuring Gelman-Rubin convergence statistic for each parameter was <1.1 (Brooks and Gelman 1998) and that chains were well-mixed. Estimated parameters were given uninformative priors. Code for the model is given in appendix A.

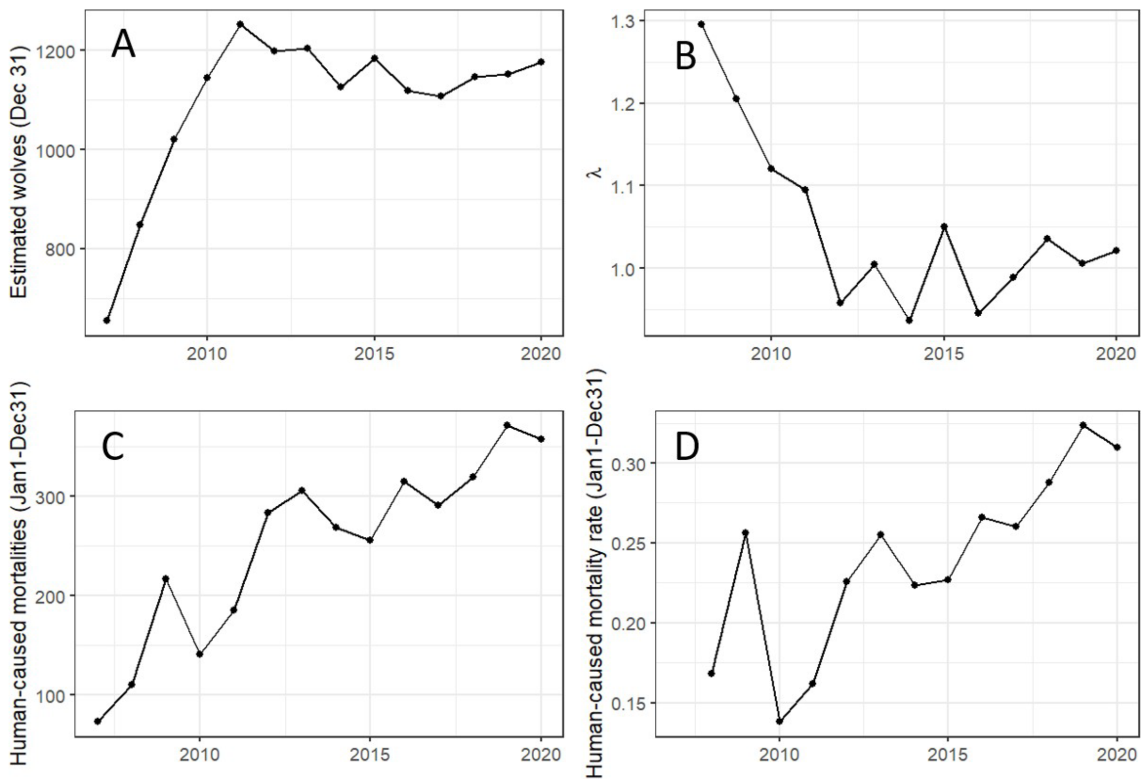

Figure 1. Statewide estimates of A) iPOM-estimated wolf population size for Dec. each year, B) estimated wolf population growth rate, c) reported human-caused mortalities (between Jan. 1–Dec. 31), and D) estimated human-caused mortality rate (H_t = human-caused mortalities$_t$ / iPOM wolves$_{t-1}$).

Results

The human-caused mortality rate index was negatively related to annual growth rates (Figure 2) as in previous studies (Gude et al. 2012). Our model estimated that a human-caused mortality rate of approximately 29% would result in stable annual population growth (λ = 1.0; 90% credible interval = 0.94, 1.07). In studies from other locations with human-caused mortality, λ values ranging from 0.94–

1.07 were observed when human-caused mortality rates ranged from 24–40% (Fuller et al. 2003). However, the human-caused mortality rates reported by Fuller et al. (2003) are not directly comparable to our index values. Fuller et al. (2003) reported the proportion of each population removed annually, whereas our estimate is based on the proportion of the previous population estimate harvested in the subsequent year, to facilitate forecasting, as described above.

All scenarios resulted in predicted declines, with a strong possibility of extirpation by the end of the 5- year period if human-caused mortality levels remained stable (Figure 3). The predicted extirpation assumed that the levels of human-caused mortality would remain at the same high level for each simulated year regardless of population response, so this result was not surprising. Constant total harvest would lead to an exponentially increasing human-caused mortality rate as wolf numbers declined. If any of these simulated human-caused mortality levels could be achieved, the commission would likely be required to intervene after 1 or 2 years to prevent the population from decreasing below the minimum level of 15 breeding pairs set in state and federal law. For the 2021-22 season, the commission set a harvest threshold of 450, which is 180 more than the 2016-20 average public harvest, at which point they would evaluate the season to determine if changes were warranted.

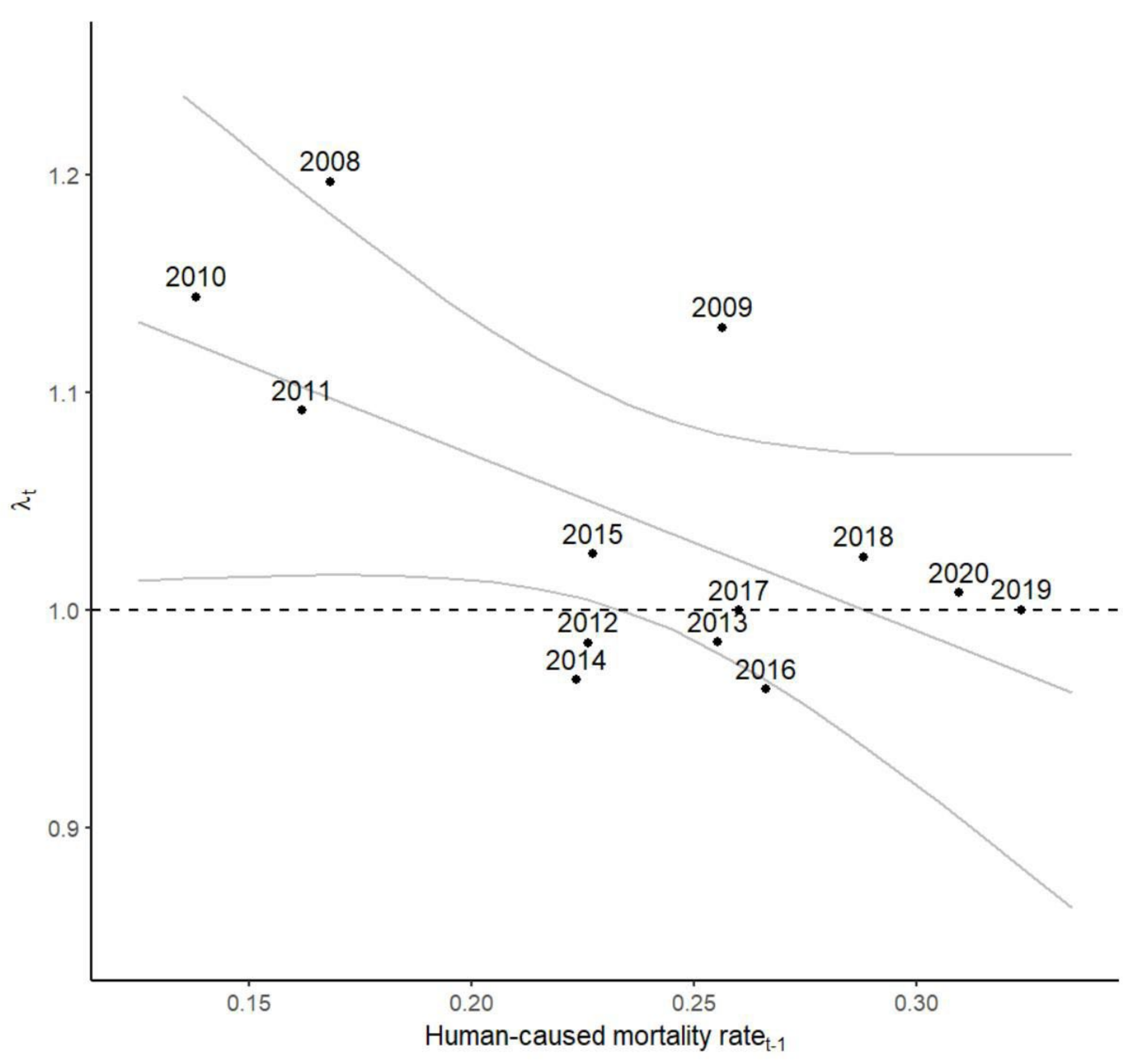

Figure 2. Estimated linear relationship and 90% credible intervals (grey lines) between annual population growth rate (λ_t) and human-caused mortality rate (human-caused mortalities$_t$ / iPOM wolves$_{t-1}$). The human-caused mortality rate resulting in an expected stable population (λ= 1) is approximately 29%.

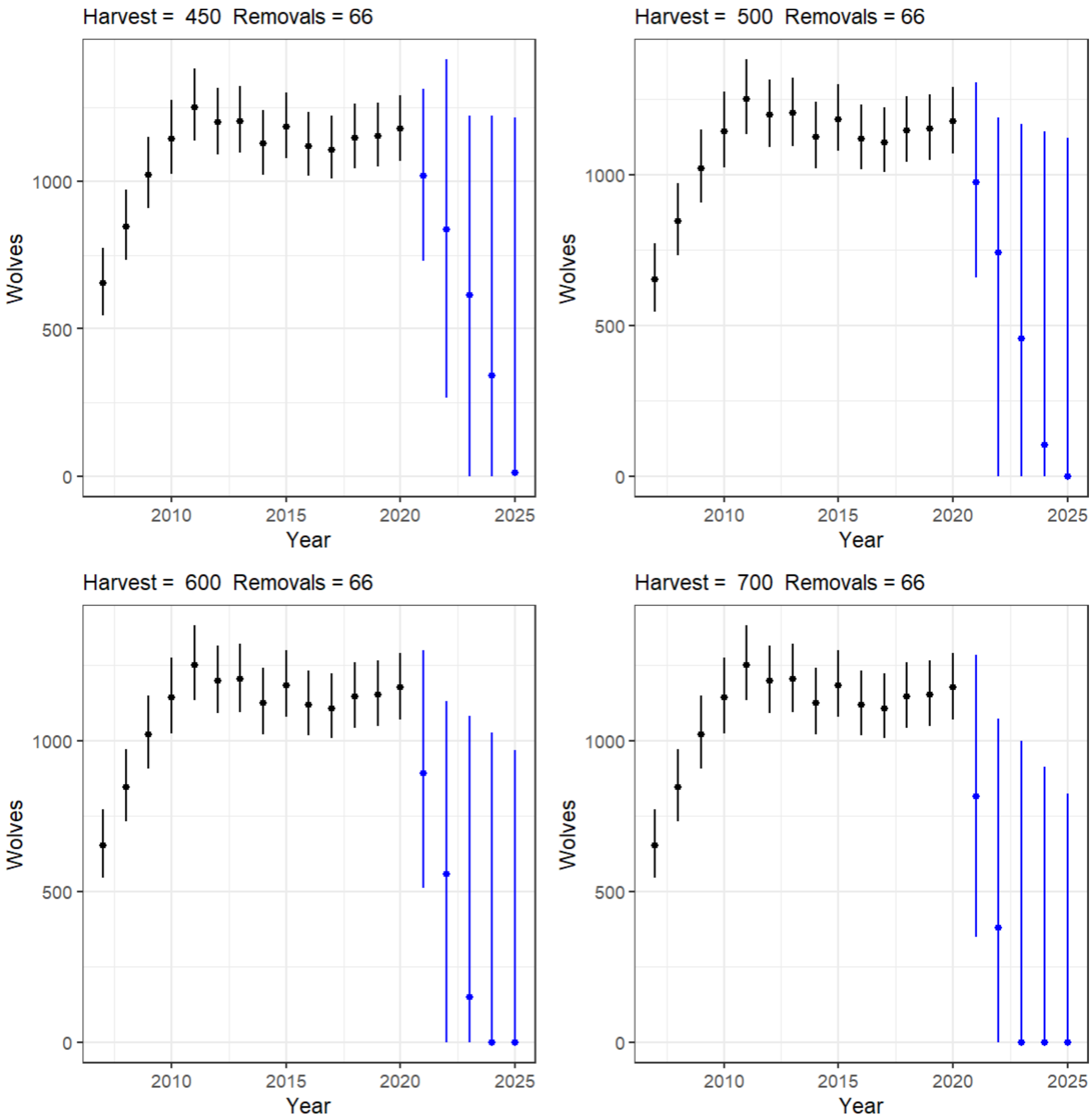

Figure 3. Population model predictions under FWP commission requested human-caused harvest and removal scenarios. Black points and error bars are iPOM estimates with 95% credible intervals; blue points and error bars are simulation results for future years with 90% prediction intervals. Panel titles reflect the human-caused mortality scenario each year into the future.

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Appendix A. Model code

```
model {

    #population model

    for(t in 1:(nyears-1)){


        # Human-caused (HC) mortality rate index calculated in simulations to allow

        uncertainty # min() prevents harvest larger than N; 1 is added to N to prevent

        division by 0 HC_mort_rate[t+1]<- min(HC_mortality[t+1], N.est[t]+1) / (N.est[t] +1)


        N.est[t+1]<- max(0, N.est[t] * lambda[t+1])


        # lambda distribution is truncated to prevent values <0 in simulations where regression
parameters would allow

        lambda[t+1] ~ dnorm(alpha+beta1*HC_mort_rate[t+1], sigma.proc^-2)T(0,)
```

```
      }



sigma.proc ~ dunif(0,10)N.est[1] ~ dnorm(650, 57.14^-2) # 2007 iPOM estimate

   alpha ~ dnorm(0, 0.001) # intercept: predicted lambda when HC mortality rate index = 0

   beta1 ~ dnorm(0, 0.001) # slope: relationship between HC mortality rate index and lambda


   # # # #observation model - describes uncertainty in annual iPOM estimates

   for(t in 2:(nyears-5)){

       ipom[t]~ dnorm(N.est[t], se[t]^-2)

   }

 }
```

Appendix 4

Wolf Hunting and Trapping Effort

All successful wolf hunters and trappers in Montana must personally report their wolf kill within 24 hours so that FWP can monitor harvest. Additionally, successful hunters and trappers that wish to retain possession of the hide and skull must present the hide and skull for inspection and registration within 10 days of kill. This information relative to harvest is gathered and maintained within a mandatory reporting database and harvest numbers are available on an online dashboard. However, not all data specific to hunter and trapper effort are collected from those successful hunters and trappers, and no effort information is gathered from unsuccessful individuals. Therefore, FWP conducts annual Hunter and Harvest Surveys to gather that additional information. Beginning in 2009 (for hunters) and 2012 (for trappers) statistical samples of wolf hunting and trapping licenses were selected, and individuals holding those licenses were contacted via telephone. To assess wolf hunting effort, hunters were asked which hunting district(s) they hunted the most and how many days they hunted in each. To assess wolf trapping effort, trappers were asked which district(s) they trapped the most, how many days they trapped in each, and how many traps/snares they set per day.

The number of wolf hunting licenses issued annually ranged from 15,520 (2009) to 24,478 (2013) (Table 1; Figure 1). The number of licenses sampled ranged from 7,953 (2020) to 13,721 (2013) and response rates varied from 47% (2021) to 68 % (2013) (Table 1).

Statewide, the number of active wolf hunters ranged from 8,175 (2021) to 15,570 (2014) (Figure 1; Table 2) and hunter days ranged from 104,893 (2020) to 228,181 (2013) (Table 3). Whereas issued hunting licenses have shown an increase in most recent years, active hunters have shown a decline. Wolf hunter numbers and hunter days were greatest in FWP Region 3 (Table 2; Table 3).

The number of trapping licenses issued to trappers with a required wolf trapping certification ranged from 1,508 (2012) to 3,124 (2013) (Table 4; Figure 2). The number of licenses sampled ranged from 1,455 (2012) to 2,113 (2013) and response rates varied from 43% (2012) to 68% (2013) (Table 4).

Statewide, the number of active wolf trappers ranged from 289 (2021) to 572 (2012) (Figure 2; Table 5) and wolf trapper days ranged from 7,524 (2021) to 21,653 (2012) (Table 6). Traps set ranged from 2,607 (2016) to 4,528 (2020) (Table 7) and trap days ranged from 87,194 (2021) to 174,135 (2012) (Table 8). Wolf trapper numbers and trapper days were greatest in FWP Region 1 (Table 5; Table 6). Traps set and trap days were greatest in FWP Region 2 (Table 7; Table 8).

More detailed hunting and trapping effort results including estimates at the deer/elk hunting district level, estimates by hunter/trapper residency, and confidence intervals on the estimates can be found at https://myfwp.mt.gov/fwpPub/harvestReports under 'WOLF'.

Table 1. Number of issued wolf hunting licenses, number of sampled licenses, number of responses, and response rates from telephone surveys of wolf hunters in Montana, 2009 - 2021.

License Year	Number Issued	Number Sampled	Responses	Response Rate
2009	15,520	8,710	5,338	0.61
2010				
2011	17,632	9,910	6,169	0.62
2012	17,746	10,006	6,325	0.63
2013	24,478	13,721	9,334	0.68
2014	19,584	10,973	7,022	0.64
2015	18,676	10,457	6,206	0.59
2016	17,182	9,074	5,250	0.58
2017	16,847	8,848	5,743	0.65
2018	17,182	8,946	5,238	0.59
2019	18,134	9,488	5,776	0.61
2020	18,557	7,953	4,275	0.54
2021	20,847	10,200	4,816	0.47

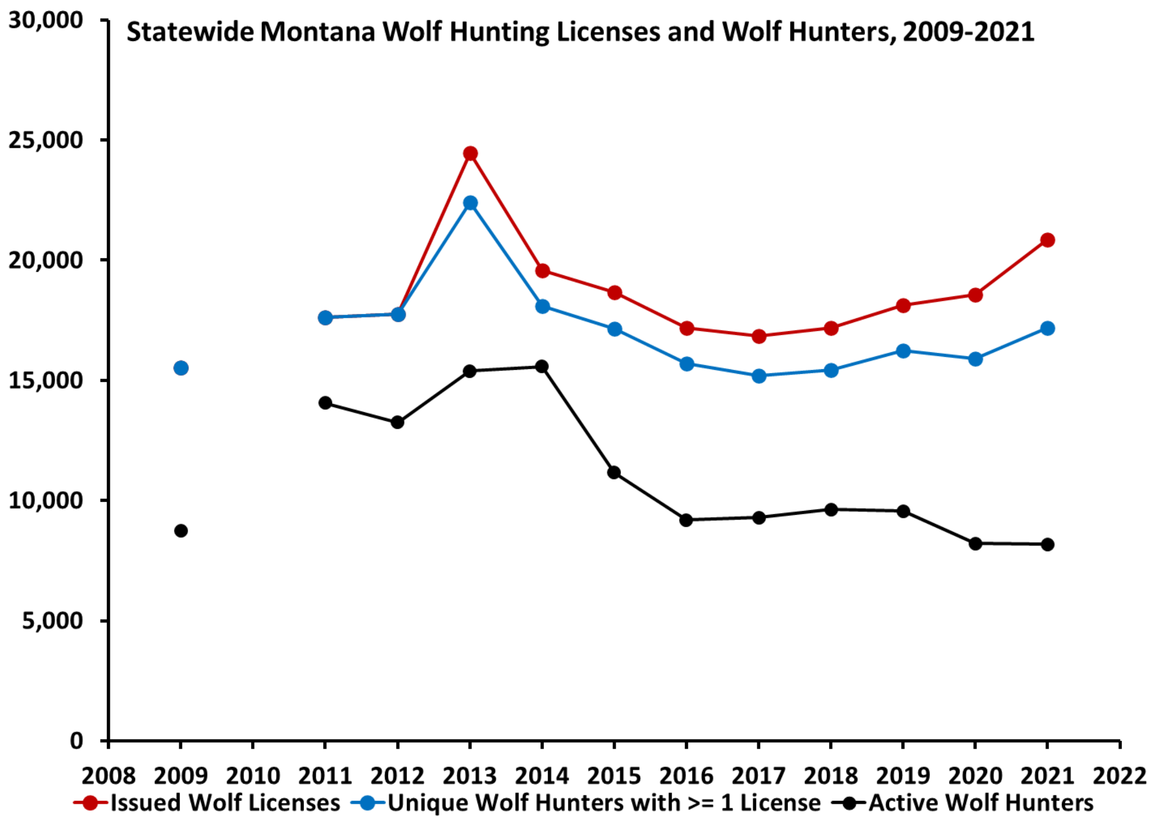

Figure 1. Number of wolf hunting licenses issued, number of hunters issued >= 1 wolf hunting license, and number of active wolf hunters estimated from Hunter Surveys in Montana, 2009 – 2021.

Table 2. Estimated number of active wolf hunters in Montana and by FWP Region, 2009 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2009	8,734	2,487	3,169	2,635	984	308	236	158	3
2010									
2011	14,066								
2012	13,253	2,869	3,588	5,498	2,199	784	284	290	0
2013	15,386	3,324	4,128	6,377	2,177	914	279	361	2
2014	15,570	3,317	3,930	6,992	2,254	934	239	350	11
2015	11,165	2,182	2,459	5,173	1,601	689	196	213	9
2016	9,194	2,022	2,113	4,049	1,275	446	104	141	3
2017	9,289	1,876	2,237	3,993	1,180	545	120	132	8
2018	9,629	2,085	2,343	4,072	1,410	557	145	199	3
2019	9,553	2,070	2,177	3,995	1,368	479	146	177	0
2020	8,218	1,765	1,944	3,494	1,211	398	149	217	4
2021	8,175	1,594	1,779	3,690	1,032	477	163	142	14

Table 3. Estimated number of wolf hunter days in Montana and by FWP Region, 2009 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2009	107,777	33,646	38,695	24,839	7,804	3,221	1,350	974	3
2010									
2011	178,067								
2012	181,793	41,328	43,813	63,778	20,601	7,760	2,103	2,501	0
2013	228,181	48,061	57,238	84,125	25,238	9,231	2,121	3,534	7
2014	216,620	43,320	52,512	83,145	24,045	8,443	2,363	3,502	46
2015	140,921	25,944	30,163	57,476	15,820	7,224	2,360	1,893	43
2016	121,422	24,787	27,860	49,947	13,201	4,172	1,235	1,244	19
2017	116,599	23,237	27,289	45,154	12,983	5,570	1,117	1,216	73
2018	120,168	24,217	27,193	46,272	14,041	6,082	1,215	1,672	6
2019	126,065	27,771	28,478	48,682	14,557	4,710	1,371	1,777	0
2020	104,893	20,285	22,208	42,813	11,521	4,642	1,413	1,966	44
2021	106,067	17,438	23,246	45,421	11,515	5,263	1,140	1,900	166

Table 4. Number of issued wolf trapping licenses, number of sampled licenses, number of responses, and response rates from telephone surveys of wolf trappers in Montana, 2009 - 2021.

License Year	Number Issued	Number Sampled	Responses	Response Rate
2012	1,508	1,455	620	0.43
2013	3,124	2,113	1,439	0.68
2014	2,693	1,734	1,099	0.63
2015	2,725	1,748	1,011	0.58
2016	2,509	1,484	853	0.57
2017	2,681	1,588	1,027	0.65
2018	2,516	1,497	905	0.6
2019	2,848	1,690	1,129	0.67
2020	2,851	1,576	869	0.55
2021	2,338	1,482	681	0.46

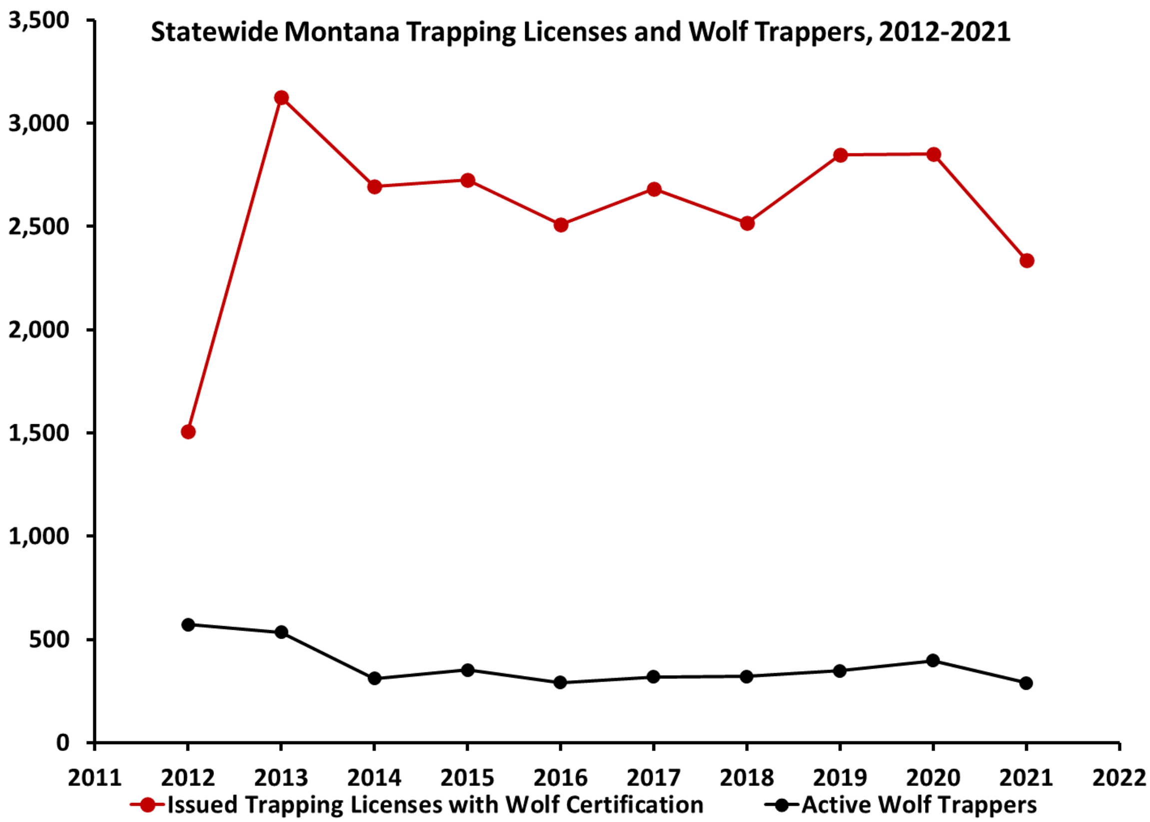

Figure 2. Number of trapping licenses issued to trappers with wolf trapping certification and number of active wolf trappers estimated from Harvest Surveys in Montana, 2012 – 2021.

Table 5. Estimated number of active wolf trappers in Montana and by FWP Region, 2012 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2012	572	195	173	141	34	34	0	2	0
2013	534	201	137	140	52	19	4	7	0
2014	311	123	52	91	27	15	0	3	0
2015	352	97	93	90	38	38	3	0	0
2016	291	104	96	56	30	3	0	3	0
2017	319	94	118	60	29	11	5	5	0
2018	320	101	103	67	28	21	3	3	0
2019	349	120	101	79	28	18	3	3	0
2020	397	147	105	106	27	13	0	0	0
2021	289	81	92	84	18	14	0	4	0

Table 6. Estimated number of wolf trapper days in Montana and by FWP Region, 2012 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2012	21,653	6,948	7,194	4,886	1,354	1,125	0	146	0
2013	21,039	8,183	5,950	4,436	1,728	706	38	13	0
2014	9,966	4,011	1,390	3,180	808	414	0	163	0
2015	10,675	2,981	2,725	2,501	1,552	721	195	0	0
2016	9,489	3,164	3,802	1,492	810	133	0	89	0
2017	9,901	2,851	4,053	1,916	680	170	175	55	0
2018	12,116	2,830	4,239	3,231	1,046	423	174	174	0
2019	12,009	3,372	3,769	3,373	661	501	167	167	0
2020	15,878	4,305	4,815	5,523	796	439	0	0	0
2021	7,524	1,762	2,016	3,044	319	170	0	213	0

Table 7. Estimated number of wolf traps in Montana and by FWP Region, 2012 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2012	4,300	1,415	1,573	845	241	207	0	20	0
2013									
2014	2,828	1,134	507	764	206	150	0	68	0
2015	3,041	647	840	866	365	277	46	0	0
2016	2,607	701	952	533	351	35	0	36	0
2017	2,754	769	1,119	518	220	63	39	26	0
2018	3,361	778	1,294	640	235	172	104	139	0
2019	3,598	1,025	1,308	863	256	146	0	0	0
2020	4,528	1,351	1,211	1,539	263	164	0	0	0
2021	3,436	615	1,037	1,363	220	152	0	50	0

Table 8. Estimated number of wolf trap days in Montana and by FWP Region, 2012 - 2021

Year	State	FWP Region 1	FWP Region 2	FWP Region 3	FWP Region 4	FWP Region 5	FWP Region 6	FWP Region 7	FWP Region Unk
2012	174,135	52,894	72,526	30,194	11,012	6,926	0	584	0
2013									
2014	96,626	36,358	16,042	27,156	7,158	5,846	0	4,066	0
2015	98,368	21,808	31,303	23,456	16,233	4,204	1,364	0	0
2016	97,262	26,895	39,818	16,250	11,636	1,591	0	1,073	0
2017	96,935	25,064	45,239	17,930	5,161	1,328	1,937	275	0
2018	133,353	24,045	53,187	28,417	9,560	3,555	6,252	8,336	0
2019	133,301	37,857	51,011	36,536	3,289	4,609	0	0	0
2020	158,921	36,149	40,962	66,941	9,396	5,473	0	0	0
2021	87,194	14,931	22,691	41,589	3,028	1,979	0	2,975	0