OREGON
WOLF CONSERVATION AND MANAGEMENT PLAN

OREGON DEPARTMENT OF FISH AND WILDLIFE

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EXECUTIVE SUMMARY
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The *Oregon Wolf Conservation and Management Plan* (Plan) was first adopted in 2005 and updated in 2010. This update, which began in March 2016, is the result of a thorough, multi-year evaluation of the Plan and included a facilitated stakeholder process. Some of the changes contained within this Plan are general updates and reorganization of content. Other changes are more substantive in nature, and include management improvements based on information gained over years of wolf management in Oregon. In general, changes made in this Plan include: 1) updates to base information (i.e., status, population, distribution, etc.), 2) new science related to the biology and management of wolves, and 3) management improvements based on information gained through years of wolf management in Oregon. Chapter II (Wolf Conservation and Monitoring) includes detailed information on the three phases of wolf management and discusses the state's two wolf management zones. Chapter III (Wolf as Special Status Game Mammal) is a new chapter comprised of content from the previous plan and addresses the Special Status Game Mammal definition and conditions of that definition. Chapter IV (Wolf-Livestock Conflicts) includes information on the use of non-lethal deterrents, the use of controlled take in certain situations, and expands livestock producer options for investigating potential wolf depredations of livestock. Chapter V (Wolf-Ungulate Interactions, and Interactions With Other Carnivores) addresses interactions between and impacts of wolves and other wildlife species. Chapter VI (Wolf-Human Interactions) addresses the types of wolf-human interactions and strategies for reducing negative situations. The final chapters address strategies for plan implementation and future direction and include Chapter VII: Information and Education, Chapter VIII: Reporting and Evaluation, IX: Research and Information Management, and Chapter X: Budget for Implementation.

Readers should note that while some sections of earlier Oregon Fish and Wildlife Commission (Commission) adopted Plans are condensed or combined in this 2019 Plan, earlier adopted Plans will continue to be made available on the ODFW wolf website at http://www.dfw.state.or.us/Wolves/index.asp.

The Plan's goal remains the same:

To ensure the conservation of gray wolves as required by Oregon law while protecting the social and economic interests of all Oregonians.

The 2005 Plan was originally crafted using an adaptive approach that requires periodic and formal evaluation using information gained through the actual management of wolves. The Oregon Department of Fish and Wildlife (ODFW) considered the following principles while reviewing and updating the Plan.

- Adhere to the factors included in the 2015 delisting analysis when considering any proposed changes.
- Maintain conservation focus for wolves in all population phases.
- Maintain flexible management options of the 2005 Plan when addressing conflict as the wolf population increases.

- Address ODFW personnel and budget limitations when evaluating future commitments.
- Develop an effective workload sharing program with the U.S. Fish and Wildlife Service (USFWS) to monitor expanding wolf populations and address wolf-livestock conflicts in the federally listed portion of Oregon.

Gray Wolves (*Canis lupus*) were listed as endangered under the federal Endangered Species Act (ESA) and the state ESA when the Plan was updated in 2010. Gray wolves were establishing in northeastern Oregon at that time; today, the status of wolves in the state is more complex. In 2011, the USFWS delisted the gray wolf from the federal ESA east of Oregon Highways 395, 78, and 95 as part of the larger Northern Rocky Mountain Distinct Population Segment; wolves west of this boundary remained federally listed. In January 2015, the Oregon conservation population objective was reached in the East Wolf Management Zone. The Commission initiated a biological status review to determine if the species required continued listing under the Oregon ESA. That review led to the delisting of wolves in Oregon in November 2015. While these changes represent landmarks in the modern history of the gray wolf, this Plan strives to provide continued conservation and effective management of wolves into the future.

The objectives and strategies contained within this Plan are intended to serve multiple functions into the future – they provide management guidance to address wolf-livestock conflicts, monitor wolf population and health factors, evaluate wolf interactions with native ungulate and other carnivore populations, conduct wolf-related research, and address wolf-human interactions. The Plan also identifies potential conservation threats for managers to consider when considering a number of management activities. While Oregon's wolf population is predicted to continue to grow and expand its distribution, it is unclear at this time what the future population and specific distribution will be. This Plan contains strategies which direct ODFW to develop detailed and predictive population models which will improve understanding of potential occurrence, habitat suitability, potential wolf range, and will inform the development of future population and distribution goals.

Wolves have reached Phase III population levels in eastern Oregon, but the state's wolf population is still relatively small at this time. Wolves occur in both eastern Oregon forested areas, and the forests of the Cascade Mountains. However, the extent they will successfully expand into the Oregon coast range is undetermined. This Plan strives to provide a framework by which the management of this species may, at some point in the future, transition to a management approach similar to other wildlife in Oregon, while continuing to recognize the unique history of the species.

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I. INTRODUCTION

A. Background

In 1999, Wolf B-45, a radio-collared female from Idaho, was the first wolf from the reintroduced Idaho population known to have travelled to Oregon. One of Oregon's most famous wolves, it was later captured by the U.S. Fish and Wildlife Service near the Middle Fork of the John Day River and returned to Idaho. Shortly after, two other wolves which originated from the Idaho reintroduced population were found dead – in May 2000 a radio-collared male wolf was struck by a vehicle south of Baker City, and in October 2000 an uncollared male wolf was found shot between Ukiah and Pendleton.

The news that wolves were back in Oregon sparked intense interest and heated debates across the state, and prompted Oregon Fish and Wildlife Commission (Commission) to initiate development of a state Wolf Conservation and Management Plan (Plan). They appointed a 14-member committee to oversee the work and, over a three-year period, the Plan was drafted with input from a wide variety of stakeholders and the public.

When the Plan was first adopted in 2005, there were no known wolves in the state. In 2008, the first modern-day reproduction by wolves was documented in Oregon when pups were discovered in the Wenaha Wildlife Management Unit (WMU) in northeastern Oregon. By the end of 2011, the wolf population had grown to 29 known wolves, including four packs and one breeding pair. A pack is defined as a group of four or more wolves traveling together in winter and a breeding pair is an adult male and an adult female wolf with at least two pups that survived to December 31 of the year of their birth. The population continued to increase and in 2013 a minimum wolf population of 64 wolves in 8 packs was documented, including 4 breeding pairs. The most recent completed surveys (2018) documented a statewide minimum population of 137 wolves, including 16 packs and 15 breeding pairs. Much has changed since the Plan was originally written. In 2011, the gray wolf was delisted from the Federal Endangered Species Act in the eastern-most portion of the state and in 2015, wolves were delisted from the Oregon ESA statewide. This Plan, however, continues to provide for conservation and management of wolves into the future.

This Plan was crafted using an adaptive management approach and requires regular reporting to the Commission and a formal evaluation every five years as required by Oregon ESA. In 2010, the Plan was reviewed and updated. In 2013, the Plan and associated rules were modified as a result of litigation arbitration and new legislation. The 2015 evaluation was delayed as the Commission deliberated whether to remove the gray wolf from the Oregon List of Endangered Species. The current Plan evaluation and review began in March of 2016 and this document is a result of that review.

B. History of Wolves in Oregon

Gray wolves are native to Oregon and their existence in the state is documented through archeological records; Native American accounts; journals and diaries of early explorers and pioneers; museum specimens; wolf bounty records; and various other books and reports. Historical

accounts point to a relatively wide distribution of wolves, although their abundance varied from place to place. The following written accounts (Young and Goldman 1944, Young and Goldman 1946) offer interesting observations of wolves at the time of westward expansion:

- "…(wolves) are exceedingly numerous in Oregon and Washington Territories, from the Cascades to the Rocky Mountain Divide." George Suckley, expedition Naturalist, 1853-55.
- "…the wolves are very numerous in this country and exceedingly troublesome." Mr. Drayton, Wilkes Expedition, vicinity of Fort Walla Walla, 1841.
- Lewis and Clark noted that seven elk killed by expedition hunters were "…untouched by the wolves, of which indeed there are but a few in this country." Lewis and Clark, winter of 1805-06, Fort Clatsop area, near the mouth of the Columbia River.

Additional wolf location information was reported by biologist Vernon Bailey (1936):

- "…in 1834 Wyeth reported several (wolves) killed along the Deschutes River."
- "…in 1835 Townsend secured the type of this subspecies near Fort Vancouver just north of the Columbia River."
- "...in 1854 Suckley collected (wolf) specimens near The Dalles."
- "...in 1897 Captain Applegate reported them (wolves) formerly common, but at that time extremely rare in the southern Cascade region."
- "…Jewett reports one large male wolf taken…August 20, 1930, near Balm Mountain on the Umpqua National Forest."
- "...another old male wolf taken (1930)…on the shore of Crescent Lake in Klamath County."
- "...two other wolves were killed in Douglas County and one in Lane County during 1930, and one near McKenzie Bridge in Lane County in 1931."

As more people moved west and wild prey populations became depleted, stockowners found it necessary to protect their livestock from carnivores, and ultimately, wolves were extirpated. Governments and bounties played a role, and the first wolf bounty in the Oregon Territory was established in 1843 at an Oregon Wolf Association meeting in the Willamette Valley. The bounty for a large wolf was $3 and was paid from "subscriptions" to the association. In 1913, the Oregon State Game Commission offered a $20 wolf bounty in addition to the regular $5 paid by the state at the time. From October 1, 1913 through May 10, 1914, payments were made on wolves in Oregon: 10 in Douglas County; 6 in Crook County; 6 in Clackamas County; 6 in Linn County; and 1 in Lane County.[1] From 1913-1946, 393 wolves were presented for payment in Oregon (Olterman and Verts 1972). Many of these wolves were taken prior to the mid1930s—no more than two wolves per year were bountied after 1937. The last records of wolves submitted for bounty in Oregon were in 1946 for an animal killed in the Umpqua National Forest in southwest Oregon[2] , and in 1947 from a person in Florence Oregon (collection location unknown).[3]

The first major work on the state's mammals, *The Mammals and Life Zones of Oregon,* described wolves as present in most timbered areas of Oregon (Bailey 1936). The author considered wolves to be most common in western Oregon, from the western foothills of the Cascade Range to the Coast. This observation may have been influenced by the distribution of the human population rather than

[1] From the Oregon Sportsman 2 (6):19, 1914, as quoted in Bailey 1936.
[2] OSGC Annual Game Report 1947.
3 Oregon bounty ledger book 1946-1947, as referenced in Robinson, M. J. 2005. Predatory Bureaucracy: The Extermination of Wolves and the Transformation of the West. University Press of Colorado.

directly related to the abundance of wolves. Information regarding wolves from other locations in Oregon where habitat existed may not have been available.

In a special report on endangered mammals of Oregon, 80 wolf specimens were located in various museums and private collections (Olterman and Verts 1972). The authors stated "…most specimens were collected from the western slope of the Cascade Mountains … This distribution is not representative of the range originally occupied by the wolf in the state because the species probably was eliminated from some areas before 1913 when specimens were first preserved." At the time of their report, they believed the wolf to be extirpated from the state and the absence of populations in neighboring states to preclude natural immigration or re-establishment.

A report compiled in 1996 stated that no authentic gray wolf records were known between 1946 and 1974 (Marshall et al. 1996). During the period 1974-1980, four records of wolves were noted, although the author considered at least two of these records to be tame wolves or wolf-dog hybrids.

During the second half of the 20th century, however, attitudes toward wolves in North America changed significantly and strong support for wolf conservation was seen throughout the United States (Mech and Boitani 2003). Socio-cultural influences, including the voice of conservationists such as Aldo Leopold, provided ecological perspectives and support for wolves.

These changing wildlife values were embodied in the federal ESA of 1973 and the Oregon ESA of 1987. Twelve years after the Oregon ESA was enacted, the first wild gray wolf was documented in the state. It came as a result of the USFWS's Northern Rocky Mountain Wolf Recovery Plan – the implementation of that plan resulted in the relocation of 66 gray wolves from Canada into central Idaho and Yellowstone National Park in 1995 and 1996.

C. Biology and Ecology

A discussion on the biology and ecology of wolves includes physical characteristics, pack size, reproduction, food habits, movements and territories, dispersal, mortality, genetics, and population growth. Significant numbers of books and papers have been written on these subjects. Efforts to condense these for the western United States have been undertaken during development of other state management plans. Appendix B, Wolf Biology and Ecology, includes a description of this topic that was adapted from the Montana Gray Wolf Conservation and Management Plan (2002) and also provides a summary of wolf diseases. Information in Appendix B was not revised in this Plan update.

D. Role of Wolves in Ecosystems

Large carnivores, including wolves, can contribute to the structure and function of ecosystems. For example, wolves can reduce abundance or pack size of a common mesopredator, coyotes (Smith et al. 2003, Berger and Gese 2007a, Merkle et al. 2009), which may in turn influence populations of smaller carnivores (e.g., foxes; Levi and Wilmers 2012, Newsome and Ripple 2014), reduce predation on some ungulates (e.g., pronghorn; Berger and Conner 2008, Berger et al. 2008), and influence small mammal populations (Miller et al. 2012). In systems where apex predators such as wolves returned after being absent for long periods, some mesopredator suppression occurred,

benefitting small mammal and avian communities and biodiversity (Crooks and Soule 1999, Ritchie and Johnson 2009b, Letnic and Dworjanyn 2011).

The removal or restoration of apex predators, such as wolves, can also influence behavior, abundance and population dynamics of prey species (*see* Section A: Potential Effects of Wolf Predation on Oregon's Ungulates in Chapter V). This can result in changes to vegetative communities (Schmitz 2006), which then influence other wildlife or ecosystem processes (Ripple et al. 2010) – often referred to as a trophic cascade (Hairston et al. 1960, Beschta and Ripple 2009). Predators can also alter behavior, movements, and distribution of prey and can influence their browsing patterns. These situations are generally referred to as behaviorally mediated trophic cascades (Schmitz et al. 1997) – predators increasing the risk of predation for prey, which can alter prey behavior (Laundré et al. 2001). In response to predation risk, some prey will alter their behavior, movements, diet, and habitat use to reduce predation risk (Hernández and Laundré 2005, Laundré et al. 2010) and this could lead to changes in vegetative communities and subsequent trophic cascades (Ripple and Beschta 2004a, Fortin et al. 2005a).

Wolf recolonization can produce direct and indirect influences on other carnivores (*see* Section D: Wolf Interactions with Other Carnivores-Multiple Predator Systems in Chapter V), prey, and vegetative communities. For example, in Yellowstone and Banff National Parks, wolf predation reduced elk density and changed elk behavior, which was correlated with increased abundance and growth of woody plant species such as willow, cottonwood, and aspen (Ripple and Beschta 2003, Smith et al. 2003, Ripple and Beschta 2004b, Hebblewhite et al. 2005, Ripple and Beschta 2012, Ripple et al. 2015, Beschta et al. 2016). Increased willow abundance in Yellowstone National Park led to increased number of beavers and habitat for birds and other wildlife (Hebblewhite and Smith 2010). The increased vegetative cover in riparian areas likely also decreased stream temperatures and reduced erosion, benefiting a wide variety of aquatic species (Hebblewhite and Smith 2010). Grizzly bear diets had a higher percentage of fruit in their diets following wolf recolonization of Yellowstone, which was correlated with decreased ungulate browsing of serviceberry (Ripple et al. 2014a); however, these conclusions have been challenged (Barber-Meyer 2015). Berger et al. (2001) suggested the historical loss of grizzly bears and wolves led to changes in riparian vegetation that also coincided with decreased abundance and diversity of bird species. Combined, these examples highlight the importance of large carnivores, including wolves, in influencing ecosystem structure and biodiversity (Beschta and Ripple 2009, Estes et al. 2011, Ripple et al. 2014b).

While the role of wolves shaping trophic cascades have been widely reported and popularized, many of the conclusions that have been reached on the topic are equivocal. For example, (Hebblewhite and Smith 2010) indicated that willow in Yellowstone appeared to have benefited from reduced browsing pressure from elk, but other woody browse species were not showing signs of recovery following wolf reintroduction. Further, Kauffman et al. (2010) found that recovery of aspen in Yellowstone was not occurring even in sites where elk were more vulnerable to predation, suggesting behavioral changes in elk alone were not sufficient to benefit aspen recovery. Middleton et al. (2013b) found further support that elk behavior is not heavily influenced by wolf predation. When wolves were in close proximity to elk (< 1 km), elk increased movement rates, shifted distributions, and increased vigilance; however, elk were only this close to wolves once every 9 days leading to minimal changes in elk behavior overall, which would likely influence the strength of any trophic cascades observed. Additionally, abiotic factors (e.g., snow depth, soil moisture) were equally important in determining willow and aspen recruitment as browsing by elk (Tercek et al. 2010, Kauffman et al. 2010). In a decade long study in Yellowstone, it was found that the reduction

in herbivore browsing attributable to reduced elk populations did not recover riparian vegetation. Rather, to restore riparian vegetation and structure, ungulate browsing must be completely removed and restoration of hydrological conditions (e.g., reconnect historic floodplain and stream channels) must occur (Marshall et al. 2013). The authors concluded, the effects of predation from a top-carnivore alone on ungulate behavior and population size is unlikely to reverse the decades long changes that have occurred in riparian systems.

It is also important to consider that while there is evidence that trophic cascades and other ecosystem-level responses have occurred following the recolonization of wolves, they have largely been observed in national parks or other protected areas where elk densities are high and not managed with recreational hunting. Outside of protected areas (such as much of Oregon), other factors may play a large role in shaping vegetative communities; ungulate density, behavior and habitat use; and ultimately ecosystem structure and composition. Land management activities such as fire suppression and timber harvest influence vegetation structure and composition (Parsons and DeBenedetti 1979, Lindenmayer and Franklin 2002). Cattle grazing also influences vegetation structure and composition (Moser and Witmer 2000, Averett et al. 2017) and may alter elk behavior and movements (Stewart et al. 2002). Hunting (Conner et al. 2001, Vieira et al. 2003, Proffitt et al. 2010, Cleveland et al. 2012) and disturbance from motorized vehicles (Johnson et al. 2000, Rowland et al. 2000, Naylor et al. 2009, Coe et al. 2011) also have a large effect on behavior, movements, habitat use, densities, and distribution of elk. Further, while elk showed changes in movements and behavior in response to both human hunting and wolves in the Greater Yellowstone Area, the observed responses to human hunting were greater than to wolves (Proffitt et al. 2009), suggesting that elk may already have behaviorally induced changes in behavior and habitat use outside of protected areas. Finally, additional factors, including climate and habitat productivity may directly affect ecosystems (Oksanen et al. 1981, Crête 1999) and the degree to which wolves influence ecosystem structure and function (Rooney and Anderson 2009). Consequently, it is unknown if ecosystem changes as observed in some protected areas will occur in the more managed landscapes of Oregon, where livestock grazing occurs on most forested lands, and where ungulate populations are carefully managed through hunting.

E. Legal Status

Federal

When this Plan was first developed in 2005, wolves across Oregon were listed as endangered under the federal ESA. That changed on May 5, 2011, when the USFWS ultimately delisted the Northern Rocky Mountain Distinct Population Segment of wolves from the list of endangered species, following initial delisting in 2009 and relisting in 2010. The delisting included the easternmost portion of Oregon bounded by Oregon Highways 395/78/95. At this date, wolves in the remainder of Oregon (west of those same highways) continue to be federally protected as endangered and the Federal ESA sets the minimum protection levels for wolf management. In the listed area, ODFW implements this Plan in conjunction with the *2019 Federal/State Coordination Strategy for Oregon Wolf Plan Implementation* (Appendix C).

State

Wolves were listed as endangered under Oregon ESA when the Plan was first adopted by the Commission in 2005. In 2009, the Oregon Legislature changed the status of wolves from protected non-game wildlife to a special status game mammal under ORS 496.004(9). This change was called for in the 2005 Plan and allows ODFW to use existing, stable state and federal funding sources and existing field staff to include wolf management as part of their daily duties. ORS 496.004(9) also directed the Commission to define the substantive standards governing this special status game mammal classification. Those standards are included in Chapter III (Wolves As Special Status Game Mammals) of this Plan.

In January 2015, the conservation objective of four breeding wolf pairs for three consecutive years in the East Wolf Management Zone (*see* Chapter II for descriptions of wolf management zones and objectives) was reached. As directed by the Plan, this moved wolf management into Phase II of a three-phase management approach in eastern Oregon and triggered a biological review of the gray wolf's status to determine if it should be removed from the Oregon List of Endangered Species. Delisting a species from Oregon ESA (ORS 496.176) is a public process that requires a rulemaking decision by the Commission based on the following five determinations:

1. The species is not now (and is not likely in the foreseeable future to be) in danger of extinction in any significant portion of its range in Oregon or in danger of becoming endangered; and
2. The species natural reproductive potential is not in danger of failure due to limited population numbers, disease, predation, or other natural or human-related factors affecting its continued existence; and
3. Most populations are not undergoing imminent or active deterioration of range or primary habitat; and
4. Over-utilization of the species or its habitat for commercial, recreational, scientific, or educational purposes is not occurring or likely to occur; and
5. Existing state or federal programs or regulations are adequate to protect the species and its habitat.

On November 9, 2015, the Oregon Fish and Wildlife Commission removed wolves from the Oregon List of Endangered Species. This decision was the result of public Commission meetings on April 24, October 9, and November 9, 2015. The biological status review and scientific analysis used in the delisting decision is available on the ODFW website, www.odfw.com/Wolves/management_plan.asp.

Although delisted statewide, wolves remain protected by the Wolf Plan and its associated rules. It is this Plan and Oregon's wildlife policy that guides long-term management of the species into the future. The wildlife policy states "that wildlife shall be managed to prevent the serious depletion of any indigenous species" and includes seven coequal management goals (ORS 496.012). It follows that continued use of many of this Plan's conservation and management measures that led to achieving early conservation objectives should ensure that future relisting is unnecessary.

F. Wolf Plan Development and Update

For a detailed history on the development of the Wolf Plan, see the 2005 Wolf Conservation and Management Plan, www.odfw.com/Wolves/management_plan.asp.

Beginning in June 2003, a 14-member Wolf Advisory Committee appointed by the Oregon Fish and Wildlife Commission developed a draft Wolf Conservation and Management Plan with input from numerous individuals and groups. At that time, the Commission directed the following guiding principles for the planning process:

1. Commission provides direction to write a wolf management plan based on "conservation" of wolves, as required by state law.
2. Commission will select a "Wolf Advisory Committee" to advise the Commission on wolf issues and draft a wolf management plan.
3. Ideas from wolf management plans produced by other states will be considered.
4. The themes and concerns expressed by the public through town hall meetings and written comments must be considered and incorporated in the final Plan.
5. Active re-introduction of wolves will not be considered. Natural dispersal of wolves from the Idaho population will be accepted.
6. The final Plan will be consistent with the Oregon ESA (ORS 496.171-496.192) and the Oregon Wildlife Policy (ORS 496.012).
7. A final Plan will strive for flexibility in managing wolf populations while providing needed protections for wolves.
8. A final Plan will seek relief for livestock producers from expected wolf depredation.
9. The Committee and the final Wolf Conservation and Management Plan will maintain its focus on wolves and will not address public land grazing or other public land management issues.
10. A final Plan will address impacts to prey populations, including deer and elk.

The first draft was released in October 2004 for public review, and the final Plan and associated administrative rules were adopted by the Commission on December 1, 2005 after an extensive public review process.

In 2010, the Plan was evaluated and updated. Most of the changes were related to the issue of wolf-livestock conflict. Input was received from numerous stakeholder groups, tribes, and partner agencies, and public input was taken throughout the review process. The 2010 Plan update was adopted in October 2010. See the 2010 Wolf Conservation and Management Plan, www.odfw.com/Wolves/management_plan.asp.

II. WOLF CONSERVATION AND MONITORING

On November 9, 2015, the Commission approved the delisting of wolves from the list of Oregon Endangered Species. The decision to delist is consistent with the Commission's long-term goal for listed species, which requires that sufficient actions be taken to ensure that future protections under the Oregon ESA will not be needed. As statewide conservation of wolves continues to be a Commission priority, this chapter focuses on methods and procedures for continued conservation and management of wolves in Oregon.

Continued conservation of the gray wolf will be achieved through the following objectives:

- Continue to promote a naturally reproducing wolf population in suitable habitat within Oregon, which is connected to a larger source population of wolves, allowing for continued expansion into other areas of the state.
- Maintain a conservation population objective for both East and West Wolf Management Zones (WMZs) of four breeding pairs of wolves present for three consecutive years. Maintain a management population objective for each zone of a minimum of seven breeding pairs of wolves present for three consecutive years.
- Maintain a management regime in the West WMZ that simulates Oregon ESA protections until the conservation population objective is met.
- Identify and monitor potential conservation threats to Oregon wolves and, if feasible, implement measures to reduce threats that can negatively affect Oregon's wolf population.
- Effectively and responsibly address conflict with competing human values while using management measures which are consistent with long-term wolf conservation in all phases of wolf management status under this Plan.
- Maintain accurate information on the population status and distribution of wolves in Oregon through a comprehensive monitoring program.
- Continue to coordinate with other agencies and organizations to achieve wolf conservation and management objectives.

A. Wolf Distribution

Objectives

- Continue to promote a naturally reproducing wolf population in suitable habitat within Oregon which is connected to a larger source population of wolves, allowing for expansion into other areas of the state.

Strategies

- Allow continued establishment of packs in Oregon through dispersal from adjacent states and within the state and not through reintroductions from outside the state.

- Maintain two wolf management zones in Oregon to provide flexibility in achieving wolf conservation and management goals for the state.
- Do not restrict wolf distribution by management zones, property ownership boundaries, or other administrative designations, unless adaptive processes deem them necessary.
- Employ management actions that support wolf packs occupying large, contiguous blocks of public land with minimal human activity and adequate prey base.
- Translocate wolves within the state only where needed to achieve conservation objectives in specific circumstances.
- Develop spatial population models to improve understanding of potential occurrence, habitat suitability, potential wolf range, and to assist with development of future population and distribution goals.

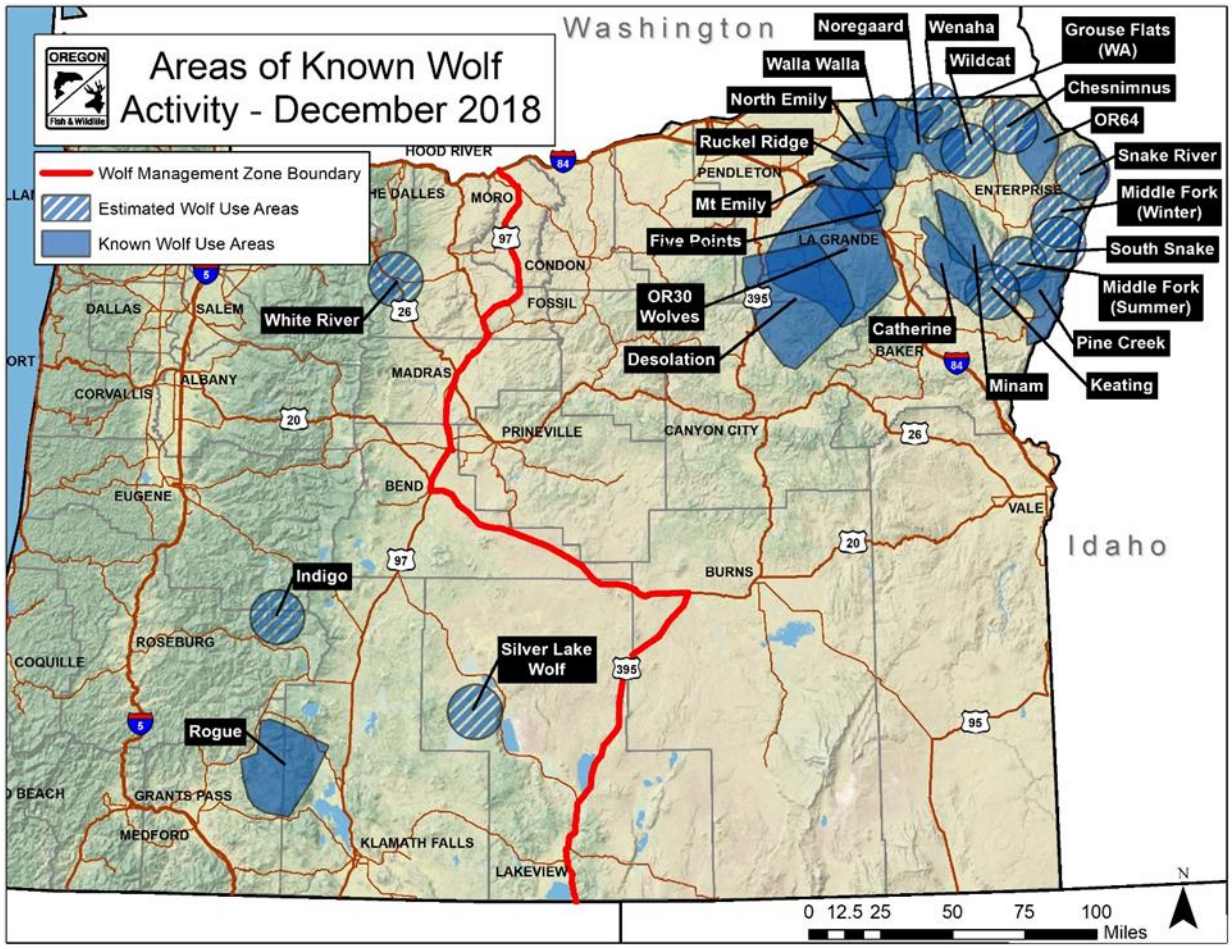

Figure 1. Distribution of known wolves in Oregon as of December 2018.

The habitat requirements of any wildlife species determine the species' potential or likely distribution on the landscape. Some species have very specific habitat requirements whereas others, like the gray wolf, are considered habitat generalists. Since establishment was documented in 2008, Oregon's wolves expanded rapidly and in 2018 resident wolves occur within approximately 18,903 km^2 of the state. Most wolves occur in northeastern Oregon, and four areas of known wolf activity now occur within the West WMZ (Figure 1). ODFW wolf collar data indicate that wolves in Oregon primarily

use forested habitat with seasonal shifts to more open habitats that reflect seasonal distributions of prey (e.g., lower elevation elk wintering areas). In addition, data from all documented resident wolf locations in Oregon through 2018 showed that 59% of all locations occur on public, 38% on private, and 3% on Tribal lands (ODFW, unpublished data). Denning occurs on both public and private land in Oregon and all known den sites occurred within forested habitat.

Dispersal and Connectivity

The ability for wolves to effectively disperse from their natal territory and establish new populations is key to the success of this Plan. Between 2011 and 2016, ODFW dispersal data of wolves from Oregon packs from Global Positioning System (GPS) or very high frequency (VHF) collars (n=21) or DNA analysis (n=12) showed that 23 dispersers (70%) remained in Oregon, and 10 wolves (30%) dispersed to other states (California, 2; Idaho, 5; Montana, 1; Washington, 2). Mean straight-line distance traveled was 189.3 km with a range of 22-580 km. Mean dispersal distance traveled for males was 209.6 km and for females was 153.8 km. Seven mortalities during dispersal were documented (Idaho, 4; Oregon, 1; Montana, 1; Washington, 1). Six of these were actively dispersing and one appeared resident in an area, but had not joined or formed a pack. All seven known dispersal mortalities were human-caused (shot).

These data support the natural dispersal method as effective to provide continued expansion and ongoing genetic connectivity between wolf populations in other states and within the state. Continued wolf movement into Oregon from Idaho is likely given the current population of wolves in the state of Idaho—an estimated 786 wolves in 108 packs at the end of 2015 (Idaho Wolf Monitoring Progress Report, 2015). Although this Plan does not specifically designate where wolves should occur in Oregon, it sets an expectation that the wolf population in the state will continue to distribute and expand into suitable range in both the east and west side of the state.

In a growing wolf population, expansion across landscapes is directly related to effective dispersal (i.e., the ability of wolves to disperse and successfully reproduce) and issues of genetic interchange as discussed above. At the time the Plan was first adopted in 2005, the ability of wolves to effectively disperse to areas of habitat outside of northeast Oregon was assumed but undocumented. However, habitat connectivity between the East and West WMZs has since been confirmed by observing the GPS locations of multiple radio-collared wolves as they traveled to southern Oregon Cascade Mountains, as well as dispersal of radio-collared wolves from northeastern Oregon to northern California (California Department of Fish and Wildlife News Release June 2016).

An examination of data from GPS-collared dispersers shows that dispersal in Oregon occurred largely through forested habitats. However, dispersers that travelled larger distances (e.g. more than 85 km) generally crossed a variety of land cover types and landscape features (i.e., open prairie or shrub habitats, roads, rivers, etc.). Data from multiple GPS-collared dispersers indicated attempted, but unsuccessful, crossings of Interstate 84 between La Grande and Pendleton. Multiple collared wolves have successfully crossed interstate highway I-84 in the same area; some crossed just once, others crossed many times. One collared wolf crossed I-5 twice in southern Oregon. Two wolves have been struck by vehicles in Oregon: May 2000 when a wolf dispersing from Idaho was struck by a vehicle on Interstate 84 south of Baker City and January 2019 when a collared wolf from a resident group was struck on Interstate 84 between Pendleton and La Grande. Combined, these data of dispersing wolves suggest interstate highways are at least partially permeable to dispersing wolves with some increased risk of mortality.

The ability of wolves to cross large rivers is also important for maintaining connectivity between Oregon wolves and the larger Northern Rocky Mountain (NRM) population, which includes Idaho. Though no wolf crossings of the Columbia River have been recorded, GPS-collared wolves (both dispersers and non-dispersing resident wolves) have successfully crossed the Snake River on multiple occasions (ODFW, unpublished data), indicating the river itself does not impede connectivity between subpopulations in Idaho and Oregon.

Wolf Management Zones

The Wolf Plan's two zones provide management flexibility in eastern Oregon and ensure continued protections for wolves in western Oregon until the conservation objective is reached. In 2018, wolves were in Phase III in the East WMZ and in Phase I in the West WMZ. Maintaining two management zones allows for different levels of active management (including lethal control in certain situations, see Chapters III, IV, V) of wolves depending on the circumstances and Phase of the zone. The zones provide emphasis to the importance of continued population connectivity with a larger population in eastern Oregon and Idaho. See Figure 2 for zone boundaries.

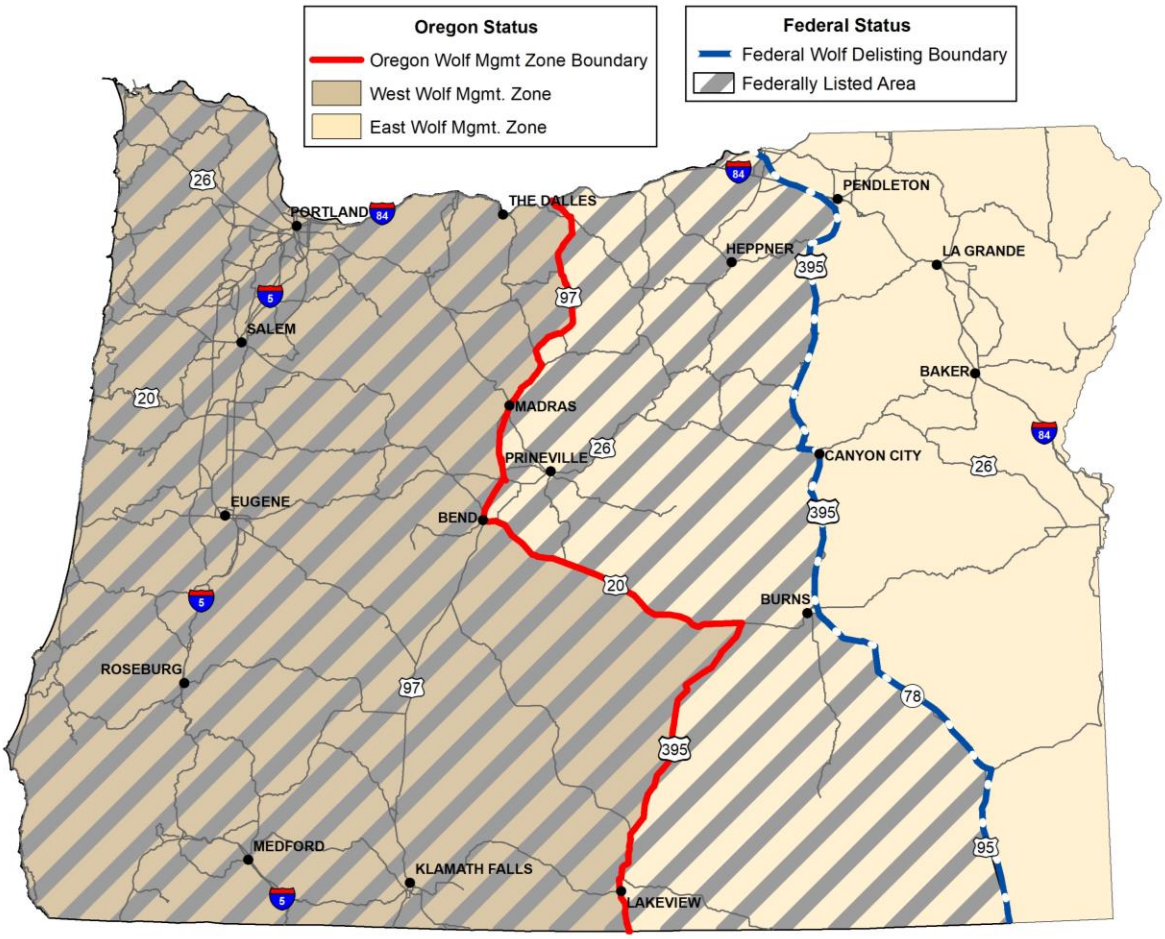

Figure 2. The boundary between East and West Wolf Management Zones (red line), and the current federal ESA status boundary in Oregon (blue line).

When this Plan was first adopted in 2005 there was little contemporary data or experience with wolves on the Oregon landscape, and an understanding of suitable habitat or how wolves would eventually distribute themselves was incomplete. Since that time, the establishment and expansion of wolves has provided managers with increasing information regarding habitat use, travel areas, and territory selection. A significant amount of potential wolf habitat in Oregon is occupied seasonally by livestock, and it is expected that depredation on livestock will continue to occur in places where wolves and livestock are closely associated. As such, management of depredating wolves will continue to be a recurring theme in managing the species. Variation in local conditions will likely cause some areas to be more prone to livestock depredations than others, and chronic conflict may preclude establishment of some wolf packs in certain circumstances. The Plan emphasizes use of non-lethal techniques to prevent livestock depredation, but allows implementation of lethal control to address chronic depredation (*see* Chapter IV). Thus, the overlap of wolves and livestock on the landscape will continue to influence both distribution and levels of wolf-human conflict.

Management decisions related to wolf distribution and population in the future will require a thorough evaluation of suitable habitat in Oregon. This will be achieved by specific habitat and population analyses conducted by ODFW (*see* Chapter IX) to determine habitat availability, capacity, probability of occurrence, and to assess impacts of various potential management actions. The analysis will use Oregon-derived empirical data and data from other pertinent areas (e.g., other NRM wolf research) and will assist with development of future management options including population and distribution objectives through additional zones and phases.

While wolves will likely not be distributed throughout all of their historic range in Oregon, wolf distribution will not be restricted by management actions to only the most remote habitats. Suitable habitat may well exist outside of these areas and provide opportunity for colonization. Continuing to promote wolf occupancy of available habitat throughout the state is intended to facilitate the long-term survival of wolves in the modern Oregon landscape.

Translocation and Relocation

Natural dispersal is the intended means for wolf dispersal across the state. In some situations, however, translocation may be considered to help meet conservation objectives in both zones of the state. Translocation to facilitate wolf movement and establishment may be used only in areas where dispersing wolves are determined to be essential to achieve conservation objectives. Translocation may be used only after a public process, involving public meetings, public testimony, and approval by the Commission. Wolves known or suspected of having depredated livestock will not be translocated. State wildlife biologists will coordinate and implement any translocation action.

Relocation differs from translocation (in this Plan) in that relocation does not require a public process and is not used to facilitate dispersal. Movement or transport of wolves within their pack area (e.g., during capture operations) is not considered relocation under this section. Though relocation is available to wolf managers on a day-to-day basis to immediately solve a localized situation or problem, it is not expected to be used on a regular basis. In the NRM area, relocated wolves showed lower survival, lower pack establishment, and a strong homing tendency (Bradley et al. 2005) —all important considerations when planning any type of relocation. In addition, depredation of livestock is not always solved by relocation of wolves alone. In the NRM area, more than a quarter of wolves relocated in response to depredation continued to prey on livestock (Bradley et al. 2005). For this reason, relocation will not be considered in Oregon for wolves known

or suspected of having depredated livestock or pets. For purposes of relocation only, wolves would be transported and released into suitable habitat. ODFW is authorized to capture and hold wolves in Oregon for the purpose of relocation, translocation, or to aid in recovery of an injured wolf.

Prior to conducting any active relocation of wolves within the state by ODFW, the governing body of each county may choose to hold a public hearing regarding such action. The existence of such a hearing shall not be a precondition to ODFW acting to relocate wolves as needed, nor does it in any way limit ODFW's legal authority over wildlife management. The purpose of the hearing is to assist in identification of suitable habitat located within a county for purposes of wolf relocation. If the governing body holds such hearings, ODFW shall assist in preparation of the record of the hearing by giving and receiving information relating to identifying suitable habitat located within the county for the purpose of wolf relocation. The record of the hearing shall itself be a part of the criteria for identifying suitable habitat in that county for the purpose of wolf relocation.

B. Population Objectives and Management Phases

Objectives

- Maintain a conservation population objective for both East and West Wolf Management Zones (WMZs) of four breeding pairs of wolves present for three consecutive years. Maintain a management population objective for each zone of a minimum of seven breeding pairs of wolves present for three consecutive years.
- Maintain a management regime in the West WMZ that simulates Oregon ESA protections until the conservation population objective is met.

Strategies

- Maintain three wolf management phases to facilitate both conservation and management needs as the population grows.
- Express the wolf population status in either region as the number of breeding pairs (Phase I and II) until the management population objective is achieved.
- Transition wolf population monitoring to the number of wolf packs present in a region when the management population objective is achieved in that region (Phase III). (A pack is defined as four or more wolves traveling together in winter.)

Annual winter counts of wolves were initiated by ODFW in 2009, and from 2009 through 2018 Oregon's wolf count increased in all years with a mean increase of 1.30 (± 0.21 SD)(ODFW, unpublished data; Figure 3). ODFW does not routinely conduct den or rendezvous surveys and relies on winter pup recruitment data to assess reproductive success. The minimum number of breeding pairs in Oregon since 2009 has varied annually but an increasing trend has been observed. The number of wolves associated with a breeding pair can vary from 4-15 wolves (ODFW, unpublished data). In Oregon, the number of wolf packs represented by a breeding pair is 1.2 packs per breeding pair for the period 2009 through 2018. The average pack size by year was 5.8 to 10.5 (average 7.6).

Management Phases

Management phases are applied to each zone independently and are only based on the population levels in each zone. Also, management activities associated with each phase may still be subject to federal ESA law, depending on the federal listing status of wolves (Figure 2).

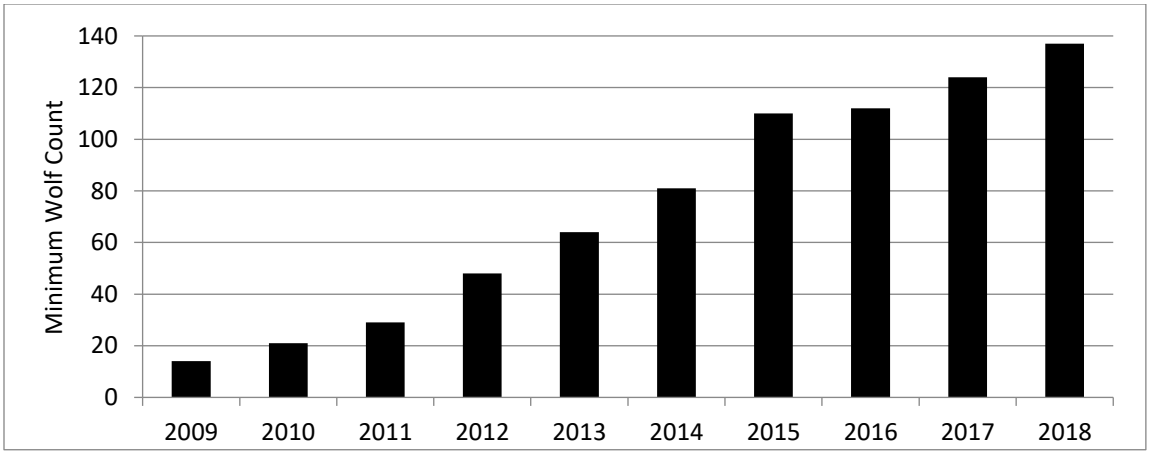

Figure 3. Oregon minimum year end wolf count from 2009 through 2018.

Phase I: **Conservation Phase**. Phase I occurs anytime a zone's minimum conservation population objective of four breeding pairs of wolves for three consecutive years is not met. Based on Oregon data, these wolf population objectives suggest the following: four breeding pairs equates to 4.8 packs. This number of packs would be equivalent to 28-51 wolves in packs. These data do not include other (non-breeding) pairs and individual wolves which may add an additional 10-15% to population estimates (Fuller et al. 2003b).

Though wolves were delisted from the Oregon ESA in 2015, the Phase I provisions for the West WMZ will remain in effect until the conservation population objective is reached for that zone or until this Plan is amended through a public rulemaking process. This will ensure a management regime that replicates Oregon ESA protections for individual wolves within the zone. The management regime for western Oregon is based upon the Commission's statutory authority to regulate the take of wildlife. Although wolves were reclassified as a special status game mammal in 2009 (*see* Chapter III), the Commission retains the authority to regulate take of wolves as necessary to ensure a healthy population.

Phase II: Transition Phase. Phase II occurs when the wolf population has achieved the conservation objective for a zone but is not in Phase III. Management activities will be directed toward achieving the Phase III management population objective of a minimum of seven breeding pairs of wolves present in a zone for three consecutive years. Seven breeding pairs equates to 8.4 packs. This number of packs would be equivalent to 49-89 wolves in packs. These data do not include other (non-breeding) pairs and individual wolves which may add an additional 10-15% to population estimates (Fuller et al. 2003b).

This phase entails continued intensive monitoring and tracking of population health factors (similar to Phase I), with an emphasis on detecting population declines and conservation threats, while continuing to address damage and safety situations. Though the intent of this phase is to prevent

population declines and the potential for relisting, the phase is not in itself a "buffer" against relisting. This is because, in certain situations, wolves could be relisted under state ESA based on several population health factors (see strategies for addressing population decline below), which could potentially be met before the population declines to Phase I levels.

Phase III: **Management Phase**. Phase III occurs when a zone wolf population has at least seven breeding pairs for three consecutive years. Management activities will be directed toward ensuring the wolf population in each zone does not decline to Phase II levels and to address unmanageable levels of conflict.

Conservation Population Objective

When this Plan was first adopted in 2005, the conservation population objective of at least four breeding pairs for three consecutive years *in eastern Oregon* was based on the prediction that, a naturally self-sustaining population of wolves would continue to exist in Oregon if delisted from the Oregon list of Endangered Species. It recognized the importance of genetic connection between Oregon's new population and the much larger population in Idaho, and the need for a sufficient number of wolves to ensure the natural reproductive potential of the wolf population would not be in danger of failure. ODFW used the federal definition of a wolf breeding pair because it provided a higher level of certainty in assessing the population status and documenting successful reproduction. The original conservation population objective was achieved in 2015, and wolves statewide were subsequently delisted by the Commission. The population analysis at the time of delisting indicated a very low probability of conservation failure under the circumstances at that time (ODFW 2015), supporting that the conservation objective was sufficient for its intended purpose.

The achievement of the conservation population objective in the East WMZ in 2015, and the continued growth of the wolf population in that zone, did not reduce the need for continued conservation in the West WMZ where the population has not yet reached this level. Because of the need for continued protection in this zone, wolves there will remain in Phase I until a population of four breeding pairs for three consecutive years is reached.

Management Population Objective

The management population objective for both the East and West WMZs is at least seven breeding pairs for three consecutive years. This population level provides for maintenance of wolf numbers and is not intended as a population cap. Achieving this objective provides a high level of assurance that the wolf population will not decline below conservation population objectives. Once the management population objective has been achieved, any further population goals (higher or lower) would be considered and defined through ODFW's normal rulemaking or planning process based on available data and public input. To facilitate future population planning, wolf managers will use data (including Oregon-specific data) on wolf movements, pack home ranges, and other population parameters to develop a population model or models. Models assist Oregon wolf managers in better understanding effective management zones, viability thresholds, population objectives, and the effects of different management options (including population caps) on the future wolf population. Depending on circumstances at the time, a new or amended planning effort based on Oregon-specific wolf data could be undertaken.

The status of wolves in Oregon will be expressed as the number of breeding pairs until the management population objective is met. After the management population objective is met, monitoring methods will transition to enumerating wolf packs rather than breeding pairs to reduce monitoring costs.

General Discussion of Wolf Population Objectives

When the 2005 Plan was developed, one of the main challenges for wolf planners was estimating the number and distribution of wolves sufficient to achieve conservation of wolves in Oregon and satisfy state delisting criteria, while protecting the social and economic interests of all Oregonians. Initial concerns ranged from setting population goals too high (thereby fostering unrealistic expectations), social and biological conflict, and uncertainty regarding the capacity of Oregon to support wolves. Drafters of the 2005 Plan relied on information from other state plans and the scientific literature to develop wolf population objectives.

Today, the Oregon landscape is different. Wolves are increasing in both distribution and abundance, and have established in both East and West WMZs. As originally predicted, most wolves occur in eastern Oregon with much of northeastern Oregon having contiguous wolf territories. The decision to divide the state into two zones with separate but equal population objectives continues to provide the flexibility needed to manage increasing wolf numbers in eastern Oregon while encouraging conservation in western Oregon. This approach also ensures connectivity to other populations of wolves in Idaho and Washington, an important factor in achieving conservation of wolves in all of Oregon.

The conservation population objective does not represent a desired population level nor is it necessarily a minimum viable population in itself. For this reason, few management changes will occur when the West WMZ achieves the objective and moves to Phase II. Conservation will remain the focus, with a goal of achieving the management objective level and Phase III.

Ultimately, the adequacy of the current conservation population objective (four breeding pairs for three consecutive years for each zone) is best determined by its ability to meet the intended purpose — to ensure conservation of the species via a naturally self-sustaining population. The objective was initially developed before wolves were established in the state, and this necessarily meant that a population that achieved the conservation objective would likely have healthy population factors (related to increasing population growth). When the objective was achieved in eastern Oregon in 2015, analysis showed the Oregon population was at very low risk of conservation failure (ODFW 2015). In that situation, the population was increasing at a mean annual rate of 43% and there were nine breeding pairs in the final year of Phase I. Clearly, the chosen conservation population objective was adequate to meet its intended purpose in eastern Oregon.

However, a zone may have population health factors, or a population that is stable or declining and around the four breeding pair level, that upon similar analysis may be at a higher risk of conservation failure. In this situation, ODFW may conduct a zone-specific population analysis, with conservation threats in this chapter in mind, when moving from Phase I to Phase II in the western zone to determine if additional conservation measures are necessary to improve population performance and move toward the management objective. Such an analysis could result in Commission action to adopt additional measures to conserve wolves if necessary.

The intent of the management population objective of seven breeding pairs in each zone is to maintain wolf numbers and direct Phase III management activities to prevent the population from longterm declines while allowing flexibilities in management options when addressing wolf-human conflicts. To assess the effect of population size on the risk of the population declining to Phase II levels, ODFW used a population model developed in 2015 (ODFW 2015). Simulations showed the probability of having fewer than seven breeding pairs within the next 20 years drops below 5% when the starting population is at least 300 wolves—a population level that could be achieved in the East WMZ in coming years. However, under this Plan, seven breeding pairs is not a sufficient population "cap" or threshold.

Once the management population objective is achieved in a WMZ, activities still continue to focus on conservation and reducing population declines. The question of how many wolves Oregon should ultimately manage for is not answered by science alone (Bruskotter 2013), and was not considered in the first 2005 Plan. Oregon's wolf population is still expanding, and there are many portions of Oregon where wolves are not yet established. While additional population planning may be premature at this time, it is expected that the Commission will be tasked with addressing the question of how many wolves to manage for in the future, based largely on available data and public input. Development of spatial population models using Oregon data will aide this process by providing a scientific basis for addressing the question of population objectives and management options into the future. ODFW has begun examining potential population models, including those used in other western states.

Strategies for Addressing Wolf Population Decline/Potential for Future State Relisting

Oregon's wolf population will be monitored throughout the three-phase adaptive management strategy. At the time of writing, wolves in the East WMZ are managed according to Phase III management strategies and continued conservation efforts allow for continued wolf population growth while addressing wolf-human conflict. The West WMZ is in Phase I and conservation strategies will continue to be prioritized until Phase II and III objectives have been met.

When the conservation population objective of four breeding pairs for three consecutive years in each zone was first adopted in 2005, Oregon had no known resident wolves. Inherently, developers of the 2005 Plan expected: 1) a population that went from none to the four breeding pair mark would have healthy population attributes causing the increase, and 2) a likelihood (with an increasing population) that more than four breeding pairs would be present in eastern Oregon at the end of the third consecutive year. Both of these expectations were realized and played an important role in the 2015 decision to delist wolves from the state list of endangered species. However, a species' status under Oregon ESA is determined by five criteria as defined in Chapter I, and if wolf population attributes deteriorate, causing a population decline or fewer packs in Oregon, this may warrant consideration for relisting at a population well above the conservation population objective. In the event of a rapid population decline, the Commission may relist the species under ESA using an emergency listing process per ORS 496.176(7).

Wolves in Oregon will continue to be affected by natural and human-caused factors; the population may continue to increase, stabilize, or decline. Though short-term downward fluctuations are rarely indicators of a serious population problem, it is possible that breeding pair success, and the wolf population, could decline on a long-term basis. While in Phase I or II, in the event of an observed

population decline, or an observed decline of other factors related to population fitness or reproductive potential, ODFW will initiate an assessment which will include causal factors, (i.e. determination of short or long-term nature of the decline) and recommendations of methods to improve the situation. The assessment will consider natural fluctuations in wolf populations and may include a one-year increased monitoring effort. Depending on the severity of the situation, an additional year of intensive monitoring may be needed and will be determined based on the assessment. Furthermore, the assessment will guide ODFW's decision to conduct a biological status review per ORS 496.176(3) to consider if relisting is needed.

In Phase III, a population decline in either zone may warrant additional monitoring measures similar to Phase I and II declines, and the level of investigation will vary depending on the circumstances of the decline. Results of any additional monitoring would be included in the normal reporting (e.g., annual report) to the Commission. Though relisting is not likely to be immediately considered, ODFW will use information gained in the assessment to employ methods to reverse the decline. If, however, the population drops to Phase II or lower levels, ODFW will immediately conduct an assessment as outlined for Phase I/II above. ODFW will reinstitute the monitoring of breeding pair status (see the Monitoring Wolf Population section in this chapter) in situations where the Phase III population declines to Phase II levels.

The Commission's authority to relist a species derives from its authority to initially list any species. This authority lies in the listing/delisting provisions of ORS 496.172 and ORS 496.176. Pertinent sections are as follows:

a. ORS 496.172(1) requires the Commission to conduct investigations of wildlife species native to this state and to determine whether any such species is a threatened or endangered species.
b. ORS 496.176(2) gives the Commission authority to, by rule, add or remove any wildlife species from either list or change the status of any species on the lists.
c. ORS 496.176(3) provides the criteria the Commission must use in making its decision.
d. ORS 496.176(5) allows for any person to petition the Commission to add, remove, or change a species' status.
e. ORS 496.176(7) provides for emergency listing by the Commission when there is a significant threat to the continued existence of the species within the state.

The decision to relist the wolf will be based upon scientific assessments of biological data. However, decisions to list or delist any species are often contentious, and some researchers have demonstrated that swings in the listing status of wolves can lead to inconsistent management authority and declining public support for wolves (Olson et al. 2014). It is in the best interest of this species and the citizens of Oregon that the state takes whatever management steps necessary to safeguard wolves from a population decline or other factors that would necessitate a relisting decision.

C. Potential Conservation Threats

Objective

- Identify and monitor potential conservation threats to Oregon wolves and, if feasible, implement measures to reduce threats that can negatively affect Oregon's wolf population.
- Effectively and responsibly address conflict with competing human values while using management measures which are consistent with long-term wolf conservation in all phases of wolf management status under this Plan.

Strategies

- Track human-caused mortality rates to the extent feasible and assess the effects of human-caused mortality on overall population performance.
- Initiate additional education and training to improve public identification of both wolves and coyotes to lessen the chance of misidentification and accidental hunter take.
- Collect and analyze genetic samples from Oregon wolves to determine ancestry, wolf-dog hybridization, and genetic connectivity.
- Monitor habitat use by wolves and connectivity of habitats using collared wolf location information.
- Determine the health status of Oregon wolves through continued monitoring and use an adaptive/responsive approach to identify emerging or endemic diseases, which may depress wolf populations or affect humans, wildlife, or domestic animals.
- Continue to assess human attitudes toward wolves in Oregon and any effects they may have on wolf conservation and management efforts.

Continued successful conservation of wolves is highly dependent on the identification of potential threats that may affect Oregon's growing wolf population. Conservation threats are factors which may continually depress or eliminate a wolf population (Boitani 2003). These factors are different from actions that may cause short-term population fluctuations and are discussed in other sections of this Plan.

Human-caused Mortality

Human-caused mortality occurs in all areas where wolves occur with people (Fritts et al. 2003), and it remains a primary influence on the dynamics of most wolf populations (Creel and Rotella 2010). In a landscape-scale project to develop an ecosystem-based strategy for the management of eastside forests in the Pacific Northwest, it was predicted that wolf mortality related to humans would be one of the primary challenges to wolf conservation within the Interior Columbia Basin (Wisdom et al. 2000). Consequently, effectively accounting for human-caused mortality will be important for conservation and management of wolves in Oregon (*see* Chapter VI: Wolf-Human Interactions).

In 2015, ODFW evaluated the effects of increased human-caused mortality on the state's wolf population at that time using an individual-based population model (ODFW 2015). Results indicated that a total human-caused mortality rate (including authorized and unauthorized take) of 15% would still result in an increasing population on average, but a total human-caused mortality rate of 20%

would cause the wolf population to decline on average. These rates were in addition to natural mortality rates (12% for adults), which would translate to a 27 to 32% total mortality rate, for a slightly increasing and slightly declining population, respectively. These findings were compatible with other studies which demonstrated wolf populations were sustainable with total mortality rates up to 25-30% (Adams et al. 2008, Creel and Rotella 2010, Sparkman et al. 2011). From 2009-2018, known human-caused mortality rates (authorized and unauthorized) did not exceed 10% annually of minimum counts in Oregon, suggesting the wolf population should continue to increase so long as total human-caused mortality continues to stay below 15% and natural mortliaty rates remain the same. Continued monitoring of human-caused mortality and refinements to population modeling efforts to account for this mortality and other mortality sources will be important for wolf conservation in the future.

At the pack level, responses to wolf mortality varies and is often related to the breeding status of the wolves that die—losses of one or both breeders can have a disproportionately negative impact on pack persistence and structure (Brainerd et al. 2008). In a study that included data from the NRM wolf population, the loss of one breeder resulted in pack dissolution in approximately 26% of the cases, and the loss of both breeders increased the rate of pack dissolution to 85%. Most breeding wolves in the study that died were human-caused mortalities and the authors recommended that lethal control in recolonizing populations should be limited to solitary individuals or territorial pairs where possible (Brainerd et al. 2008). In another study (Borg et al. 2015), pack persistence following the loss of one or both breeders was also affected by pack size (larger packs persisted at a higher rate) and seasonality of breeder loss. In this case, summer loss of breeders may have less of a negative impact because females are not pregnant and pups are older. Human-caused mortality in reproductive packs will have a lesser effect when pups are greater than six months old and when packs contain more than six members (including three or more adults) (Brainerd et al. 2008). Given these conclusions, it is important to consider the composition of packs when assessing potential effects on wolf populations.

In Oregon, human-caused mortality includes both authorized and unauthorized take (Table 1). Authorized take includes lethal removals permitted by statute or administrative rule and have included take to address livestock conflict (e.g. administrative removals, landowner permits, wolves caught in the act) or human safety. Unauthorized take consists of accidental (e.g. vehicle collisons, guard dogs) and illegal (e.g., poaching) take. Authorized take of wolves is the mortality parameter over which ODFW has the most control. Other sections of this Plan (and associated rules) outline when human-caused mortality may be authorized. When wolf numbers are low, sustained high levels of human-caused mortality under variable environmental conditions increases the risk of population failure. Larger populations are able to sustain higher levels of human-caused mortality without threatening overall conservation of populations (ODFW 2015). Given the relatively small population size of Oregon's wolves, ODFW will closely regulate authorized take. Consequently, this Plan does not establish hunting seasons, or take quotas for wolves. The use of those management tools in the future would require larger wolf populations to reduce any risk of conservation failure and would require Commission approval through a separate public rulemaking process (Chapter III). Further, administrative removals are allowed in specific circumstances under this Plan, and these are precisely tracked and regulated. If monitoring indicates declines in survival, reproduction, population growth rates, or population size that may influence wolf population viability, ODFW has the authority to reduce or eliminate most authorized take to ensure the long-term conservation of wolves in Oregon.

Table 1. Documented wolf mortalities in Oregon from 2000-2018 (years without documented mortalities are not included). Major mortality categories include human-caused, natural, and unknown. Human-caused consist of authorized lethal removal (e.g. mortalities associated with livestock depredation and human safety) and unauthorized lethal removal (e.g. accidental and unlawful mortalities). Pending mortalities are those where the investigation of unauthorized take has not been completed. Examples of natural mortalities include death due to disease or injury. Unknown mortalities are those without sufficient evidence to determine cause of death.

	Human-Caused					Natural	Unknown	
	Authorized		Unauthorized					
Year	Depredation Related	Human Safety	Accidental	Unlawful	Pending			Annual Total
2000			1	1				2
2007				1				1
2009	2							2
2010				1				1
2011	2		1					3
2012				1				1
2013				1		2		3
2014								0
2015			1	2	1		3	7
2016	5			1	1			7
2017	5	1	2	3	1	1		13
2018	3		1	2		1		7
Total	17	1	6	13	3	4	3	47

Of perhaps greater concern for long-term conservation, is the potential effects of unauthorized take on wolf populations, as ODFW has less control over unauthorized take. Further complicating the issue is that unauthorized take, specifically unlawful take, is often difficult to measure and document. Recently, it has been suggested that unauthorized take may be underestimated in some wolf populations, contributing to reduced population growth rates (Sweden: Liberg et al. 2011, Wisconsin: Treves et al. 2017). While the potential for increased and undocumented unauthorized take may have occurred and reduced population growth rates in those study areas, both wolf populations increased during the period of analysis. It has also been suggested that changes in policy for wolf management (i.e., allowing of authorized take) may cause an increase of unauthorized take of wolves and reduce population growth rates (Chapron and Treves 2016). This suggestion has been repeatedly challenged (see Olson et al. 2017, Pepin et al. 2017, Stien et al. 2017) and it is unclear if the potential increase had a measurable effect on the size of the wolf population (Olson et al. 2017). Due to the potential that some instances of unauthorized take (i.e., poaching) may be concealed (referred to as 'cryptic poaching'), estimates of unauthorized take and associated mortality risk may be underestimated (Treves et al. 2017). However, the degree to which this may occur in Oregon is unknown. Regardless, the potential effects of unauthorized take should be considered an important factor influencing wolf conservation, especially in cases of small population sizes. Given the potential for higher levels of unauthorized take than anticipated and that this may reduce potential population growth rates of wolves (Liberg et al. 2011, Treves et al. 2017), assessing levels of unauthorized take will be important when evaluating the impacts of human-caused mortality to wolf conservation and management in Oregon.

In most cases, unauthorized killing of Oregon wolves has been a result of illegal shooting, and one case reported as mistaken identity resulted in the killing of a radio-collared wolf in Grant County in 2015. Wolves can be difficult to distinguish from coyotes, and the coloration of individual wolves likely contributes to misidentification. Smaller red wolves and Mexican wolves are further at risk because they are smaller and more similar in size to coyotes. It has been proposed that unauthorized losses of wolves as a result of mistaken identity (e.g., confusing wolves with coyotes while hunting) may negatively affect the overall conservation of red wolves and Mexican wolves (Newsome et al. 2015). Although NRM gray wolves are much larger than red and Mexican wolves, evaluating misidentification as a potential threat for gray wolves should be considered. Coyotes are classified as predatory animals in Oregon (ORS 610.002) and per ORS 496.162 this Plan does not prescribe limitations on the taking of coyotes. However, to lessen the chance of misidentification and accidental hunter take, ODFW will implement additional education and training through existing program avenues – hunter education, website information, and media contacts. For example, variations of Figure 4 (below) occur in the Big Game Hunting Regulations and Furbearer Hunting and Trapping Regulations and a coyote and wolf identification quiz was created and posted to the ODFW wolf website.

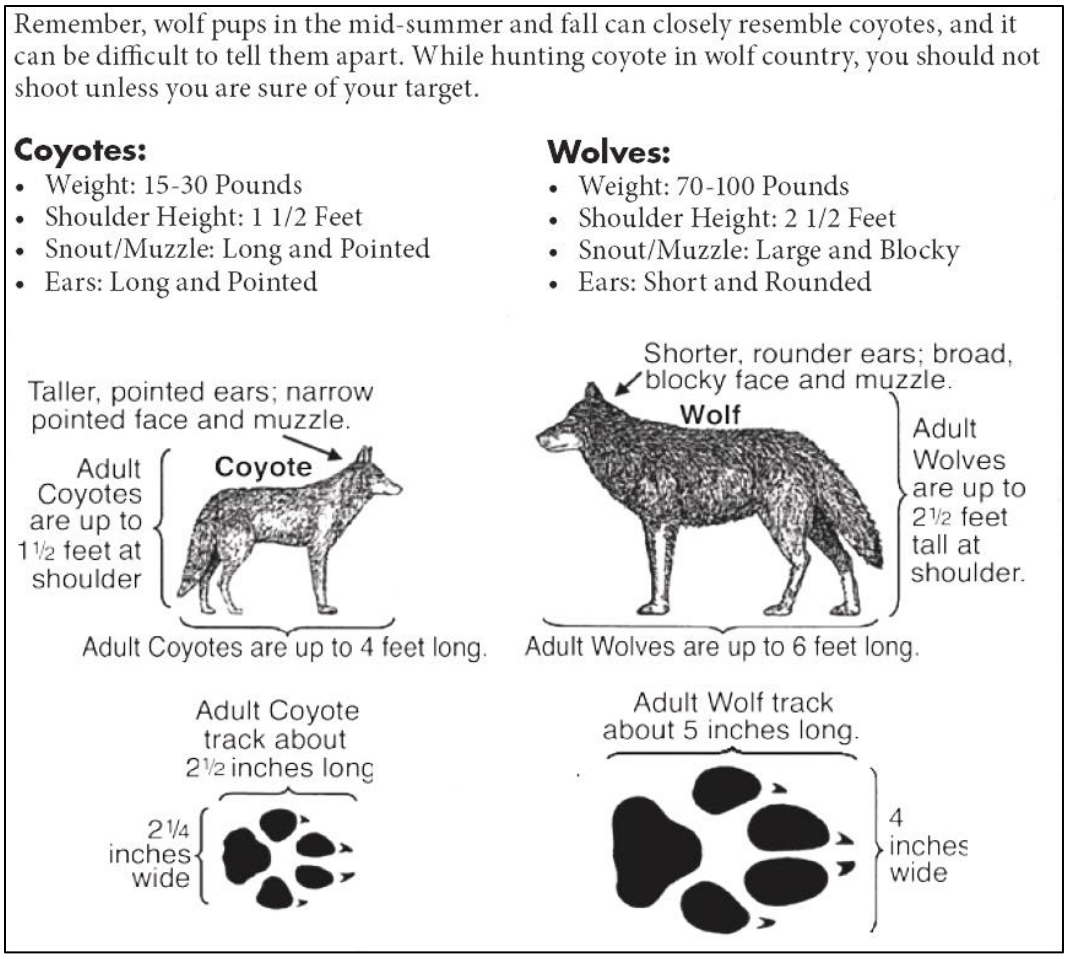

Figure 4. Identification guide for wolves and coyotes from the Oregon Big Game Hunting Regulations. A similar guide is found in the Furbearer Hunting and Trapping Regulations.

Genetic Diversity and Connectivity

Genetic diversity of Oregon's wolves is important and the loss of genetic variability among wolves within the population over time can negatively affect a number of population performance parameters (e.g., reproductive rates, survival, and resistance to disease). While there are examples of small and isolated wolf populations that have persisted for decades (Fritts and Carbyn 1995, Boitani 2003, Liberg 2005), inbreeding is a threat to the long-term viability of small, isolated populations (Liberg 2005, Fredrickson et al. 2007), and this may be exacerbated by wolves' smaller effective population sizes as few adults breed relative to the overall population. Although no data suggests Oregon wolf populations are small and isolated, maintaining adequate numbers of breeding adults over time is important to maintaining genetic variability.

To understand this subject, it is important to understand the origin of Oregon's wolves, which came from dispersers from the growing NRM population in Idaho, Montana and Wyoming (Figure 5). Wolves from southern Canada had naturally recolonized and were successfully reproducing in northwestern Montana in the late 1980's. Wolves reintroduced into central Idaho in 1995 and 1996 originated from two distinct wolf populations in Canada: 15 wolves from 7 packs came from Hinton, Alberta in 1995, and 20 wolves from 9 packs came from Fort St. John, British Columbia in 1996 (M. Jimenez, USFWS, personal communication). At the same time 31 wolves were reintroduced into Yellowstone National Park in Wyoming. Additionally 10 wolves were relocated from the recolonizing northwestern Montana subpopulation to Yellowstone National Park in 1997 (Vonholdt et al. 2008). Genetic analysis concluded that the reintroduced wolves were as diverse as their general source population (Forbes and Boyd 1996;1997) and that genetic variation within the NRM population is high (Forbes and Boyd 1996;1997, Vonholdt et al. 2008).

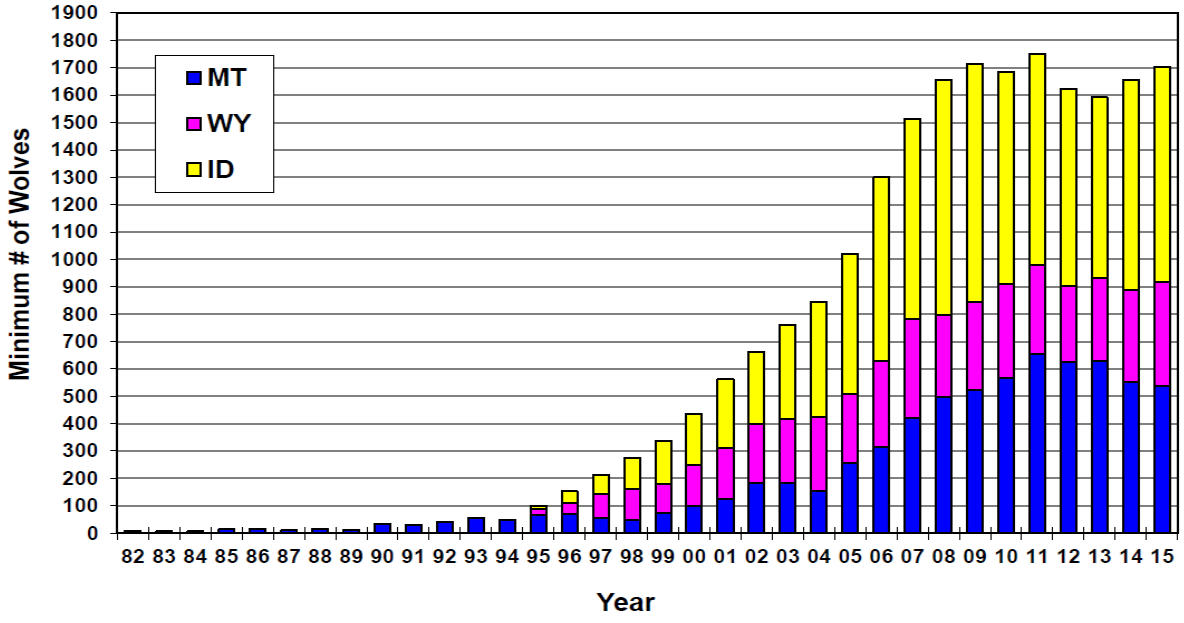

Figure 5. Estimated number of wolves in documented packs, other documented groups, and lone wolves in Montana, Wyoming, and Idaho 1982-2015. Note that various regulations and management actions occurred across states and years so some trends were influenced by policy changes. Figure from www.fws.gov/mountain-prairie/es/wolf-2016.php.

Genetic diversity is typically maintained via genetic interchange between subpopulations—as few as one to two immigrants per generation (approximately five years for wolves) can minimize the effects of inbreeding (Vila et al. 2003, Liberg 2005). This can be achieved by the demonstrated ability of wolves to rapidly disperse long distances and avoid inbreeding by selecting unrelated mates (Vonholdt et al. 2008). Idaho, Montana, Washington, and Wyoming wolf populations are genetically connected to each other and to Canada through natural dispersal (U. S. Department of the Interior 2009). It follows that natural dispersal should allow a sufficient number of immigrants to arrive in Oregon as long as sufficient connectivity is maintained between populations in adjacent states (Hebblewhite et al. 2010).

In Oregon, effective genetic interchange with a larger Idaho subpopulation has been demonstrated by Oregon's westernmost wolf pack (Rogue) in the southern Oregon Cascade Mountains which is one generation removed from the central Idaho population—the breeding male of the Rogue pack (wolf OR7) is an offspring of an Idaho-born female (wolf B300). Radio-collar data shows that dispersing wolves immigrate to and emigrate from Oregon, indicating that Oregon is part of a metapopulation with Idaho and Washington. Genetic sampling of captured Oregon wolves (ODFW, unpublished data) confirms genetic relatedness to the Idaho subpopulation of wolves, further indicating a biological connection between the two subpopulations.

While genetic diversity is currently considered high, monitoring will continue to assess levels of genetic interchange and population structure of Oregon wolves. Concerns of reduced genetic variability or isolation among Oregon wolves may be mitigated by management actions such as increased protection (especially individual breeder wolves) or translocation to augment depressed subpopulations. However, this is likely unnecessary based on data presented in this section.

Habitat

Wolves are highly adaptive and are habitat generalists that can thrive in a variety of habitat types and structures. Further, adequate prey is considered of paramount importance and thought to regulate wolf populations in many areas. Even with these relatively simple requirements, wolf establishment and persistence may be limited or affected by a number of habitat-related variables. A review of predictors of important wolf habitat from previous research includes: 1) forested areas (Mladenoff et al. 1995, Larsen and Ripple 2004, Oakleaf et al. 2006a, Benson et al. 2015); 2) public ownership of land (Mladenoff et al. 1995, Carroll 2003, Larsen and Ripple 2004); 3) prey availability (Mech and Boitani 2003, Peterson and Ciucci 2003, Larsen and Ripple 2004, Oakleaf et al. 2006a); 4) low human presence (Belongie 2008); and 5) low road density(Mech et al. 1988, Kohn et al. 2001, Carroll 2003, Larsen and Ripple 2006, Belongie 2008, Zimmermann et al. 2014, Benson et al. 2015).

While Oregon's wolf population has expanded geographically since its establishment in 2008, breeding wolves are still absent from much of Oregon. In an attempt to identify potential habitat and range of wolves in the state, based on the above predictors (excepting private land), ODFW developed a coarse map in 2015 using spatial data related to land cover type, elk ranges, human population density, road density, and cultivated or other land types altered by humans. The results of this project are contained in Appendix D. The resulting map of potential wolf range corresponded well with known wolf distribution in Oregon, and suggests that habitat availability is not currently limiting the continued expansion of wolves in Oregon.

The map, however, also illustrates that not all of Oregon's historical wolf habitat is currently available to wolves because of high human densities, extensive road systems, and cultivated habitats. Current areas of unsuitable habitat and range include the Willamette Valley, Columbia Basin, and highly developed portions of central, southern, and eastern Oregon. Some portions of Oregon's Coast Range may also be unsuitable for wolf establishment and persistence, though this is untested as wolves are not known to occur in that portion of the state at this time. Oregon's human population is estimated at 4.1 million people and has increased 7% since 2010. It is projected to reach 4.8 million people by 2030 (2017 World Population Review). The extent to which this will impact available wolf habitat is unknown, though most of the projected population growth will occur in the already developed Willamette Valley and Portland metropolitan area.

Human Attitudes Toward Wolves

As shown previously, the initial extirpation of wolves from the state and other areas was a direct result of negative human attitudes that resulted in high levels of persecution of wolves. Human attitudes toward wolves are important to the overall conservation of wolves because they can affect behavior and actions toward wolves (Browne-Nuñez et al. 2012, Treves et al. 2013). They can also influence management and policy decisions that influence population sustainability. Intolerance of wolves caused by negative human attitudes or perceptions may dispose people to illegal behavior (Treves et al. 2013). Therefore, the well-established relationship between human-caused mortality and conservation of wolves warrants that ODFW consider public attitudes toward wolves when developing management policies.

A worldwide review of public attitudes towards wolves from 1972-2000 showed a general public support for wolves and wolf restoration efforts (Williams et al. 2002). However, the research suggested that people with the most positive attitudes about wolves have been those with the least experience with them. People who live in areas with wolves have more negative attitudes toward wolves than the general public, and negative attitudes are further amplified by wolf predation of livestock (Ericsson and Heberlein 2003). Residents within Wisconsin's wolf range showed an overall decline in tolerance of wolves between 2001 and 2009 (Treves et al. 2013). This time period was associated with changes in policies towards wolves that allowed increased authorized take and during which the wolf population and the number of depredations more than doubled. In Utah, an area without wolves, researchers showed no significant changes in attitudes toward wolves during a similar (1994-2003) timeframe (Bruskotter et al. 2007).

Some research has suggested that negative attitudes which result in illegal killing of wolves may be moderated with the use of effective and responsible management programs (Olson et al. 2014). Because public acceptance of some management actions (e.g., population management, lethal removal of depredating wolves) is often tied to overall attitudes toward wolves (Musiani and Paquet 2004), it will be important for managers in Oregon to monitor changes in human attitudes toward wolves and management actions of wolves. This could be accomplished through Oregon-specific monitoring of attitudes and perceptions of Oregon's diverse public through universities or other scientific research organizations.

Hybridization

Wolves are capable of hybridizing with other canid species and documented hybridization has occurred with coyotes, domestic dogs, and feral dogs. While some researchers believe that

hybridization may cause the loss of pure gene pools (Hess et al. 2013), others suggest that hybridization may not be an important conservation concern in some populations of wolves (Vila and Wayne 1999). In some instances, the hybridization may be limited to a single event or result in the evolution of a group of wolves suggested to be a distinct species (Wilson et al. 2000). Generally, behavioral and physiological differences between wolves and wolf hybrids, coyotes, and dogs keep the populations distinct (Vila and Wayne 1999).

Because wolf hybrids can be difficult to distinguish from wild wolves, negative encounters between humans and domesticated wolf-dog hybrids often are incorrectly attributed to wild wolves. The potential does exist for the genetic pollution of some wolf populations, but the risk is low considering offspring from wolves and dogs will often have a low survival rate (Vila and Wayne 1999). Though domestic wolf-dog hybrids are widely reported to exist in Oregon, there are no known wild-living populations of wolf-dog hybrids. In addition, wolf-dog hybrids have not been identified in genetic samples collected and analyzed to date (ODFW, unpublished data). Combined, these data substantiate that hybridization between wolves and dogs is not currently threatening the overall conservation of wild wolves in Oregon. Continued monitoring of Oregon's wolves by collection and analysis of genetic samples from all handled wolves will inform managers of the presence and prevalence of wolf-dog hybrids.

Wolf-dog hybrids are regulated as domestic dogs in Oregon, and the Wolf Plan has no jurisdiction over wolf-dog hybrids. Authority to regulate the breeding, raising, and holding of wolf-dog hybrids lies with individual Oregon counties. Some Oregon counties have adopted ordinances that regulate the possession of captive wolves and wolf hybrids. For example, Union County prohibits breeding of captive wolves, keeping wolves within the county, and releasing of a predatory animal. The possession of wolves or hybrids as pets is discouraged because of the potential threat to human safety. "Hybrids and tame wolves have little fear of humans, are less predictable and manageable than dogs, and are considerably more dangerous to people" (Fritts et al. 2003).

To help protect wild wolf genetic health in Oregon, the Commission adopted rule OAR 635-044-0460 in January 2017 regarding the holding of wolves. The new rule tightly regulates the holding of pure wolves and not the holding of hybrid wolf-dogs. However, it does require proof of hybridity, and lack of this proof may result in a required holding permit (which cannot be issued after January 20, 2017). Components of the wolf holding rule include:

- Wolves held in captivity require a wildlife holding or wildlife exhibitor/animal entertainment industry or wildlife sanctuary permit.
- After January 20, 2017, wolves held under a valid permit may only be transferred to an AZA accredited facility as approved by ODFW.
- Wolves cannot be imported, exported, purchased, sold, or exchanged except by permit from ODFW.
- Specifically prohibits wolves from being removed from the wild.
- Captive wolves cannot be bred, reproduced, or propagated.

Diseases and Wolf Health

Diseases in carnivores generally have minimal impact on humans or domestic species such as livestock. Though rare, nearly all occurrences of important diseases in carnivores are associated with

carnivore-specific pathogens including viruses like rabies, canine parvovirus, and canine distemper. These often involve public health concerns and may result in carnivore population effects. Very little disease-caused mortality has been documented in Oregon wolves, and there are currently no known disease issues affecting Oregon wolf populations or threatening Oregon's public, other wildlife, or domestic species. A summary of diseases potentially affecting wolves in Oregon is contained in Appendix B of this Plan.

To test for diseases in Oregon, ODFW routinely collects blood serum samples during wolf capture events. Serum samples are banked and can be used to test for common wolf pathogens which may influence local wolf populations. As of the writing of this Plan serologic screening has been performed on 38 wolf samples and positive titers and prevalence rates for the following diseases have been documented: Leptospirosis (5%), canine distemper virus (8%), canine adenovirus (66%), and canine parvovirus (89%) (ODFW, unpublished data). It is important to note that a positive serologic test does not necessarily indicate an active infection, but instead indicates an exposure to the pathogen.

It will be important to continue identifying emerging and re-emerging diseases or endemic diseases already occurring on the landscape. Disease testing and monitoring is part of most sound wildlife management programs and will be included in Oregon's wolf management efforts. At a base level, routine collection and banking of blood serum of captured wolves will allow continued testing for many specific pathogens. Other collection of samples (e.g., endoparasites and ectoparasites, body tissues) will be performed on an as observed and available basis. Furthermore, in situations of new or re-emerging disease detection, new management or research needs, increased observed or suspected disease-caused wolf mortality, or other indicators that diseases may be affecting or depressing local wolf populations, ODFW will implement a responsive testing protocol to monitor and remedy the problem if possible. This response protocol will include the following:

- Identify specific pathogens and the risk factors that pose a health threat to people, wolf populations, or domestic animals.
- Determine rationale for specific disease testing (surveillance, management and control, research) and whether testing meets criteria for costs versus benefits and the probability of providing meaningful results.
- Use the best technology available or gold standard testing protocols for each disease.
- Assess management implications of any detected disease to humans, domestic animals, and other wildlife (i.e., is it socially or biologically important?).
- Determine the prevalence of an identified disease tested (e.g., how many animals in the population are affected?).
- Determine other species that may play a role in transmission, reservoir maintenance, or serve as an intermediate host in the case of parasites. If a disease is known to occur in domestic or other wild animals, consider testing those potentially affected species.
- Determine if testing should be compulsory (test all live-captured or killed wolves for specific, identified diseases) or opportunistic based on management questions or research requests.
- Evaluate the costs associated with testing. Costs would be expected to increase with increasing wolf population numbers.
- Identify a threshold for when testing may prove unnecessary.

D. Monitoring Wolf Populations

Objective

- Maintain accurate information on the population status and distribution of wolves in Oregon through a comprehensive monitoring program.

Strategies

- Use radio-telemetry as the primary monitoring technique to assess the number of wolf breeding pairs and designation of wolf pack home ranges during Phases I and II. Once Phase III is reached, use radio-telemetry in select situations and for annual counts of wolf packs.
- Use field observations and reported sightings by the public that are verified to assist managers in determining the distribution of wolves in Oregon, and the extent of wolf range expansion.
- In addition to annual counts of wolves, use data derived from multiple sources to assess overall population health.
- Evaluate new methods for monitoring wolf populations, including the use of citizen-collected data, and methods developed and tested in other states.
- Continue to maintain the ODFW database on wolf population parameters and incorporate research findings.

Overall, data from multiple sources will be used to assess overall population health; including annual counts, telemetry data, survival rates, disease testing, and a variety of monitoring techniques. Radio-telemetry will continue to be an important technique for producing necessary data for guiding management decisions and providing information regarding important population parameters such as pack distribution, mortality, dispersal, population trends, wolf den locations, rendezvous sites, winter use areas, and wolf territory boundaries. GPS collars will continue to be used in select collaring situations where additional or more precise data is required. However, in some cases VHF radio-telemetry collars will be employed to monitor wolves due to their increased reliability and battery longevity. Regardless the type of collar, telemetry will continue to be useful for monitoring wolf breeding pairs during Phase I and Phase II. Collaring data is also a critical component during development of population models to build decision management tools.

As the statewide wolf population increases, the use of monitoring methods which do not require capture of wolves will become increasingly important. Non-capture methods currently employed include howling, track, aerial, and scat surveys; and trail camera surveillance. New pack counts and survey techniques are being developed and tested in other states with wolves, and Oregon will continue to evaluate and use these methods as they become available. In addition, biologists will continue to collect genetic samples (in any phase) from captured wolves and other sources (e.g., scat) as available and within budgetary resources. These samples can be used to monitor breeder success, dispersal, genetic connectivity, and other population attributes. Data collected by the public through broad-scale citizen science projects (i.e., data collected by a network of volunteers) may be useful in monitoring wolves in Oregon. Examples of large-scale citizen science projects include the long-standing Christmas Bird Count; the data-rich eBird (Sullivan et al. 2009); or the Wisconsin Volunteer Carnivore Tracking Program initiated in 1995 (Wisconsin DNR 2017). Biological data

collected by volunteers generally requires training, specific proficieny standards, and in some cases a firm commitment by volunteers to complete surveys. In addition, rigorous filtering of volunteer-collected data is required to ensure its usefulness to managers. In Oregon, citizen-based surveys or monitoring may be helpful with assessing wolf presence, distribution, breeding status, and abundance. Potential types of volunteer monitoring include tracking, scat detection/collection, trail camera, and howl surveys. ODFW will continue to evaluate the potential for citizen science volunteer projects to provide useful wolf monitoring information at an optimal cost-benefit basis on a case-by-case basis.

ODFW will have primary responsibility to monitor the wolf population under this Plan. Collaboration with tribes, other state and federal agencies, jurisdictions, universities, landowners, local government, and the public is essential to the success of the monitoring program. This coordination will be especially important when monitoring packs near state borders or when packs are located on or near tribal lands.

During Phase I and Phase II, wolves will be collared within reasonable and practical limits with respect to budgetary constraints and human/wolf safety. For known packs, effort will be made to collar at least one member of the pack with emphasis on at least one breeding adult. Other pack members may be collared to the extent feasible and depending on circumstances or pack-specific monitoring needs.

During Phase III, the wolf population will generally be monitored through counts of wolf packs as an indirect estimator of breeding pairs. However, in years where initial survey data or other information indicate the possibility of dropping below Phase III population levels, breeding pairs will continue to be enumerated for that year. Biologists will begin the transition from breeding pairs to packs by concurrently surveying packs during winter and determining the number of breeding pairs during Phase II. For the purpose of population monitoring and research to guide decision-making, collaring will be used in select situations, such as with wolves that appear in new locations. However, radio-telemetry will also be employed in situations not specifically related to population monitoring such as select situations of livestock depredation or other wolf-human conflict. While not all packs will be expected to have collared wolves, managers will consider the proximity to livestock and history of wolf-livestock conflict when prioritizing collaring levels.

E. Coordination with Other Governments, Agencies, and Organizations

Objective

- Continue to coordinate with other agencies and organizations to achieve wolf conservation and management objectives.

Strategies

- Continue to use the expertise of the U.S. Fish and Wildlife Service (USFWS), the U.S. Department of Agriculture's Wildlife Services Program (Wildlife Services), U.S. Forest Service (USFS), Bureau of Land Management (BLM), Oregon Department of Agriculture (ODA), tribal governments and private sector professionals, and other state agencies.

- Use the *2019 Federal/State Coordination Strategy for Oregon Wolf Plan Implementation* in portions of Oregon where wolves are listed under the federal ESA. See Appendix C. Urge the USFWS to update this strategy on a schedule compatible with this Plan.
- Work with the Oregon State Police Fish and Game Enforcement Division, the lead enforcement agency, and other law enforcement entities including the USFWS, U.S. Forest Service, and county sheriff departments.
- Coordinate with other state land management agencies such as the Department of State Lands, Department of Forestry, and Parks and Recreation Department as needed.
- Engage non-governmental wolf stakeholder organizations for input regarding wolf management in Oregon.
- Inform public and private land managers of general wolf activities on their respective lands as needed.
- Inform county boards of government of wolf-related activities as needed.

Successful implementation of the Wolf Plan requires continued close coordination with adjacent states, other government agencies, tribes, county governments, nongovernmental organizations, and willing landowners to share resources, reduce costs and avoid potential duplication of effort with these entities. Similar coordination efforts are a regular part of many current wildlife management activities.

Although many conservation and management hurdles were overcome during the first 10 years of this Plan's implementation, the management of wolves in Oregon in the future will require continual improvement of methods to resolve conflicts between wolf stakeholders. Deep-rooted social identity strongly influences thoughts about wolves and their management (e.g., tolerance) (Naughton-Treves et al. 2003) and despite agency efforts to address issues related to management and livestock depredation, the antagonism and conflict between pro-wolf and anti-wolf groups can be significant (Bangs et al. 2005, Madden and McQuinn 2014). In Oregon, it is expected that an increasing and expanding population of wolves may result in more, not less, conflict in the future. Additionally, as wolves expand into new areas of Oregon new and different levels of public engagement with ODFW may appear.

III. WOLVES AS SPECIAL STATUS GAME MAMMALS

In 2009, the Oregon Legislature changed the status of wolves from protected non-game wildlife to a special status game mammal under ORS 496.004(9). This change was called for in the 2005 Plan and allows ODFW to use existing, stable state and federal funding sources and existing field staff to include wolf management as part of their duties. These funding sources include both federal Wildlife Restoration grants (also known as Pittman-Robertson: PR) and fees from the sale of hunting licenses.

The special status game mammal classification recognizes the wolf's distinct history of extirpation and conflict with certain significant human activities as well as its unique place in human social attitudes based on experiences and myths that span centuries. This classification is based on Oregon's management successes with respect to other large carnivore game mammals (e.g., black bear, cougar) but also recognizes the factors that make the wolf somewhat distinct from other large carnivores. The classification provides the most options for long-term management by retaining, in addition to protective measures, tools such as responsive hunting and trapping for management purposes, although these management tools would not be applied in the same manner as under a traditional game mammal or furbearer classification.

ORS 496.004(9) lists all Oregon game mammals but specifically directs the Commission to define in rule the substantive standards governing wolves as a special status game mammal. Therefore, the Commission adoption of the framework of this Plan and the provisions within satisfy this requirement, but particularly the standards specific to this classification include, but are not limited to, those below.

1. When in Phase I and II, wolves are protected consistent with the conservation direction outlined in the Plan and lethal removal is only authorized in the Plan for specific depredation circumstances (i.e. chronic depredation, caught in the act). Lethal removal for human safety is authorized by statute in all Phases.
2. When in Phase III, the Plan also directs wolf protection and authorizes lethal removal, but includes the use of controlled take with the following stipulations. Use of controlled take as a management tool requires Commission approval through a separate public rulemaking process.
    (a.) Controlled take would be by ODFW special permit authorization only, and focused on a specific area or situation experiencing conditions that warrant a management response.
    (b.) General season hunts (e.g., seasons open to holder of appropriate license and tag without restriction to the number of participants) are not permitted. Controlled hunts (e.g., planned hunts with a specific timeframe, area boundaries and where the number of hunters is limited through a public drawing or other means) require Commission approval through the planning and hunt development public process.
    (c.) In the circumstances where controlled take is being implemented, trapping may be used for lethal management control. Before receiving special permit authorization from ODFW, trappers must be approved by ODFW. This ensures that both equipment and methods are best suited to the desired management outcome.
    (d.) Controlled take may be used in two circumstances as a management response tool to assist ODFW wildlife conservation and management efforts:

i. Long term, recurring depredation of livestock
    1. The take will only address conflict situations in a specified area, and
    2. The take will not impair wolf population viability or reduce overall population health factors within the region.

ii. Wild ungulate populations not meeting established management objectives or herd management goals
    1. ODFW has determined that wolves are a major cause of the population not meeting established ungulate objectives or herd management goals (e.g., movements, use of key feeding areas, survival rates, nutrition, or other biological factors) and that the controlled take is expected to improve the situation.
    2. The take will not impair wolf population viability or reduce overall population health factors within the region.

(e.) In addressing appropriate management response to wild ungulate impacts per paragraph d*(ii)* criteria above, ODFW will consider the following factors: 1) data or other information indicating that wolves are a major cause of ungulates not meeting objectives; 2) ability to address the situation through non-lethal means; 3) the level and duration of wolf removal necessary to remedy the situation; 4) ability to measure ungulate response to management actions; and, 5) identification of other potential major causes of an ungulate population not meeting objectives and attempts made to address them.

(f.) In an effort to inform future actions and wolf management related to controlled take, ODFW will monitor the results and evaluate the impacts of any wolf removal under this section. As part of the annual wolf report to the Commission, information on wolf take and any documented effects on ungulate populations will be reported.

Other Considerations

Other provisions related to the special status game mammal classification are:

- The maximum enforcement of applicable statutes imposing penalties for harming or killing a wolf illegally has been sought by the State. In 2016, the Oregon Legislature amended ORS 496.705 to increase the penalty for unlawful taking of gray wolves from $1,000 to $7,500. The Oregon State Police administers a TIP (Turn in Poachers) reward program through the Oregon Hunters Association specifically for citizens who turn in or provide information leading to the issuance of citation of someone who has illegally killed a wolf or other wildlife. Previously, only cash rewards were provided but in 2017, the Oregon Legislature amended ORS 497.112 to allow cash or hunter preference points as a reward.
- Where consistent with the above, Oregon's wildlife laws, wildlife damage statutes, and other related statutes remain applicable to this classification.
- Nothing in this classification would otherwise change legal options available to livestock producers and other citizens under this Plan or other current law aimed at addressing wildlife damage, livestock protection, and protection of human life.

IV. WOLF-LIVESTOCK CONFLICTS

The ranching and farming industries are important components of the Oregon economy, and addressing conflicts between wolves and livestock is an essential part of this Plan. The Wildlife Policy (ORS496.012) directs ODFW to manage wildlife populations at optimum levels and in a manner consistent with the primary uses of the lands and waters of the state. ORS 496.004 defines "optimum level" as "…wildlife population levels that provide self-sustaining species as well as taking, nonconsumptive, and recreational opportunities". In addition, ORS 610.055 directs that appropriate measures must be taken to assist farmers, ranchers and others in resolving wildlife damage, and that federal, state, county and local government should cooperate in efforts to control wildlife damage. In the case of damage, wildlife is defined to mean fish, wild birds, amphibians, reptiles, feral swine (as defined by the Oregon Department of Agriculture) and other wild mammals (ORS 496.004). Combined, these policies mandate that this Plan effectively address wolf-livestock conflict at a variety of scales, from industry-wide to individual producers. This chapter focuses on information, methods and management actions to reduce or minimize wolf-livestock conflicts in Oregon.

A. Livestock Depredation and Other Effects

Livestock Status and Losses in Oregon

Oregon has approximately 1,297,945 cattle, and 214,613 sheep within its borders.[3]

Land ownership in the state is split evenly between private and public lands. The federal government owns nearly half the land in Oregon and much of that land is utilized by the cattle industry. In 2016, the U.S. Forest Service permitted 91,341 cattle[4] and the BLM approximately 151,877 cattle to graze on federal lands within Oregon. In eastern Oregon, it was estimated in 1997 that two-thirds of beef cattle spend some of the year on federal lands (Tanaka et al. 1997).

Current losses of livestock in Oregon to depredation from coyotes, cougars and bears vary by county depending upon the dominant vegetation, the number of carnivores and the number of livestock. Coyotes, the most abundant of the three, caused 63% of cattle losses by a predator in 2010 (USDA National Agricultural Statistics Service, 2011). In 1997, a statewide Wildlife Damage Survey was conducted by the Oregon Agricultural Statistics Service for the Oregon Department of Agriculture. Total livestock losses for that year from cougar, black bear, coyote, bobcat, eagles, ravens and dogs for all types of livestock amounted to $1.6 million. Losses for cattle/calves and sheep/lambs was $824,000 and $767,000 respectively. An additional cost to producers for livestock injured by predators was $214,000. The survey also recorded $1.3 million spent by producers on non-lethal predator damage prevention. Prevention expenses included fencing, hazing devices, and guardian animals (Oregon Agricultural Statistics Service 1997).

[3] USDA Census of Agriculture 2012.

[4] USDA Grazing Statistical Suummary 2016.

Wolf-livestock Conflicts

Wolves prey on domestic animals in all parts of the world where the two coexist (Mech and Boitani 2003, Karlsson and Johansson 2010). However, Mech and Boitani stated, "we know of no place in North America where livestock compose a major portion of wolf prey, or where wolves rely mainly on livestock to survive." Further, wolves do not automatically hunt livestock (Chavez and Gese 2006), but may learn to and begin killing livestock at some point. Additionally, wolves encountering livestock on a regular basis are likely to depredate sporadically (Bangs and Shivik 2001, Wydeven et al. 2004). This observation differs from the situation in Europe and Asia where livestock are common components of wolf diets.

Confirmed wolf depredations result in a comparatively small proportion of all livestock losses, though wolf damage can be significant to individual livestock producers (Collinge 2008, U.S. Fish and Wildlife Service 2015). In the NRM area overall, losses of livestock to wolves have been small relative to the overall numbers of livestock (U. S. Department of the Interior 2008). From 2008 through 2013, an average of 189 cattle depredations (range=143-214) and 410 sheep depredations (range=162-749) occurred each year. Sixty-two of 355 (~17%) known wolf packs that existed in 2014 were involved in at least one confirmed livestock depredation (U.S. Fish and Wildlife Service 2015). In Oregon, between 2000 and 2018, 23 of 34 (68%) known wolves/packs were involved in at least one confirmed livestock depredation and 17 wolves/packs have depredated two or more times (50%). Of those 17, 13 depredated a third time and 11 depredated a fourth time (ODFW, unpublished data).

In Oregon, data collected from 2009-2018 shows a total of 134 incidents of confirmed depredation which resulted in 193 confirmed losses—71 cattle, 89 sheep, 3 goats, 3 llamas, 1 alpaca, 3 livestock protection dogs, 16 chickens, and 7 geese. As the Oregon wolf population increased from 2009-2018, incidents of wolf depredation trended upward (Figure 6), though not at the same rate as the minimum wolf count (Figure 3).

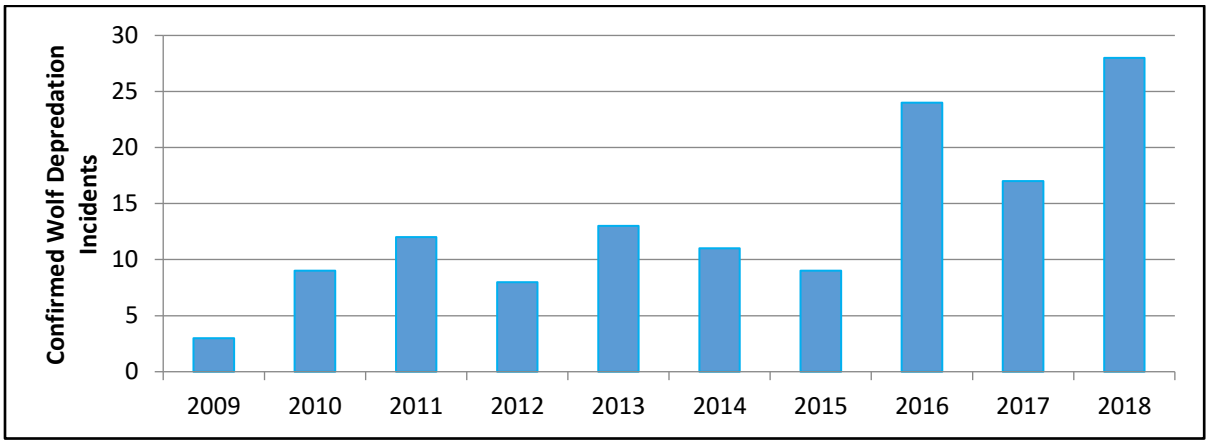

Figure 6. Confirmed wolf depredations incidents by year in Oregon (2009-2018)

Factors that can affect wolf depredation of livestock include pack size (Wydeven et al. 2004, Bradley et al. 2015), livestock density (Hebblewhite 2011), pasture size and remoteness (Bradley and Pletscher 2005), livestock husbandry methods (Fritts et al. 2003, Sime et al. 2007, Dondina et al. 2014), and abundance of native prey (Fritts et al. 2003, Bradley 2004, Treves et al. 2004, Bradley and

Pletscher 2005). Consideration of these factors, and others, may make it possible to predict the risk of wolf depredation, thereby increasing the potential for successful preventative measures. Wolf depredation often reflects the seasonality of livestock calving (Fritts 1982), grazing practices, and seasonal variation in energetic requirements of wolf packs (Fritts et al. 2003, Musiani et al. 2005, Morehouse and Boyce 2011). In Montana, cattle depredations increased in the spring (March-May) when calves were small, then showed a peak in the fall when pups were bigger, and pack cohesion and energetic demands of the pack were higher. Sheep were more vulnerable year-round, with depredation increases in summer and fall months when sheep are dispersed on the landscape (Sime et al. 2007). In Oregon, confirmed depredations to date have followed a similar spring/fall pattern (Figure 7).

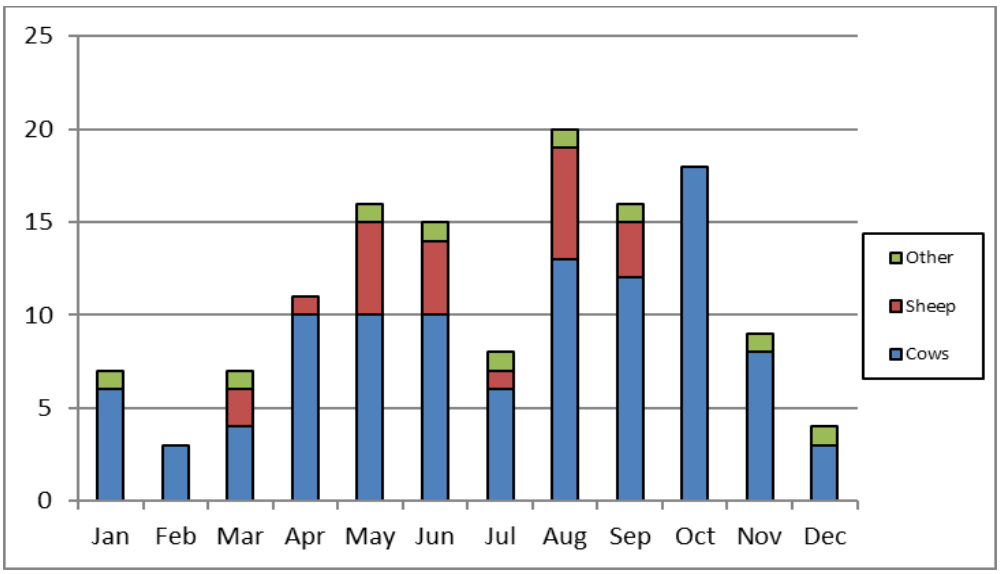

Figure 7. Total confirmed depredation incidents by month in Oregon (2009-2018).

Most cattle losses as a result of wolf depredation in the northern United States are calves (Fritts et al. 2003, Oakleaf et al. 2003, Sime et al. 2007). Calves depredated by wolves tend to be smaller (Oakleaf et al. 2003), and may be in poorer physical condition (Bradley and Pletscher 2005). In western Wyoming, calf loss in an area with both wolves and grizzly bears increased with increasing livestock density, and the overall effect of wolves and grizzly bears increased calf loss by 2% (Hebblewhite 2011). Selection of calves by depredating wolves has also been observed in Oregon. From 2009-2018, 94 of 110 (85%) of cattle that have been killed or injured by wolves have been calves, and 16 of 110 (15%) have been adult cattle (ODFW, unpublished data). Depredation incidents involving multiple-cattle are uncommon as only four incidents have been documented in Oregon over that span (ODFW, unpublished data).

Sheep are vulnerable to wolf predation year-round due to their size and, unlike cattle, adult sheep are commonly killed by wolves (Fritts et al. 2003, Sime et al. 2007). This pattern has been observed in Oregon where 43 of 104 (41%) of sheep killed or injured (2009-2018) involved adult sheep while 61of 104 (59%) involved lambs. In addition, more than half of Oregon's sheep depredation incidents involved multiple animals (ODFW, unpublished data), ranging from 2 to 24 injured or dead sheep.

Wolves readily scavenge on livestock carcasses and removal of carcasses or other attractants can reduce wolf presence near livestock (Fritts et al. 2003, Bangs et al. 2006). In Alberta, 85% of livestock scavenging events occurred at livestock carcass disposal sites, which are often in close proximity to livestock (Morehouse and Boyce 2011). While some research did not demonstrate a clear link between depredation and carcass disposal (Bradley 2004, Bradley and Pletscher 2005), limited Oregon data has shown reduced wolf use of private land wintering livestock and calving areas following carcass removal (ODFW, unpublished data). Use of this practice will continue to be emphasized in Oregon to help reduce interactions between wolves and livestock.

Detection and documentation of wolf depredation losses can sometimes be difficult, which is why confirmed wolf depredation data in Oregon are considered minimum figures. Several studies have shown that cattle depredations are less likely to be detected in open range situations (Oakleaf et al. 2003, Sommers et al. 2010, Morehouse and Boyce 2011). In one study (Oakleaf et al. 2003), researchers detected only 1 of 8 predator-caused calf mortalities in remote forested and mountainous terrain. The authors also suggested that higher detection rates were expected in less timbered or less rugged country. Sommers et al. (2010) found that in some habitats 6.3 calves were killed by wolves for each confirmed depredation. These studies suggest that the rate of undetected depredations will depend partially on the characteristics of the rangeland (i.e., remoteness and accessibility) and the corresponding likelihood of finding dead livestock. Identification of wolf-caused depredation can also be affected by livestock density, frequency of human presence, summer precipitation, reporting bias, and the presence of other predators (Hebblewhite 2011). Even when livestock carcasses are located, accurate determinations of wolf depredation can affect overall data on wolf depredations, as experienced investigators cannot always identify wolf depredation (Fritts et al. 2003). Many factors can affect the accurate determinations of wolf depredation on livestock including weather, time since death of the animal, amount of consumption, decomposition, evidence of other predators, and experience of the investigator

Aside from depredation kills, wolves also wound, chase, and test cattle. There is little published information that quantifies indirect effects of carnivores on domestic ungulates, though several researchers suggest that indirect effects of wolves on cow-calf production can be significant (Laporte et al. 2010, Steele et al. 2013). Indirect effects of carnivores on livestock foraging behavior can include reduced forage efficiency, greater time spent on vigilance, and possibly selection of poorer habitat and diet to avoid predators (Howery and DeLiberto 2004). Furthermore, harassment by predators can increase physiological stress responses (Cooke et al. 2013) or modify travel and bunching response (Laporte et al. 2010). Reduced animal health, decreased reproduction, lower weaning weights, and weight lost due to reduced forage efficiency may all affect the revenues of livestock producers, although there is little research of how these wolf-specific effects relate to additional production costs. In one Wyoming study, cattle prices and not wolf effects drove the gross margin of ranches (Steele et al. 2013); this is consistent with other research indicating non-predation factors, such as market fluctuations and extreme weather, may be greater threats to livestock production than wolves (Chavez et al. 2005).

B. Working Dog and Pet Depredation

At the time this Plan was updated, no pets or sporting dogs have been confirmed lost by wolf predation or attack in Oregon. However, as wolves expand their range, dog owners will need to be aware of the potential risks to their animals. Areas or situations where wolves and domestic dogs

encounter each other can result in dog or wolf mortality. Wolves are territorial and may alter their regular movements or activities to seek out and confront domestic dogs. In Wisconsin, wolf-caused losses of hounds used for black bear hunting resulted in more total compensation paid, in some years, than for livestock losses (Treves et al. 2002). In some regions of the world, dogs are an important food source for wolves, to the extent that wolves reportedly have reduced the number of stray dogs in some areas (Mech and Boitani 2003).

Working dogs used to herd or protect livestock are considered livestock for the implementation of this Plan and the Oregon Department of Agriculture's Wolf Depredation Compensation and Financial Assistance Grant Program (ORS 610.150), and they are vulnerable to wolf depredation. Prior to December 31, 2018, four events of depredation of livestock protection dogs while guarding sheep or cattle have been documented in Oregon, resulting in the death of three dogs and injury of two others (ODFW, unpublished data). The killing of guard dogs by wolves has also been well documented in the NRM Recovery Area (Bangs and Shivik 2001, Mech and Boitani 2003, Bangs et al. 2006). Guard dogs appear to be more effective and less at risk when an adequate number of experienced dogs per herd are present coupled with the presence of trained herders (Stone et al. 2008). However, livestock producers using working dogs in conjunction with trained herders face added costs to protect their livestock from predator depredation. Additionally, working dogs and trained herders may be more effective for protecting sheep flocks than protecting cattle.

In Oregon, some wolves are likely to use areas near human habitation or areas used for recreation which could put pets or working dogs at risk. Dogs running at large or dogs working cattle or sheep may be vulnerable in these situations. Bird hunting dogs or hounds used in areas occupied by wolves also could be at risk. Continued public education will be important in preventing wolf/domestic dog interactions.

C. Tools for Minimizing Livestock Depredation

An integrated approach is required to minimize depredation of livestock, including the use of both proactive and corrective measures in situations of active depredation. In the relatively short timeframe that wolves have re-established in Oregon, wolf managers and livestock producers have implemented a number of non-lethal and lethal techniques to minimize depredation. The effectiveness of non-lethal and lethal techniques to minimize depredation can vary. Treves et al. (2016) provided a summary of 12 published papers assessing effectiveness of non-lethal and lethal techniques to reduce livestock depredation by canids, felids, and ursids. Of the five non-lethal examples, the researchers found that four were effective at reducing depredation and one showed no effect. Of the seven assessments of lethal control techniques, two were found to be effective at reducing depredation, two showed counterintuitive results, and three showed no effect. Determining effectiveness of lethal control methods is difficult however, because effective study designs (i.e., random assignment of treatments) may not always be logistically possible, studies are often observational in nature, and confounding variables may be present or analyses techniques may be inappropriate. For example, Wielgus and Peebles (2014) concluded lethal control increased the risk of wolf depredation the following year, but using the same data set and a different analysis technique, Poudyal et al. (2016) found the opposite pattern. Bradley et al. (2015) examined effectiveness of lethal control on recurrent depredations at a pack level over 5 years and observed that entire pack removal (79% reduction in recurrent depredation) was more effective at reducing depredation than partial pack removal (29% reduction in recurrent depredation). This suggests

lethal control may be effective at reducing livestock depredation at a local scale in some scenarios. Given these findings, ODFW will continue to emphasize use of non-lethal techniques whenever possible, but lethal control of wolves may be required in some situations of chronic livestock depredation.

Non-lethal Deterrents

Techniques to discourage depredation are continually being developed, and many have been specific to wolves in the NRM states (Bangs and Shivik 2001, Bangs et al. 2006, Stone et al. 2008). Further, Treves et al. (2016) found that in several experimental studies, various non-lethal techniques were effective at reducing livestock depredation across a variety of predator species. In addition, the role of certain husbandry practices such as increasing supervision, pasture choice based on habitat features, stocking rates of different ages have been shown to reduce livestock depredation risk (Muhly et al. 2010). Though non-lethal measures and husbandry practices may not have universal effectiveness and may not be feasible in some situations, they can be effective in reducing conflict in some situations (Sime et al. 2007). Not all non-lethal measures are useful in all situations, and it is important that managers and producers identify which measures are appropriate. The following is a list of non-lethal or preventative measures to help livestock producers minimize the risk of wolf predation on livestock and most have been implemented in Oregon. This list is provided to help identify measures which are appropriate for different wolf-livestock conflict situations.

ODFW maintains an actively managed document that addresses the current status of "ODFW Non-Lethal Measures to Minimize Wolf-Livestock Conflict". That document and additional information on non-lethal measures can be viewed at: www.odfw.com/Wolves/non-lethal_methods.asp

Reducing Attractants
The physical removal or treatment of livestock carcasses (or portions of) which may attract wolves. Removal may occur by hauling carcasses to disposal in a landfill or other appropriate location, or by burying, composting, or incinerating in some situations. In situations where carcasses cannot be practically removed, temporary fencing or fladry (see below) may be useful to prevent wolf use of the carcasses.

Fencing
Fencing used specifically to deter wolves from livestock, may be permanent or temporary, and constructed of a variety of fencing materials and electrified, depending on the situation. In general, fencing is considered when attempting to protect livestock in a small pasture, enclosure, or when stock is gathered in a reasonably protectable area (e.g., sheep nighttime bedding area). It is generally not applied to larger or dispersed grazing operations.

Fladry
A rope or electric wire (turbo fladry) with evenly spaced red flags that hang down (Musiani et al. 2003), creating an apparent psychological barrier that wolves avoid crossing. Highly portable and quickly installed, fladry can be used for a variety of livestock operations including sheep night penning and some calving areas, but can be challenging to install and maintain at large scales. It is best used as mobile protection on a short-term basis in a small area. Fladry requires regular maintenance for effective use. In general, fladry is not intended for use over long periods of time in

the same location (usually less than 90 days) because wolves may become habituated, and thereby reduce its effectiveness.

Livestock Management Practices

These livestock management practices are actions taken specifically to help avoid wolf-livestock conflicts and can include practices such as changing pastures use to avoid areas of wolf activity, evening feeding, calving season changes, changing herd structure, low-stress livestock handling, and others.

- Changing Location: If possible, changing pastures or grazing sites to avoid wolf use areas may be an option when wolf use data or recent depredation indicates area-specific problems.
- Changes to Herd Structure: Producers may choose to put cows with small calves and weaned calves in more protectable situations or areas that have less wolf use. For areas with known wolf use, producers may choose to put dry cows, cows with larger calves, and ewe-only bands in those areas as they consist of larger or older animals that are less vulnerable to depredation.
- Delayed Turn Out: In some situations, producers choose to wait to put calves in forested pastures and allotments until after the elk and deer have produced their young for the year, greatly increasing natural food sources.
- Evening Feeding: Feeding in the evening can have the effect of bunching cows and calves into a common area where they would be less vulnerable to night predation. Evening feeding may also affect birthing times of livestock (some animals do not generally give birth while their stomach is full).
- Changes to Calving and Lambing: Livestock are at increased risk during the calving and lambing seasons and several management actions may reduce risk to younglivestock. Calving and lambing in more protectable situations can reduce loss from wolves and other causes versus calving in large forested pastures or open range allotments. Birthing earlier to have larger calves on allotments and reducing the length of the calving period have also appeared to be effective for some producers.
- Low-Stress Livestock Handling: A technique was developed for working with cattle to efficiently move cattle while minimizing animal stress. Traditional livestock handling can be stressful to cattle, which may lead to poor animal health, less efficient movement, and creates noise when calves are separated from their cows. Wolves in the area can be attracted to the noise and vulnerable calves. One of the main features of low-stress livestock handling is creating herd movement through the least amount of energy and pressure as necessary. With respect to predation risk, low-stress livestock handling offers several benefits. First, cattle moved in this manner are more likely to remain in a herd and cows are less likely to be separated from their calves. Calves that remain with their mothers and cattle standing their ground in a herd are less vulnerable to predation. Secondly, cattle placed through low-stress livestock handling are less likely to scatter after being moved, allowing the producer to place the cattle in an appropriate area and be more confident that the herd will remain there even in the producer's absence.

Livestock Protection Dogs

Use of specific breeds of guarding dogs or other animals that are used with intent to protect livestock from wolf depredation and alert the producer to wolf presence. Breeds such as Pyrenees, Anatolian, Akbash, or other established guarding breeds are commonly used. Livestock protection

dogs are most effective when a person is nearby to respond if dogs engage wolves and are normally used in conjunction with herded livestock such as sheep, but may be used in some situations for cattle or other livestock species. Multiple trained adult dogs are usually recommended, but the number may depend on the level of wolf activity in the area, size of grazing area, and behavior characteristics of the dogs. Wolves may be more aggressive near dens or rendezvous sites and dogs are not recommended in these areas.

Human Presence as a Non-lethal Measure

The underlying concept of increasing human presence as a deterrent to wolf depredation is that wolves tend to avoid humans. Human presence actions are often conducted with the primary intent of reducing or deterring wolf depredation, though in some situations it may be passive or secondary to other ranching operations (e.g., all-night presence for the purpose of calving while wolves are in the area would be expected to minimize wolf-livestock conflict). Two approaches to using human presence as a deterrent are: 1) regular or planned presence using range riders, hazers, herders, or other planned human guarding of livestock, and 2) presence in response to wolf information (e.g., tracks, observations of wolf activity, abnormal livestock behavior, notification by ODFW), or during susceptible depredation times such as nighttime, when wolves are known to be present in areas of livestock. Monitoring for signs of wolf activity, though not considered a non-lethal measure by itself, is important to help prioritize effective wolf-deterring human presence. Types of human presence associated with ranching operations include:

- Hazers and Range Riders: Generally considered to be regular or sometimes continuous presence for the specific purpose of protecting livestock, range riders patrol areas with wolves and livestock at hours when wolves are most active (dawn, dusk, night). The rider uses information available to patrol in livestock areas with current wolf activity and is equipped to actively haze wolves away from livestock when found. In areas of active depredation and in large areas with dispersed livestock, more than one range rider may be necessary to provide adequate protection.
- Herders or other Guarding: This is directly applicable to sheep operations where herding is a normal part of sheep ranching. During the daytime herders often keep the sheep bunched making the sheep more protectable and preventing sheep from becoming separated from the band. Herders may be most important at night when sheep are gathered in bedding areas. Effectiveness is increased if a herder is working with livestock protection animals, fladry, or other barriers to protect sheep. Additional herders may be needed in areas of high wolf activity to specifically work at night when depredation is most likely to occur.
- Individual Response: This is human presence which may be additional to regular ranch operation and with the intent of deterring wolf-livestock conflict if wolves are present. It is often tailored to situations when wolves are in proximity to livestock (i.e., may not be practical or expected when wolves are known to be in another area). Presence may be conducted by patrolling during active wolf periods such as dawn and dusk, and in situations such as calving or lambing periods, and may be best conducted at night to further reduce depredation. It also includes monitoring and responding to information of wolf activity in areas of livestock. This response may be increased when gathering or moving livestock as these activities can create distress and noise in livestock when there is a temporary separation of cows from their calves.

Alarm or Scare Devices

This includes any combination of alarm system with lights and/or loud sounds which are used for the purpose of scaring wolves from areas of livestock. Primarily used for protection of defined/enclosed areas or small pastures, but in certain situations can be used to deter wolves from using a more general area, especially calving pastures.

- Radio-activated-guard (RAG) devices: These are scare devices which are triggered by the signal from an approaching radio-collared wolf. When activated they emit strobe light flashes and varying loud sounds designed to deter the wolf. RAG devices can also be used as an alarm device to alert a producer that radio-collared wolves are in the area. RAG devices may be available through ODFW or other organizations. These devices can only be used in areas where one or more wolves are radio-collared.
- Other light and sound making devices: These may be warranted in situations similar to above but where wolves are uncollared and could include a variety of lighting devices (e.g., Fox Lights), motion-activiated alarm devices (e.g., Critter Gitter), radios, music players, etc. Varying the sounds and frequently changing positions of the device will increase effectiveness and reduce the chance that wolves become habituated.

Hazing or Physically Scaring Wolves

This is direct harassment of wolves with the intent to use human actions to actively scare wolves away from livestock and may include loud noises (e.g.,yelling, air horns, firing shots in a safe direction), spotlights or other confrontation with wolves. There are two types of harassment recognized by Oregon Administrative Rule: non-injurious and non-lethal injurious. **Please Note: Harassment of wolves is regulated, and is discussed later in this chapter.**

Experimental Practices

There are a number of non-lethal and preventative practices (i.e., bio-fencing, belling cattle, inflatable tube men, using wolf-savvy cattle, shock collars, and possibly others) which may reduce depredation risk, but are not yet known to be effective. Experimental practices are encouraged but may require additional use to determine if they are practical, useful, and the conditions in which they would be most effective. Producers are encouraged to coordinate experimental practices with ODFW before implementing them.

There may be other non-lethal deterrents not included on this list that may be reasonably expected to minimize wolf-livestock conflict in some situations. ODFW periodically updates the ODFW wolf webpage based on new research, information, and experience in working with wolves, landowners, and situations of wolf-livestock conflict. This page can be accessed at www.odfw.com/Wolves/non-lethal_methods.asp.

Lethal Removal

Lethal removal of wolves to resolve wolf-livestock conflict is controversial and heavily scrutinized by the public (Musiani et al. 2005, Bangs et al. 2006, Bradley et al. 2015). In Montana, despite the lethal removal of 254 wolves prior to 2006, the population continued to grow and expand its distribution (Sime et al. 2007). The combination of non-lethal and lethal methods (which included the ability to take wolves caught in the act of attacking livestock) was thought to have kept depredations at a lower level than was originally predicted (Sime et al. 2007). The general

understanding is that the effectiveness of lethal removal is only short term, often lasting only the grazing season (Bradley 2004, Musiani et al. 2005). When employed in Oregon, lethal removal of wolves in response to depredation is considered to be a corrective action—its purpose is to stop presently occurring damage by wolves in a localized area, and not necessarily to address the potential of future depredations at a regional or statewide scale.

The effectiveness of using lethal removal to stop or minimize depredation, while continuing to provide overall conservation for the species, is key in determining its usefulness in solving depredation. However, research into the effects of lethal removal are ambiguous, likely because studies are observational in nature and often related to the scale of analysis (e.g., pack level versus range-wide). One study found a positive relationship between lethal control at a statewide scale and future-year depredations, supporting the concept that lethal control had the opposite of its intended effect (Wielgus and Peebles 2014), though this finding was refuted by other studies (Poudyal et al. 2016, Kompaniyets and Evans 2017). Analysis of long-term statewide data in Minnesota showed that killing a high number of wolves did not result in fewer depredations the following year (Harper et al. 2008), but on a shorter term basis lethal control was effective in reducing further losses in sheep, and in cattle in some situations (e.g., if at least one adult male wolf was removed). In the NRM at the pack scale, lethal removal was effective at reducing further depredations, though the effectiveness was strongly related to the number of wolves removed, where entire pack removal was more effective than partial pack removal (Bradley et al. 2015).

In situations of lethal removal of breeder wolves, the probability of pack dissolution is increased (Brainerd et al. 2008, Borg et al. 2015), though the dissolution does not appear to have significant effects on overall population dynamics due to strong compensatory mechanisms (Borg et al. 2015). Even so, lethal removal of solitary individuals or territorial pairs in situations of chronic wolf-livestock conflict would be expected to have fewer effects on overall wolf conservation (Brainerd et al. 2008). This study also recommended that impacts to overall wolf populations is reduced when lethal removal is conducted on reproductive packs when pups are ≥6 months old and packs contain ≥6 members (including ≥3 adult-sized wolves)(Brainerd et al. 2008). Depredations in Oregon often occur during the spring and fall months, overlapping these considerations in many cases.

While lethal removal has been observed to reduce subsequent depredation at the pack level over a shorter time period, there is less evidence to support long-term reduction. A cycle can develop where new wolves re-colonize, cause new depredations, which leads to additional removals (Musiani et al. 2005). This situation is often unacceptable to advocates, livestock producers, and wolf managers (Bangs et al. 2006). In Montana, partial pack removal reduced subsequent depredations by 29%, while full pack removal reduced subsequent depredations by 79% over a span of five years (Bradley et al. 2015). In this study, pack size of remaining wolves following lethal removal was the best predictor of recurring depredations with larger remaining packs having a higher probability of recurring depredation than smaller packs.

In Oregon, authorized lethal removal for chronic depredation has occurred on six different situations involving wolves (Keating, Imnaha in 2011 and 2016, Harl Butte, Meacham, Pine Creek). In two of those situations, subsequent depredations by the same wolves occurred during or following efforts to removal of some but not all individuals (Imnaha 2011, Harl Butte). In spring 2018, depredations continued after the removal of one individual of the Pine Creek pack but ceased for the year following removal of a third individual. In 2016, the entire Imnaha pack (4 members) were lethally removed. Depredations began again less than 4 months later in the same area, by

unrelated wolves that had occupied the Imnaha pack's former territory. Depredations were effectively stopped following the removal of both Keating wolves in 2009 and following the breakup of the Meacham Pack after the breeding female was removed (ODFW, unpublished data). For these reasons, lethal control of wolves is best used in an adaptive, integrated management program, which includes non-lethal and preventative measures as a starting point to reduce risk of depredation.

Protection of livestock by allowing the taking of wolves caught in the act of attacking livestock is an additional tool to resolve wolf-livestock conflict (Bangs et al. 2006). This type of take is thought to empower producers to protect livestock (Sime et al. 2007) and immediately targets only the offending animal(s) while eliminating further control by agencies (Bangs et al. 2006). In Oregon, the single wolf taken under this Plan's caught-in-the-act provisions (May 2016) embodied both of these principles; depredation has not recurred since the taking, and the remaining pack was a successful breeding pair in 2016. Specific regulations concerning this type of take are detailed later in this chapter.

Human tolerance toward wolves is long recognized as an important factor in recovery (Chapter II) and persistence of wolf populations (Fritts and Carbyn 1995, Fritts et al. 2003, Bangs et al. 2006). While lethal removal is only conducted in Oregon as a corrective measure, the concept of removing depredating wolves is believed to improve tolerance and reduce illegal take of wolves by the public (Bangs et al. 1995). However, the ability of lethal removal in situations of livestock depredation to improve tolerance by humans toward wolves is unclear. Research in Wisconsin suggested that lethal control measures in the short-term were ineffective for increasing tolerance (Browne-Nuñez et al. 2012) and may even increase illegal take (Chapron and Treves 2016). Additional research in Wisconsin, however, showed that illegal behavior toward wolves can be moderated with effective state management programs which included lethal control of depredating wolves (Olson et al. 2014). Continued outreach, education, and effective management will be critical to increasing tolerance of wolves and ensuring long-term conservation of wolves in Oregon.

Compensation

Though not a direct tool for minimizing wolf-livestock conflict, compensation for wolf-caused losses is common in most states with wolves. In Oregon, compensation is part of the state's integrated approach to addressing damage by wolves. Some researchers have reported the ineffectiveness of compensation as a means to increase tolerance toward wolves by livestock producers (Naughton-Treves et al. 2003, Stone 2009, Boitani et al. 2010); however, one study in the NRM showed that compensation was successful in maintaining more acceptance of wolves than would have existed without it (Stone 2009). Furthermore, in states where tolerance was not increased by compensation programs, there was still strong approval of compensation programs by intended recipients (Naughton-Treves et al. 2003, Stone 2009), and that if compensation was available, most livestock producers with losses did seek to be compensated (Stone 2009). As part of the development of the 2005 Oregon Wolf Plan, public support for a compensation fund was clearly stated in comments generated during town hall meetings held by ODFW throughout the state during 2002 and 2003. Additionally, a poll of Oregonians in 1999 demonstrated public support for the return of wolves to the state and for compensation to livestock producers for wolf-caused losses (Davis and Hibbitts 1999).

The 2005 Plan called for the implementation of a compensation program and in 2011 the Oregon Legislature created a compensation program (ORS 610.150) and a funding mechanism for the

program (ORS 610.155). The program is administered by the ODA and uses a combined approach—compensation for direct losses, missing livestock, and reimbursement for non-lethal costs. See the Livestock Producer Assistance section in this chapter.

D. Strategies to Address Livestock Conflict

Objective

- Continue to implement a three-phased approach based on population objectives that minimizes conflicts with livestock while ensuring conservation of wolves.

Strategies

- Implement an adaptive management approach to wolf conflicts for both East and West WMZs that emphasizes non-lethal control techniques while the wolf population is in Phase I and transitions to a more flexible approach to depredation control in Phase II and Phase III.
- Promote, educate, and equip landowners, livestock producers, and the public with tools and knowledge to implement non-lethal and lethal wolf management techniques.
- Allow the use of multiple approaches that will give individuals flexibility to customize wolf management to their situation.
- Continue to pursue the establishment of wolf management specialist positions within ODFW to minimize conflicts and work directly with individuals who experience conflicts.
- Keep landowners, livestock producers, and the public informed of general wolf distribution information as needed.
- Inform land management agencies, landowners, livestock producers, and the public of planned or completed wolf management activities as needed.
- Use lethal controls on packs and/or individual wolves that depredate on livestock under specified circumstances as described in this Plan.

The intent of these strategies is to prevent any losses from occurring or resolve wolf-livestock conflicts before they result in additional losses while ensuring conservation of wolves. Non-lethal techniques will be the first choice of managers in situations of wolf-livestock conflict in all phases. While multiple non-lethal techniques employed in other states should be used here, adaptations to these techniques and development of new non-lethal techniques will be encouraged as needed to address factors unique to Oregon. In situations where chronic losses are occurring, lethal control actions may be employed to minimize livestock losses regardless of the wolf population status. While there are differences in how livestock conflicts are addressed in the three phases, the differences are not substantial. The Plan endeavors to provide as much flexibility to address conflicts as possible while wolves exist in low numbers, while still remaining focused on achieving wolf population objectives for each zone.

This three phased-approach that is based on the current population status of wolves will continue to provide options to wolf managers, livestock producers, and the public while promoting the goal of conservation for wolves. When wolf numbers are low, more emphasis is placed on non-lethal deterrents and modifications to livestock production practices. Wolf managers and livestock

producers are not required to exhaust all non-lethal techniques, but instead, a good faith effort to achieve a non-lethal solution is expected. In order to use the widest array of management tools available in any given management phase, livestock producers will be encouraged to employ management techniques to discourage wolf depredation, and agencies will advise and assist in implementing such techniques. In order to meet these growing demands and ultimately minimize conflict, establishing additional ODFW wolf-specific positions and continuing with ODA Wolf Depredation Compensation and Financial Assistance Grant Program for non-lethals will be essential.

Wolf managers working with livestock producers are encouraged to employ management techniques that have the highest likelihood of success in resolving the conflicts and are reasonable for the individual situation. This includes the identification of circumstances that may attract wolf-livestock conflict. For implementing actions to resolve conflict, ODFW considers that a condition on the landscape is not inherently unreasonable if the condition is a common practice, regardless of the presence of wolves. For example, a livestock carcass pile or disposal area was a common practice of many livestock operations before the presence of wolves. However, even if not considered inherently unreasonable, a carcass may be identified to be an attractant to wolves and ODFW may recommend removal of the attractant before control actions are considered. Conversely, a carcass that is intentionally placed in a location for the purpose of attracting wolves or other scavengers may be considered unreasonable, and under this Plan options for addressing the conflict are reduced. Carcasses of natural prey species (e.g., deer and elk) do not generally attract wolf-livestock conflict and it is not expected that individual wildlife carcasses, which commonly occur on the landscape (e.g., road kills or wildlife killed by natural causes), will be removed. However, in some cases wildlife carcass disposal sites may be identified as an attractant which may lead to wolf-livestock conflict. In these cases, the carcasses should also be removed and use of the disposal site discontinued.

Non-lethal conflict deterrence plans are recommended (but not required) for livestock producers ranching and farming in Oregon to reduce conflict and aid in agency reponse to chronic depredation. Livestock producers know their operations and understand their livestock's vulnerabilities best and have local knowledge of the history of depredations in their areas. Therefore, ODFW will continue to help operators develop site-specific strategies to reduce conflict that are best suited for specific situations. In the event of wolf activity or a suspected depredation, a non-lethal conflict deterrence plan would guide decision making on what steps to take to eliminate further conflict. Should chronic depredation occur, the plan would be used to ensure that non-lethals have been deployed in a manner consistent with legal requirements before lethal control may be considered. This expedites ODFW's evaluation of the situation and responses to queries from the public.

In all Phases, non-lethal techniques will continue to remain the first choice of managers dealing with conflicts. However, in Phase III, more emphasis may be put on lethal control to ensure protection of livestock in situations where livestock are at substantial risk despite the continued use of non-lethal measures.

When chronic depredation occurs, ODFW evaluates each situation on a case-by-case basis to determine the appropriate response action. Merely meeting the criteria (see criteria below for minimum requirements of chronic depredation in each phase), will not automatically result in lethal removal actions. ODFW considers a number of factors when considering if lethal control actions are warranted or how they will be applied. Wolf-specific considerations may include the number and

identification (where information is available) of depredating wolves, pack area and status (number of adults, pups, and ages), proximity to dens/rendezvous areas, health (old age, injuries), frequency, severity and distance between depredation incidents, past depredation history of the pack, wolf behavior and travel patterns, terrain and remoteness, and the potential of lethal control to change pack behavior and minimize depredation. Livestock specific considerations may include the type of livestock and level of vulnerability (e.g., calves/lambs, or adults), time of year, grazing season, potential changes in husbandry practices, continued presence of livestock, pasture size and remoteness, non-lethal measures used, ability to implement effective non-lethal measures, and stocking density of livestock.

Upon adoption by the ODFW Commission and filing with the Secretary of State, this Plan and its associated technical rules automatically amends current administrative rules concerning harassment and take. The text below summarizes the types of harassment and take allowed by this Plan. Consult the associated technical rules (OAR 635-110-0010 through-0030) for precise wolf regulations. In the event of a conflict between this Plan and the technical rules, the technical rules govern.

Phase I (Conservation Phase)

In Phase I, the use of non-lethal measures to prevent or resolve depredation is emphasized and, with few exceptions, an extensive process is generally required by producers and ODFW before lethal control measures can be considered. OAR 635-110-0010 describes the specific regulations regarding harassment and take of wolves in response to wolf-livestock conflict.

For the purpose of addressing wolf-livestock conflict, ODFW will implement the following general process in Phase I areas:

1. When resident wolf use of an area is determined, ODFW will designate "Areas of Known Wolf Activity" and coordinate with potentially affected producers about wolves, wolf management, conservation, and non-lethal measures and procedures.
2. If depredation is confirmed, ODFW will designate an "Area of Depredating Wolves" and will prepare and make publically available an area-specific conflict deterrence plan for the situation. Producers are encouraged, but not required to implement measures within this plan. However, options for future lethal removal will be based largely on implementation of non-lethal measures within the deterrence plan.
3. Chronic depredation in Phase I is defined as at least four qualifying incidents of depredation within the previous six months by the same wolf or wolves. Qualifying incidents of depredation will be based on the level of non-lethal measures used for each situation after an "Area of Known Wolf Activity" is designated.
4. In situations of chronic depredation where lethal control actions are being considered, ODFW will document the wolf depredation and non-lethal measures used, and make the information publically available

The following explains options available to livestock producers in situations of wolf-livestock conflict.

Important Note: At the time of this Plan's adoption, wolves in the West Zone, and a portion of the East Zone (west of Hwy's 395-78-95) are listed as endangered under the Federal Endangered Species Act. All management related to harassment and take of wolves in this federally-listed area is regulated by the U.S. Fish and Wildlife Service, not ODFW. The information below only reflects ODFW rules regarding harassment and take of wolves once they are delisted from the Federal ESA. Until that time, federal laws preempt these rules.

Non-injurious harassment of wolves includes scaring off an animal(s) by making loud noises (e.g. safely firing shots into the air,)or otherwise confronting the animal(s) without doing bodily harm. It is allowed without a permit by livestock producers (or their agents) on land they own or land they lawfully occupy, or by permittees (or their agents) who are legally using public land under valid livestock grazing allotments. For non-injurious harassment to occur, the following criteria apply:

- It is allowed only for wolves in close proximity of livestock or in the act of testing, chasing, or otherwise disrupting livestock.
- It must not result in injury to the wolf.
- It must be reported to ODFW within 48 hours.

Any non-injurious harassment that does not meet each requirement of this rule requires a permit in advance from ODFW.

Non-lethal injurious harassment means scaring off a wolf (or wolves) older than 6 months without killing but with some injury to the wolf and includes rubber bullets, bean bag projectiles, and vehicle or other pursuit-oriented hazing. It is conducted for the purpose of minimizing wolf-livestock conflict when livestock are present. It is allowed by permit issued by ODFW to livestock producers (or their agents) on private lands they lawfully occupy or by permittees (or their agents) who are using public land under valid livestock grazing permits. Non-lethal injurious harassment permits shall remain valid for the livestock grazing season in which it is issued provided the livestock operator (on private and public land) is compliant with all applicable laws, including permit conditions. The agency shall inform permit holders (on public and private land) of non-lethal methods for minimizing wolf-livestock conflict, provide guidance upon request, and inform permit holders that receiving future lethal control permits will be contingent upon documentation of efforts to use non-lethal methods. For a non-lethal injurious harassment permit to be issued, the following criteria must apply:

- ODFW confirms wolf depredation on livestock or other wolf-livestock conflict (i.e. testing, chasing, or otherwise disrupting livestock).
- The applicant will work with ODFW to determine appropriate course of action.
- ODFW will consider locations of known wolf dens and the presence of livestock before a permit is issued.
- The harassment does not result in the death of a wolf.
- No identified circumstances exist that are attracting wolf-livestock conflict.
- The harassment must be reported to ODFW within 48 hours.

Relocation may occur when a wolf or wolves become inadvertently involved in a situation or are present in an area that could result in conflict with humans or harm to the wolf. Examples include a wolf caught in a trap set for another animal or a wolf found living within or near communities and causing human safety concerns. This action differs from translocation in that the need is more immediate to solve a particular situation. For such action to occur, four criteria must be met:

- The action must be directed by ODFW.
- The wolf is not known or suspected by ODFW to have depredated livestock or pets.
- The action must be taken to prevent conflict with humans or reduce the possibility of harm to the wolf.
- Wolves will be relocated to suitable habitat at the direction of ODFW.

In Phase I, lethal take of wolves may be authorized in three situations regarding conflict with livestock as described below. Threat to human safety is a fourth situation in which the use of lethal force is allowed under statute and as discussed in Chapter VI of this Plan. As addressed in Chapter III, controlled take is not allowed.

1. A person or the agent of a landowner or lawful occupant may use lethal force to stop a wolf on land the person owns or lawfully occupies without a permit under the following conditions:
   - The wolf is in the act of:
     i. biting, wounding, or killing livestock or working dogs, or
     ii. chasing livestock or working dogs, if non-lethal actions were used per OAR 635-110-0010 8(b)(C) and 8(c) and occurs during a situation of chronic depredation of livestock (determined by ODFW).
   - No bait or other intentional actions to attract wolves have been used.
   - The wolf carcass must not be removed or disturbed, and the scene preserved.
   - The incident must be reported to ODFW within 24 hours.

2. ODFW may authorize its personnel or authorized agents to use lethal control in certain situations of chronic depredation of livestock by wolves. For such action to occur, a number of criteria must apply:
   - Chronic depredation is defined as at least four qualifying incidents of depredation, confirmed by ODFW, of livestock within the previous six months by the same wolf or wolves. A first confirmed depredation in an area outside an "Area of Known Wolf Activity" qualifies toward a situation becoming chronic. Subsequent depredations may only qualify based on the level of non-lethal measures implemented for the situation. See OAR 635-110-0010 (8) for specific rules.
   - Livestock producers in the "Area of Depredating Wolves" have worked to reduce wolf-livestock conflict and are in compliance with wolf protection laws and the conditions of any harassment or take permits.
   - ODFW determines that the situation of wolf depredation upon livestock in the "Area of Depredating Wolves" is likely to remain chronic despite the use of additional non-lethal conflict deterrence measures.
   - The wolf or wolves identified for removal are those ODFW believes to be associated with the qualifying depredations, the removal of which ODFW believes will decrease the risk of chronic depredation in the "Area of

Depredating Wolves".

- ODFW documents and makes publically available its determinations, relevant information and findings related to the depredation situation and any decisions to use lethal control to remedy the situation.
- ODFW lethal control authorization expires when the wolf or wolves targeted for removal are removed, have left the area, or in 45 days after issuance. Under very specific circumstances, additional depredations may result in extension or reinstatement of lethal control actions. See OAR 635-110-0010(10) for specific rules.

3. Under extreme circumstances, ODFW may also authorize the use of lethal force. This decision would be made by the ODFW Director or designee, must be made public and include relevant findings and determinations, and must be exercised within 14 days of the determination or of the last confirmed depredation, whichever comes later. Extreme circumstances means:
   - Four or more confirmed livestock depredations by the same wolf or wolves within a seven day period.
   - No bait or other intentional actions to attract wolves have been used and non-lethal measures are and will likely remain ineffective.
   - Depredation has escalated beyond reasonable, available means of ODFW and affected livestock owners to stop additional depredations from occurring.

Phase II (Transition Phase)

Non-injurious harassment of wolves is allowed under the same conditions as in Phase I.

Non-lethal injurious harassment is conducted for the purpose of minimizing wolf-livestock conflict when livestock are present. It does not require a permit on private land, and therefore is allowed for livestock producers or their designated agents on their own or lawfully occupied land without permit or preauthorization. However, non-injurious techniques should be attempted initially. A permit is required on public land, and may be issued to permittees or their agents who are legally using public land under valid livestock grazing allotments. The injurious harassment permit shall remain valid for the duration of the grazing season in which it has been issued provided the grazing permittee is in compliance with applicable laws including permit conditions.

Regarding non-injurious harassment on private or public land, the following criteria apply:

- Wolves may be pursued, for the purpose of minimizing wolf-livestock conflict.
- Any harassment must be reported to ODFW within 48 hours.
- No identified circumstances exist that are attracting wolf-livestock conflict.

Permit critera for use on public land include:

- ODFW confirms wolf depredation on livestock or other wolf-livestock conflict in the area.
- The permittee will work with the agency to determine the appropriate course of action.
- Locations of known wolf dens will be considered before issuing a permit.

Relocation of wolves will be considered under the same circumstances as in Phase I.

In Phase II, lethal take of wolves may be authorized in situations of conflict with livestock as described below. Threats to human safety is an additional situation in which the use of lethal force is allowed by statute, as discussed in Chapter VI of this Plan. As addressed in Chapter III, controlled take of wolves is not allowed.

1. Landowners, livestock producers, grazing permittees, or their designated agents may use lethal force to stop a wolf that is in the act of biting, wounding, killing, or chasing livestock or working dogs under the following conditions:
   - No bait or other intentional actions to attract wolves have been used.
   - The wolf carcass must not be removed or disturbed, and the scene preserved.
   - The incident must be reported to ODFW within 24 hours.

2. Livestock producers, on land they own or lawfully occupy, or their designated agents, or permittees (or their designated agents) who are legally using public land may be issued a permit that provides authorization to take a gray wolf under the following conditions:
   - The area has had at least two confirmed livestock depredations within a consecutive 9-month period.
   - ODFW designates a lethal control permit area that is within the area of the depredating wolves, and determines that wolves present a significant risk to livestock present in the area.
   - Efforts to use non-lethal methods which are appropriate for the situation are documented.
   - No identified circumstances exist that are attracting wolf-livestock conflict.
   - The recipient of the permit is in compliance with applicable laws, including permit conditions.
   - Wolves taken under these permits are the property of the state and must be reported to ODFW within 24 hours.

3. To stop chronic depredation on private and public land, state personnel or agents are authorized to use lethal force on wolves as follows:
   - The area has had at least two confirmed livestock depredations within a consecutive 9-month period.
   - Efforts to use non-lethal methods which are appropriate for the situation are documented.
   - No identified circumstances exist that are attracting wolf-livestock conflict.
   - Evidence does not exist of non-compliance with applicable laws, including permit conditions.

Phase III (Management Phase)

Non-injurious harassment of wolves is allowed under the same conditions as in Phase I except that the harassment does not have to be reported to ODFW.

Non-lethal injurious harassment is allowed under the same conditions as in Phase II, except that wolf depredation on livestock or other wolf-livestock conflict in the area may be confirmed by either ODFW or USDA Wildlife Services.

Relocation of wolves will be considered under the same circumstances as in Phase I.

In Phase III, lethal take of wolves may be authorized in situations of conflict with livestock as described below. Threats to human safety is an additional yet separate situation in which the use of lethal force is allowed, as discussed in Chapter VI of this Plan.

1. Landowners, livestock producers, grazing permittees, or their designated agents may use lethal force to stop a wolf that is in the act of biting, wounding, killing, or chasing livestock or working dogs under the following conditions:
   - No bait or other intentional actions to attract wolves have been used.
   - The wolf carcass must not be removed or disturbed, and the scene preserved.
   - The incident must be reported to ODFW within 24 hours.

2. Livestock producers, on land they own or lawfully occupy, or their designated agents, or permittees (or their designated agents) who are legally using public land may be issued a permit that provides authorization to take a gray wolf under the following conditions
   - The area has had at least two confirmed livestock depredations within a consecutive 9-month period. Wolf depredation on livestock may be confirmed by either ODFW or Wildlife Services.
   - ODFW designates a lethal control permit area that is within the area of the depredating wolves, and determines that wolves present a significant risk to livestock present in the area.
   - Efforts to use non-lethal methods which are appropriate for the situation are documented.
   - No identified circumstances exist that are attracting wolf-livestock conflict.
   - The recipient of the permit is in compliance with applicable laws, including permit conditions.
   - Wolves taken under these permits are the property of the state and must be reported to ODFW within 24 hours.

3. To stop chronic depredation on private and public land, state personnel or agents are authorized to use lethal force on wolves as follows:
   - The area has had at least two confirmed livestock depredations within a 9-month period. Wolf depredation on livestock or other wolf-livestock conflict may be confirmed by either ODFW or Wildlife Services.
   - Efforts to use non-lethal methods which are appropriate for the situation are documented.
   - No identified circumstances exist that are attracting wolf-livestock conflict.
   - Evidence does not exist of non-compliance with applicable laws, including permit conditions.

4. Controlled take, which requires Commission approval through a separate public rulemaking process, would be by ODFW special permit authorization for the public, and focused on a specific area or situation experiencing conditions that warrant a management response. Regarding livestock conflict, controlled take may be authorized in Phase III in areas to

address situations of long term, recurring wolf-livestock conflict. The take will only address conflict situations in a specified area, and the take would not impair population viability or reduce overall wolf population health factors within the region.

E. Agency Response to Wolf Depredation

Objective

- Develop and implement an effective and transparent wolf depredation response program that responds to the needs of Oregon livestock producers and minimizes the risk of wolf-livestock conflict.

Strategies

- Respond to reports of wolf-livestock complaints in a timely manner (similar to response protocols for cougars and black bears) to investigate the situation, and if appropriate recommend actions to minimize depredation.
- Continue to include wolf responsibilities in the ODFW-Wildlife Services contract in Oregon.
- Ensure that investigations and determinations of wolf depredation are objectively conducted using a consistently applied standard of physical evidence—regardless of the agency performing the investigation.
- Coordinate with USFWS in federally listed areas to reduce wolf-livestock conflict while conserving wolves.

Wildlife Services agents respond to coyote, cougar, and black bear depredation complaints in 26 counties in Oregon. ODFW has historically provided State General and Wildlife License funds to Wildlife Services to address damage from statutorily defined predatory animals, cougar, black bear, furbearers, and wolves. However, future funding for Wildlife Services is contingent on legislative appropriation. Counties, private entities, Oregon Department of Agriculture and others also fund Wildlife Services activities at varying levels.

Federally Listed (ESA) Portion of Oregon

Where wolves are listed under federal ESA in Oregon, ODFW and Wildlife Services implement this Plan within the *2019 Federal/State Coordination Strategy for Oregon Wolf Plan Implementation* (Appendix C). The Strategy outlines roles and responsibilities of each agency and how the agencies will collaborate to implement wolf management in Oregon. The Strategy is under review and will be updated to reflect the current situation in Oregon.

When a livestock owner suspects wolf-livestock depredation and requests an investigation, Wildlife Services, ODFW, and USFWS (or any combination of these agencies) will investigate. The agency receiving a request for an investigation will coordinate with the other two agencies. Initial investigations will be completed on-site, but prior to making a final agency determination or providing public notification on whether a wolf or wolves were responsible (unless it is clear that

wolves were not involved), the investigating agency(s) will confer to review and discuss the evidence found.

- The USFWS is the lead agency for decisions on the use of lethal control and/or injurious harassment in response to depredation. USFWS will coordinate closely with ODFW on the implementation of non-lethal control efforts and on monitoring of wolf activity.
- ODFW, as authorized under its Section 6 permit, is the lead agency for coordinating with affected landowners on non-lethal control actions and for monitoring wolf activity in response to depredation on livestock. ODFW is required to investigate and confirm wolf depredation in situations where the affected livestock producer wishes to pursue compensation payment through the ODA Wolf Depredation Compensation and Financial Assistance Grant Program.
- Wildlife Services are experienced at investigating dead livestock and addressing predation, and will frequently be involved in depredation investigations. They will work with ODFW and USFWS in the federally listed area to investigate livestock depredations and implement and maintain non-lethal tools.

Federally Delisted Portion of Oregon

In federally delisted portions of Oregon, ODFW will continue to respond to wolf complaints and do so in a manner similar to the way the agency handles cougar and black bear damage complaints. Livestock owners with a suspected wolf depredation or other wolf-livestock conflict contact ODFW or Wildlife Services to initiate the investigation process. ODFW would advise Wildlife Services (or the reverse) of the situation and one or both would proceed to the location. The scene would be secured and ODFW and/or Wildlife Services personnel would cooperatively conduct the investigation.

While in Phase I and II, ODFW will make the final determination on investigations of suspected wolf depredation. ODFW, Wildlife Services agents, and the livestock producer will work cooperatively to determine the appropriate response, including non-lethal or lethal techniques (if warranted), to prevent further loss of livestock. The specific response to depredation will depend on wolves' legal status and population levels.

When in Phase III, either ODFW or Wildlife Services may conduct investigations of suspected wolf depredation. Close coordination between the two agencies will be paramount to successful implementation of this Plan. Both agencies will review and implement consistently applied training protocols and standards used when investigating suspected wolf depredation and making determinations. Furthermore, ODFW will continue to rely on objectively conducted and evidence-based investigations, regardless of which agency conducts the investigation. This means that ODFW will not only consider if a depredation is "confirmed," but also the physical evidence associated with the confirmation of depredation when implementing response measures outlined in this chapter. When evaluating an investigation of wolf depredation, ODFW will consider:

- The protocol used when conducting the investigation and its ability to lead to an objective determination.
- The amount of physical evidence or information collected and its ability to inform an accurate determination.
- The level of consistency between the physical evidence documented and the determination of depredation.

- The level of consistency of interpretation of physical evidence with other investigations and determinations.
- Investigations and resulting documentation should be completed at a high professional level.

ODFW's current contract with Wildlife Services includes responding to wolf depredations in addition to cougar and black bear. Continued and perhaps increased funding will be necessary to provide coverage in all counties with wolves in Oregon.

Important Note: At the time of this Plan's adoption, USDA Wildlife Services will not assist in the lethal removal of wolves or expand its role in depredation investigations (including confirming wolf depredations) until it has evaluated its obligations under the National Environmental Policy Act.

F. Livestock Producer Assistance

Objective

- Maintain and enhance a cooperative livestock producer assistance program that proactively minimizes wolf-livestock conflict and assists livestock producers experiencing wolf-related livestock losses.

Strategies

- Provide education, outreach, and technical assistance to landowners and livestock producers to reduce wolf-livestock conflicts.
- Work with livestock producer organizations, county extension services, ODA, conservation organizations, and other appropriate groups and agencies to make outreach and educational materials available regarding depredation prevention (e.g., media materials, workshops, website resources, site reviews and evaluations).
- Provide resources necessary to implement non-lethal wolf deterrent techniques as needed and available.
- Provide training to state and county personnel, volunteers, and cooperators as needed. Training will focus on non-lethal methods to reduce depredation, procedures for securing a depredation scene, preserving evidence, and identification of wolf depredation.
- Continue to support ODA's Wolf Depredation Compensation and Financial Assistance County Block Grant Program.
- Provide landowners and local livestock producers information on areas where wolves are known to be active.

ODFW has a long history of providing assistance to landowners and citizens affected by the actions of various wildlife species. ODFW has specific authority by the Oregon Legislature to manage wildlife populations in the state, guided by the agency's Wildlife Damage Policy. Field biologists respond to and provide assistance for a variety of wildlife damage complaints in both rural and urban settings. The type of assistance provided can take many forms including, but not limited to; technical advice, protective barriers, repellants, lethal or non-lethal removal, emergency hunts, hazing permits, kill permits, and forage enhancement programs.

Working proactively with livestock producers to minimize wolf-livestock conflicts will continue to be an important component of a livestock producer's assistance program. Sharing new information and techniques related to reducing potential wolf-livestock conflicts and making available the necessary tools and equipment will be essential for a successful program. ODFW will continue to work with other states, organizations, tribes, and academic institutions to develop and refine preventive measures which reduce overall wolf-livestock conflicts.

In 2012, the ODA established and implemented a Wolf Depredation Compensation and Financial Assistance grant program (ORS 610.150) to assist livestock producers with costs associated with wolf depredation and non-lethal control measures. Funds from this grant program are awarded to counties to help create and implement county wolf depredation compensation programs under which:

- Compensation is paid to persons who suffer loss or injury to livestock or working dogs due to wolf depredation.
- Financial assistance is provided to persons who implement livestock management techniques or non-lethal wolf deterrence techniques designed to discourage wolf depredation of livestock.
- Awards are only available to producers through counties with a wolf depredation compensation program to help with implementation and administrative costs.

The program is currently funded through a combination of federal grant funds, and funds in the Wolf Management Compensation and Proactive Trust Fund established by the Oregon Legislature in 2011 (ORS 610.155). Funds are made available to producers through Oregon counties participating in the program. In 2017, a total of 10 participating counties were awarded $252,570 in grant funds. ODFW assists with the implementation of this program through two primary roles: determining when wolf depredation occurs and delineating areas of known wolf activity. In addition, ODFW will continue to provide input to counties on appropriate non-lethal and preventative measures. For additional information regarding the program, see http://staging.apps.oregon.gov/oda/programs/ISCP/Pages/WolfDepredation.aspx.

Attaching radio-collars and monitoring members of established wolf packs can provide important information regarding wolf movements in relation to areas used by livestock. Continued coordination between ODFW biologists and livestock producers regarding current wolf movements and historical activity areas will allow livestock producers to anticipate potential conflict areas and respond appropriately. Livestock producers would have the option of making informed decisions regarding their animal husbandry practices in response to knowledge of wolf activity in livestock areas.

V. WOLF-UNGULATE INTERACTIONS AND INTERACTIONS WITH OTHER CARNIVORES

Oregon has native populations of elk, mule deer, white-tailed deer, black-tailed deer, bighorn sheep, mountain goats, and moose. These ungulates have high social, biological, economic, and recreational value in Oregon, and are also an important food source for native carnivores. Revenue generated from hunting is important to rural communities (Martin and Gum 1978, Fried et al. 1995, Sarker and Surry 1998), and license and tag sales provide funding for wildlife and conservation activities implemented by ODFW (Geist et al. 2001). Consequently, managers are presented the challenge of maintaining ungulate populations which are capable of sustaining carnivore populations and recreational hunting opportunities for the public, while minimizing agricultural damage.

In addition to their recreational and economic importance, ungulates also play an important role in shaping and structuring ecological communities. Large herbivores consume large amounts of plant biomass that can influence vegetation and ecosystem structure (Hobbs 1996, Augustine and McNaughton 1998, Weisberg and Bugmann 2003, Wisdom et al. 2006). Furthermore, large herbivores are important for conservation of sustainable carnivore populations (Wolf and Ripple 2016). In some situations, large carnivores can influence herbivore population abundance and behavior, which may affect lower trophic levels and ecosystem structure (Ripple and Beschta 2004b, Berger et al. 2008, Ripple et al. 2010, Estes et al. 2011, Newsome and Ripple 2014, Ripple et al. 2015, Wilmers and Schmitz 2016, Winnie Jr and Creel 2016).

For years, Oregon has sustained populations of several medium and large carnivores that are known to prey upon ungulates including black bear, cougar, coyote, and bobcat. The recent recolonization by wolves has undoubtedly added complexity to ungulate population dynamics within the state. However, the effects of wolves on native ungulate populations are difficult to determine because of the complex multiple-prey, multiple-predator system and unique climate observed in Oregon. There is a large body of literature to suggest a complex suite of abiotic, bottom-up, and top-down forces including hunter harvest, predation, primary productivity, and climatic conditions that may be limiting or regulating factors of ungulate population dynamics (Crête 1999, Melis et al. 2009, Griffin et al. 2011, Brodie et al. 2013, Johnson et al. 2013). In some instances, non-predation related mechanisms, such as high levels of harvest by humans, extreme summer or winter weather, or habitat changes may be the ultimate driver of ungulate declines (Vucetich et al. 2005, White and Garrott 2005, Wright et al. 2006, Middleton 2012, Brodie et al. 2013, Middleton et al. 2013a). These factors may work independently or synergistically to affect ungulate populations and the relative magnitude of each effect may differ depending on local conditions. Consequently, the relative effects of wolf predation in Oregon are likely to be situation dependent and influenced by additional localized or regional factors. Despite Oregon's unique climate and assemblage of predators and prey, there is a large body of literature upon which the potential effects of wolves on native ungulate populations may be assessed. This chapter will provide a summary of potential effects of wolves on ungulate populations and provide preliminary information about wolf predation in Oregon.

A. Potential Effects of Wolf Predation on Oregon's Ungulates

The concepts of compensatory and additive mortality represent two ends of the spectrum of predation-caused mortality and are key in understanding the effects of predators on ungulate

populations. In general, predation can be considered compensatory mortality when it compensates for some other source of mortality – that is, an animal that was killed by a predator would have otherwise died from some other source (e.g., overwinter starvation). In contrast, predation is considered to be additive to other sources of mortality in situations where individuals removed by predation likely would have otherwise survived. In some situations, wolf predation may be compensatory because wolves are known to kill vulnerable or weak animals and remove less fit individuals from the population (Boyd et al. 1994, Peterson and Ciucci 2003, Smith et al. 2004, White and Garrott 2005). However, wolves are also known to kill relatively healthy animals, particularly during advantageous hunting conditions (e.g., deep snow) (Nelson and Mech 1986, Mech et al. 2001), and in these situations the mortality may be additive. Determining the degree to which predation is additive or compensatory is difficult and often relies on controlled experiments with results often confounded by climatic conditions or other factors interacting with predation (Mech et al. 2001, Hebblewhite 2005, Vucetich et al. 2005). While predicting the effect of wolves on Oregon's ungulate populations is difficult, a review of research conducted elsewhere can provide a better understanding of the potential effects.

Elk

Wolves are effective predators of elk and in areas where they co-occur, elk are typically the primary prey of wolves, with predation focused on calves and older adults (Mech and Peterson 2003). Preliminary examination of wolf diets in the Wenaha and Mt. Emily WMUs in northeast Oregon supports this conclusion (ODFW, unpublished data).

In a meta-analysis of 12 elk populations, calf survival through summer was investigated in systems with three (cougars, black bear, coyotes), four (addition of wolves) and five (addition of grizzly bear) predators. The addition of wolves to the system resulted in similar calf survival, with wolf predation nearly compensatory for mortality caused by other existing predators (Griffin et al. 2011). Other studies highlighted that wolves, owing to their coursing hunting style, typically selected physically disadvantaged and older, or younger-aged prey that might otherwise succumb to severe winter or summer drought conditions (Vucetich et al. 2005, Atwood et al. 2007, Barber-Meyer et al. 2008, Metz et al. 2012), further illustrating the generally compensatory nature of wolf predation on elk calves.

When preying on adult elk, wolves typically kill older animals (Boyd et al. 1994, White and Garrott 2005, Evans et al. 2006, Wright et al. 2006, MacNulty et al. 2016). Older cow elk can be reproductively senescent (Stewart et al. 2005) and contribute little to population growth rates(Gaillard et al. 1998, Raithel et al. 2007). Furthermore, older elk typically have lower survival rates than younger elk (Evans et al. 2006, McCorquodale et al. 2011, Clark 2014) and are more likely to die during severe winters or other adverse environmental conditions (Garrott et al. 2003, Garrott et al. 2009, Brodie et al. 2013). This suggests that wolf predation on these individuals is largely compensatory (Garrott et al. 2009) and will have minimal effects on elk population growth rates.

While wolf predation on adult elk, particularly older animals, appears to be largely compensatory, wolf predation combined with predation from all other native carnivores in western North America reduced survival of cow elk by <2% (Brodie et al. 2013). While reductions in cow elk survival can reduce population growth rates of elk (Gaillard et al. 1998, Raithel et al. 2007) this small decline in cow survival is unlikely to reduce sustainability of elk populations, but may affect antlerless elk hunting opportunity. Wolves will also prey upon bull elk (Mech and Peterson 2003). The number of

bull elk in the population has little influence on population growth rates, so long as sufficient numbers of prime-aged males are in the population to breed females during their first estrous cycle (Noyes et al. 1996). Wolves are unlikely to kill enough bull elk to cause this situation to occur, but removal of bull elk from the population through wolf predation could ultimately reduce availability of bull elk to hunters.

In multiple prey systems, predators may either utilize prey opportunistically (e.g., kill prey as encountered) or they may selectively prey upon a particular species or age class of prey (e.g., actively seek out juvenile ungulates). In Oregon, selective predation on juvenile age classes of elk can have strong effects on recruitment (Johnson et al. 2013, Clark 2014, Proffitt et al. 2014), which explains a large amount of variation in population growth rates of elk (Harris et al. 2008). Given the large effect that variation in calf elk survival can have on elk population dynamics (Raithel et al. 2007), wolf predation on calves may have a large effect on elk populations in areas with high predation rates on calf elk by cougars (Clark 2014).

In addition to the direct effects of wolf predation on elk, wolves may also have a number of indirect effects. Wolves tend to be inefficient hunters and are rarely successful at more than 20% of attempted hunts (Smith et al. 2000, Mech et al. 2001) and success is less than 10% when only adult elk are the prey being hunted (MacNulty et al. 2011). As a result, wolves continually test prey to identify weak individuals (Peterson and Ciucci 2003) and this near constant hunting pressure and risk of predation from wolves could lead to changes in behavior that influence elk habitat use, vigilance, movement rates, and migration patterns. If predation risk causes elk to utilize areas of lesser forage quality for long durations, increase movement rates, or spend less time feeding, elk fitness and reproductive potential would be expected to decline (Creel et al. 2009). Additionally, in situations where elk must allocate more time to scan for predators, they may become nutritionally challenged, which could reduce pregnancy rates (Cook et al. 2004, Cook et al. 2013, Cook et al. 2016) or survival (Cook et al. 2004, Bender et al. 2008). However, little research has linked the anti-predator behaviors discussed above to reduced fitness and/or reproductive output of ungulates (Lind and Cresswell 2005).

In some situations, elk have utilized habitat differently following wolf colonization (Creel et al. 2005, Mao et al. 2005, Atwood et al. 2009). These studies found that elk avoided open areas, used areas with less snow, and used steeper terrain to reduce predation risk. Within winter ranges, the mosaic of open, risky sites and safer areas with denser vegetation allowed elk to reduce predation risk (Kauffman et al. 2007). Elk moved from open grasslands to forested areas (which may be avoided by wolves, Kunkel and Pletscher 1999) in areas of higher wolf density (Creel et al. 2005, Fortin et al. 2005b). In some areas, elk utilized more structurally complex landscapes following wolf colonization which may have reduced their vulnerability to wolf predation, but increased their susceptibility to cougars (Atwood et al. 2009). This was supported by the proportion of elk in cougar diets having increased significantly over the duration of the study (Atwood et al. 2007). This is a possibility that could occur in Oregon, where cougars selectively prey upon calves (Clark 2014), though it has not been observed to date (ODFW, unpublished data).

In some landscapes, elk can mitigate the risk of predation by movement and habitat selection (Kauffman et al. 2007). In areas of Montana, elk abandoned traditional calving grounds near wolf dens (Hamlin and Cunningham 2009), though this has not been documented in Oregon. In other areas, elk showed decreased fidelity to winter ranges (Barber-Meyer et al. 2008), abandoned winter ranges altogether, and formerly non-migratory herds began to display migratory behavior (Eisenberg

2012). Large portions of two major elk herds in and near Banff National Park have become non-migratory, using areas near human development where human activity reduced wolf presence and therefore, predation risk (Hebblewhite et al. 2002, Idaho Department of Fish and Game 2010). This was despite the fact that migration afforded higher quality forage to elk (Middleton 2012, Middleton et al. 2013a). This suggests elk may actively reduce risk of predation by changing habitat use despite the negative consequences of utilizing lower quality habitat.

Several studies have shown increased vigilance rates by elk in areas wolves occur and as wolf density increases (Laundré et al. 2001, Wolff and Van Horn 2003, Eisenberg 2012). However, Middleton (2012) and Gower et al. (2009) noted that predation risk did not translate to generalized alertness in elk. For example, elk did not reduce foraging time even when wolves were in close proximity (Middleton et al. 2013b). Several researchers suggest that elk are able to scan for predators while chewing (Fortin et al. 2004a, Gower et al. 2009, Middleton 2012, Middleton et al. 2013b), and Fortin et al. (2004b) demonstrated that elk only slightly reduce their bite rate when engaged in vigilant behaviors and fitness may not be affected. This was supported by Middleton et al. (2013b) where predation risk did not impact spring body fat levels of elk. Further, others have not detected changes in nutritional indices for elk before and after wolf reintroduction (White et al. 2009) and body fat levels were adequate to prevent fitness-induced pregnancy loss (White et al. 2011).

In many areas, direct predation by wolves cannot fully explain decreased calf recruitment which prompted inquiry into the potential consequences of wolf-induced fear and stress on elk pregnancy rates (Creel et al. 2007, Creel et al. 2009, Hamlin et al. 2009, Creel et al. 2011, White et al. 2011). Creel et al. (2007) documented decreased progesterone in fecal samples of elk exposed to chronic predation risk, which could reduce pregnancy rates, and progesterone concentrations were predictive of calf recruitment. Garrott et al. (2009) also detected decreased pregnancy rates for elk subjected to wolf predation risk and proposed this occurred because of either elk anti-predatory behaviors in response to wolf presence or nutritional deficiencies in elk due to prolonged drought. However, others have observed no decrease in pregnancy rates since wolf reintroduction (Hamlin and Cunningham 2009, White et al. 2011). Furthermore, the link between pregnancy rates and calf recruitment ignored predation costs on calf survival (White et al. 2011) and new information showing that calves comprised the majority of summer wolf diets was not considered (Metz et al. 2012). Given the equivocal patterns observed in changes in body condition and pregnancy rates of elk exposed to wolf predation risk, it is difficult to determine the degree to which wolves will effect body condition and pregnancy rates of elk in Oregon, if at all. For example, Middleton et al. (2013b) concluded that effects of wolf predation are more likely to occur through direct consumption of prey, rather than indirect, non-consumptive effects on prey behavior.

Northern Yellowstone Elk Herd

The documentation of long-term decline of the northern Yellowstone elk herd highlights the difficulties in determining the effects of predation on ungulate populations. While it is clear that the northern Yellowstone elk herd declined since the reintroduction of wolves, the role and magnitude of wolf predation in this decline is not clear (MacNulty et al. 2016). When preying upon adult elk, wolves in Yellowstone consistently preyed upon older individuals (>10 years; MacNulty et al. 2016) and this will translate to minimal effects on elk population size (Wright et al. 2006, Eberhardt et al. 2007).

Approximately half of the elk killed by wolves in the northern Yellowstone elk herd were calves (Smith et al. 2004, Wright et al. 2006, Metz et al. 2012). The effect of wolves on calf recruitment is likely having the greatest effect on the northern Yellowstone elk herd, but the exact role that predation on calves plays on elk population dynamics is not well understood given predation is often compensatory (Proffitt et al. 2014). While calf elk represent a large proportion of wolf-killed prey in the northern Yellowstone system (Metz et al. 2012), wolves do not necessarily contribute to reduced survival rates of calves. Overwinter calf survival prior to wolf reintroduction (Singer et al. 1997) was similar to following wolf reintroduction (Barber-Meyer et al. 2008) even though wolf densities were at the highest observed since reintroduction (Cubaynes et al. 2014). In contrast, survival during the summer prior to wolf reintroduction (Singer et al. 1997) was over twice as high as observed following reintroduction (Barber-Meyer et al. 2008). Since wolf reintroduction, predation on calves from black and grizzly bears more than doubled, which corresponded with increased grizzly bear numbers (Kamath et al. 2015). Cougar numbers also increased 76% from 1987-1993 and 1998-2004 (Ruth et al. 2017), but despite this increase, cougars were responsible for similar amounts of predation before (1.5%) and after (2.6%) wolf reintroduction (Singer et al. 1997, Barber-Meyer et al. 2008). Further, it appears wolf predation in the absence of grizzly bears is largely compensatory for cougar predation (Griffin et al. 2011). Given the observed changes in several carnivore populations, it is difficult to determine the relative role of wolves in decreased summer calf survival.

Hunter harvest likely also contributed to some of the declines by removing a larger proportion of prime-aged cow elk compared to wolves (Lemke et al. 1998, Vucetich et al. 2005). The combined effect of human harvest (focused on prime-aged cows) and predation from multiple carnivores (focused on calves) on two critical age classes for elk population growth (Gaillard et al. 1998, Raithel et al. 2007) likely contributed to population declines in elk observed from the late 1990s to mid-2000s. Under high levels of predation on calves, even minimal hunting pressure on cow elk can result in reduced survival (Brodie et al. 2013) and population declines (Vucetich et al. 2005, Clark 2014). Consequently, managers may need to consider reducing antlerless elk harvest in some situations following wolf colonization, as was eventually done for the Northern Yellowstone elk herd (Loveless 2015).

Effects of Wolves in Other Areas

Hebblewhite et al. (2002) compared population dynamics of elk herds in the absence and presence of wolf predation in Banff National Park. They found that in areas without wolves, elk populations were regulated by density-dependent mechanisms and limited by human-caused mortality. Elk populations subjected to wolf predation were primarily limited by the combined effects of snow depth and wolf predation; however, snow depth was not a significant predictor of population dynamics of elk prior to wolf recolonization, suggesting an interacting effect of climate and predation. This finding that ungulate populations are largely regulated by habitat and climate in the absence of wolf predation is similar to research conducted on other ungulate populations in North America (Messier 1991, Gasaway et al. 1992, Sæther 1997, Singer et al. 1997, Gaillard et al. 1998, Taper and Gogan 2002). Ungulate abundance may be restricted as a result of the interplay between predation and low vegetative productivity and/or harsh climate conditions (Hebblewhite 2005, Melis et al. 2009, Brodie et al. 2013). These results may be an artifact of the increased vulnerability of ungulates to predation when escape is hindered by deep snow and/or animals experience decreased fitness due to climate-related energy loss and food stress (Hebblewhite et al. 2002, Hebblewhite 2005). These findings also highlight the interactive effects of the habitat and climate with wolf predation that make it difficult to generalize the effects of wolves on prey.

Wolf predation has likely contributed to declines in some Idaho elk populations, but wolf predation alone does not explain the magnitude of these declines. For example, elk population declines in central Idaho were primarily caused by decreased habitat quality as a consequence of decades of fire suppression and reductions in timber harvest, as well as extreme winter conditions in the mid-1990s (Idaho Department of Fish and Game 2006, White et al. 2010). Bear and wolf predation exacerbated these declines and elk populations have yet to recover (Idaho Department of Fish and Game 2006, White et al. 2010). A similar situation appears to have occurred in the Bitterroot Valley, Montana, where prior to wolf re-establishment in 2002, elk population declines appear to have been initiated by a combination of high antlerless harvests, habitat factors resulting in poor elk body condition and low pregnancy rates (<70%), and a growing cougar population (Hamlin and Cunningham 2009, K. Proffitt, Montana Fish, Wildlife, and Parks [MFWP], personal communication). Research is ongoing in the Bitterroot Valley to understand the mechanisms driving this population trend.

Deer

Predation effects on deer appear to be largely influenced by the relation of deer to ecological carrying capacity (Ballard et al. 2001). Populations near carrying capacity, while heavily preyed upon, do not respond well to predator control (Ballard et al. 2001), and predation mortality is largely compensatory. When deer populations are below carrying capacity, predation has the potential to be additive and predators will have a larger effect on deer populations. In general, it is thought that deer populations tend to be directly regulated by factors other than predation (Ballard et al. 2001, Bergman et al. 2015).

Mule Deer

In much of Oregon, mule deer ranges overlap with elk. Consequently, in these areas of overlap, deer are likely to be secondary prey for wolves because elk typically dominate wolf diets in these systems (Mech and Peterson 2003). Preliminary data from Oregon supports this assertion where wolf diets were >70% elk (ODFW, unpublished data). While deer can make up >20% of wolf diets in some areas (Mech and Peterson 2003), the low rate of predation on deer in areas where elk occur suggests it is unlikely wolves will have a large direct effect on mule deer populations. In areas where deer occur in the absence of elk in Oregon (i.e., southeastern Oregon) it is likely that the available prey base will only support a low density wolf population (Fuller et al. 2003a, Mech and Peterson 2003, Peterson and Ciucci 2003). Information on effects of wolves in systems where mule deer are the primary prey is limited and it is difficult to assess the effect wolves will have in these single prey systems. Wolves can reduce coyote densities, at least temporarily (Crabtree and Sheldon 1999, Hebblewhite and Smith 2009), which could reduce any potential effects of coyotes on deer as seen in pronghorn (Berger and Conner 2008, Berger et al. 2008) and any predation from wolves may substitute for reduced coyote predation.

Given their low prevalence in wolf diets, wolves are unlikely to have large direct effects on mule deer populations. However, wolves may indirectly contribute to increased predation by cougars. Cougars are the primary predator of deer in western North America (Iriarte et al. 1990) including Oregon (Clark 2014). Wolves may cause cougars to utilize steeper terrain (Buotte et al. 2005), which is more likely to be used by mule deer (Johnson et al. 2000, Ager et al. 2003), increasing their use of mule deer (Elbroch et al. 2015a). In Oregon, cougars occupying the Mt. Emily WMU had similar amounts of mule deer in their diets before (Clark 2014) and after (ODFW, unpublished data) wolves

colonized the area. Wolves may also influence changes in behavior and population reductions of cougars (Buotte et al. 2005, Bartnick et al. 2013, Ruth et al. 2017) and coyotes (Arjo and Pletscher 1999, Switalski 2003a, Berger and Conner 2008, Merkle et al. 2009, Newsome and Ripple 2014) and predation pressure on deer may be reduced. This relationship has been suggested for pronghorn, where fawn survival increased following the reintroduction of wolves and reduction in coyote densities (Berger et al. 2008), but it is not known if this will occur with cougars and mule deer.

Black-tailed Deer

Evidence exists that wolves may reduce black-tailed deer populations. For example, wolves introduced to a small island where they previously did not exist caused deer populations to approach extinction (Klein 1995). Cougars and wolves were significant predators of doe deer on Vancouver Island (McNay and Voller 1995) and experimental reductions of wolf populations led to increased fawn survival (Atkinson and Janz 1994) and population growth (Hatter and Janz 1994). Additionally, in southeast Alaska, deer density is higher on islands without wolves compared to those occupied by wolves (Smith et al. 1987). These studies are restricted to islands and in areas with single-prey systems, and the results may not translate well to Oregon. Black-tailed deer in Oregon have extensive range overlap with Roosevelt elk, which are likely to be the primary prey of wolves (Mech and Peterson 2003). Consequently, the magnitude of wolf predation on black-tailed deer in Oregon is likely to be less than observed in single prey systems. However, the effect of wolves on black-tailed deer in multiple prey systems is not well understood at this time.

White-tailed Deer

Wolf predation on white-tailed deer can be substantial (Messier 1991, Mech and Peterson 2003), but effects of wolf predation is largely dependent on winter severity, habitat, and presence of alternative prey (Nelson and Mech 1986 , Fuller 1990, Nelson and Mech 1991, Mech and Peterson 2003, Peterson and Ciucci 2003). White-tailed deer population declines have been observed in areas with a combination of severe winters (Post and Stenseth 1998, DelGiudice et al. 2002), high human exploitation (Fuller 1990, DelGiudice et al. 2002), and wolf predation (Messier et al. 1991, Post and Stenseth 1998). However, there is little evidence available to suggest that wolf predation alone will negatively affect white-tailed deer populations (Mech and Peterson 2003).

Columbian white-tailed deer occur at lower densities in western Oregon and have a more limited distribution than white-tailed deer in eastern Oregon. Columbian white-tailed deer are unlikely to serve as the primary prey of wolves given their relatively low population size. In situations where wolf numbers are determined by their primary prey, which is likely to be elk, and they selectively prey upon small populations of Columbian white-tailed deer, wolves could negatively affect this prey population. This type of scenario has been observed with endangered woodland caribou (Wittmer et al. 2005, Bergerud et al. 2007) and opens the possibility of selective predation on a rare secondary prey also being observed in Oregon. The probability of this scenario occurring in Oregon is unknown at this time.

Moose

Moose occur at low densities in northeast Oregon, with known populations less than 100 individuals (ODFW, unpublished data). While moose can be an important component of wolf diets (Mech and Peterson 2003), the low density of moose in Oregon will reduce wolf hunting efficiency. Successful

hunting opportunity for wolves is a combination of encounter rates (i.e., how frequently wolves locate moose) and ability to kill (i.e., locating a vulnerable individual) (Peterson and Ciucci 2003). Given the current low moose abundance, wolves will infrequently encounter moose and will likely kill few individuals. However, given the small population size of moose, even limited predation may negatively affect their populations, especially if reproductively valuable cow moose are killed. Oregon's moose population occurs at the edge of the species range and moose at the boundaries of their southern range have inherently low population growth rates (Ruprecht 2016). This will cause moose to have a low potential growth increment, and wolf predation may occur at a high enough level to affect the moose population.

While monitoring has been limited, wolves did not kill any radio-collared adult moose in northeast Oregon and no moose were documented in wolf diets during winter monitoring of predation of the Wenaha wolf pack (ODFW, unpublished data) where a large proportion of Oregon's moose population occurs. However, wolf predation on moose may be most common during summer when wolf predation is focused on calves (Mech and Peterson 2003) and we currently do not have data to determine the degree to which wolves in Oregon prey upon calf moose.

Bighorn Sheep and Mountain Goats

Wolves are a coursing predator that typically relies on open and flat habitats to successfully capture prey (Peterson and Ciucci 2003). Bighorn sheep and mountain goats typically occupy steep and extremely rugged terrain which limits the effectiveness of wolves to successfully kill these species and is the primary attribute these species use to escape wolf predation (Mech and Peterson 2003). While wolves are known to kill bighorn sheep and mountain goats, success rates are low, and wolves typically have a lower percentage of these species in their diet than is available on the landscape (Peterson et al. 1984, Huggard 1993, Dale et al. 1995, Mech and Peterson 2003), likely because they have low habitat overlap with wolves. Consequently, wolves are unlikely to have a large direct effect on bighorn sheep and mountain goat populations in Oregon.

In contrast to wolves, cougars can be effective predators of bighorn sheep and mountain goats, although predation may be sporadic and is often the result of specialized predation by a few individuals (Ross et al. 1997, Logan and Sweanor 2001). Wolves may indirectly affect bighorn sheep and mountain goat populations if they cause shifts in cougar distributions and habitat use. Evidence exists that cougars may spatially avoid wolves by using more rugged habitats (Akenson et al. 2005, Buotte et al. 2005, Ruth et al. 2017). This may cause cougars to spend more time in areas occupied by bighorn sheep and mountain goats and could lead to increased predation from cougars as encounter rates between cougars and prey increase. This relationship has not been documented in Oregon where cougars have more abundant prey species (e.g., deer) available in most areas.

B. Elk and Mule Deer Populations since Wolf Re-establishment

Ungulate and wolf populations are now interacting in at least nine WMUs in northeast Oregon. At the WMU level, these interactions have occurred from between four to ten years based on documented wolf establishment. In six of the nine WMUs, elk populations increased to varying degrees after a wolf group or pack was established in the WMU (Table 2). Declines were observed in the Chesnimnus, Imnaha, and Sled Springs WMUs. However, interpretation of the impact on wolf predation on elk populations in these WMUs are confounded by management efforts to reduce

the elk population through antlerless harvest to minimize conflicts with elk on private land. Additionally, the highest observed change in population size (Wenaha WMU) is confounded by management efforts to reduce cougar numbers in that unit, which corresponded with increased calf survival and population growth rates of elk (Clark 2014). Calf recruitment measured by late winter calf ratios varied across the area and through time with a generally increasing trend in two WMUs, declining trend in two WMUs, and a generally static trend in five WMUs.

Table 2. Trend in Rocky Mountain elk populations for Wildlife Management Units with at least one established wolf pack in northeastern Oregon. Population estimates within a WMU column become bold and shaded the year a wolf pack was documented in the WMU.

Year	Catherine Creek	Chesnimnus	Imnaha	Minam	Mt Emily	Sled Springs	Snake River	Walla Walla	Wenaha	Total Elk Estimate
2003	450	2,900	950	1,800	4,800	2,100	3,000	1,500	1,150	18,650
2004	450	2,900	1,000	2,000	4,600	2,150	3,350	1,500	1,400	19,350
2005	650	3,000	1,100	2,000	4,300	2,100	3,400	1,450	1,350	19,350
2006	800	3,100	1,100	2,100	3,900	2,600	3,500	1,400	1,450	19,950
2007	800	3,400	1,100	2,100	2,500	2,600	3,700	1,500	1,600	19,300
2008	1,000	3,400	1,200	2,100	4,600	2,600	3,700	1,500	1,600	21,700
2009	1,250	3,500	**2,200**	2,100	3,000	2,500	4,000	1,500	**1,600**	**21,650**
2010	1,100	3,700	**2,200**	2,100	3,000	2,500	4,000	1,500	**1,500**	**21,600**
2011	1,050	3,700	**2,200**	2,100	**2,800**	2,500	**4,000**	**1,500**	**1,600**	**21,450**
2012	1,150	5,300	**2,250**	**2,300**	**2,900**	2,700	**4,000**	**1,500**	**1,800**	**23,900**
2013	1,500	5,200	**2,300**	**2,400**	**3,000**	3,000	**4,350**	**1,600**	**2,350**	**25,700**
2014	1,350	**5,000**	**2,200**	**2,450**	**3,100**	3,100	**4,300**	**1,600**	**2,450**	**25,550**
2015	**1,050**	**5,100**	**2,000**	**2,500**	**3,100**	**3,100**	**4,300**	**1,600**	**2,550**	**25,300**
2016	**900**	**4,500**	**2,000**	**2,500**	**3,200**	**3,100**	**4,300**	**1,700**	**2,600**	**24,800**
2017	**1,750**	**4,400**	**2,000**	**2,500**	**3,200**	**2,900**	**4,400**	**1,750**	**2,700**	**25,600**
2018	**1,450**	**4,400**	**2,000**	**2,600**	**3,300**	**2,800**	**4,600**	**1,700**	**2,700**	**25,550**

In contrast to elk, mule deer populations in all nine WMUs with established wolves in northeast Oregon have fewer mule deer in 2018 than when a wolf pack became established in the WMU (Table 3). However, the observed decline in mule deer numbers generally began prior to establishment of wolves (Table 3). Similar population declines have also been observed throughout most of Oregon's mule deer range. Fawn recruitment measured by late winter fawn also varied across the area and through time and tended to stay within the long term range of variability. In general, it is broadly thought that deer populations tend to be regulated by factors other than predation (Ballard et al. 2001, Bergman et al. 2015). Consequently, the degree to which wolves have contributed to population changes in northeast Oregon is unknown.

Table 3. Trend in mule deer populations for Wildlife Management Units with at least one established wolf pack in northeastern Oregon. Population estimates within a WMU column become bold and shaded the year of wolf pack establishment.

Year	Catherine Creek	Chesnimnus	Imnaha	Minam	Mt Emily	Sled Springs	Snake River	Walla Walla	Wenaha	Total Deer Estimate
2003	1,750	3,600	4,800	3,500	4,600	4,800	2,600	1,800	1,200	28,650
2004	1,700	3,500	4,800	3,500	4,100	4,800	2,600	1,850	1,300	28,150
2005	1,500	3,600	4,500	3,700	4,200	4,900	2,800	1,850	1,400	28,450
2006	2,000	4,100	4,300	4,300	4,750	9,100	2,400	2,000	3,000	35,950
2007	1,700	3,400	4,200	4,000	5,000	8,300	2,350	1,995	2,950	33,895
2008	1,950	2,850	4,150	3,650	5,000	7,650	2,400	1,950	2,600	32,200
2009	1,850	2,600	**4,000**	3,150	4,900	7,450	2,300	1,850	**2,900**	**31,000**
2010	1,250	3,050	**4,400**	3,350	4,750	8,000	2,400	1,750	**2,900**	**31,850**
2011	1,700	3,300	**4,350**	3,200	**4,750**	8,000	**2,550**	**1,800**	**2,600**	**32,250**
2012	1,300	3,200	**3,600**	**3,300**	**4,550**	7,200	**2,400**	**1,700**	**2,650**	**29,900**
2013	1,300	3,350	**3,700**	**3,300**	**3,500**	7,200	**2,500**	**1,730**	**2,700**	**29,280**
2014	1,700	**3,300**	**2,700**	**2,300**	**3,650**	5,800	**2,700**	**1,770**	**2,750**	**26,670**
2015	**1,650**	**3,400**	**3,000**	**2,600**	**3,800**	**6,400**	**2,900**	**1,800**	**2,600**	**28,150**
2016	**1,500**	**3,400**	**3,000**	**2,600**	**3,800**	**6,400**	**2,900**	**1,800**	**2,600**	**28,000**
2017	**1,100**	**3,400**	**3,000**	**2,600**	**3,700**	**6,000**	**2,900**	**1,750**	**2,400**	**26,850**
2018	**1,550**	**2,700**	**2,500**	**2,000**	**3,650**	**6,000**	**2,200**	**1,700**	**2,250**	**24,550**

C. Big Game Wildlife Management Units and Management Objectives

ODFW established WMUs and management objectives (MOs) to manage deer and elk populations and hunter numbers. WMUs were established to allocate harvest and distribute hunters rather than delineate big game species herd ranges. WMUs are long standing geographic areas with boundary descriptions and maps printed in the annual Oregon Big Game Regulations pamphlet. MOs are the number of deer and elk that ODFW strives to maintain in each WMU in the state (*see* Figures 8 and 9 for maps of WMUs).

There are two types of MOs for each WMU. MOs for deer and elk are set for both the population size and the desired ratio of bucks per 100 does (buck ratio) and bulls per 100 cows (bull ratio). Annual herd composition information, including buck, bull, and spring fawn and calf to adult ratios, are used to monitor the adult male population segment and the recruitment of young animals into the population. Management strategies are designed to maintain population characteristics near MOs.

When ODFW determines MOs for deer and elk in a WMU, a variety of factors are considered. These include landowner tolerance, habitat, land ownership, winter range, carrying capacity and public access. How each factor influences the final MO varies by species and the unique circumstances of each management unit. The primary consideration for each MO is the department's statutory obligation to prevent the serious depletion of indigenous wildlife, provide

optimum recreational and aesthetic benefits, and maintain populations at levels compatible with the primary uses of the land. In areas where deer and elk winter primarily on private lands, damage to private property is a critical factor influencing MOs.

Elk Population Information

Currently, nearly two thirds of the Rocky Mountain elk populations (63%) are at or above desired population MO for the WMU (Figure 8). Conversely for Roosevelt elk only 19% of the WMUs are at or above population MO (Figure 9). Generally, where populations are below MO, particularly in western Oregon, poor habitat conditions, human-caused factors, and possibly predation are contributing to low calf ratios that may be depressing populations. In 2018, the statewide elk population was estimated to be about 132,000 of which about 72,000 were Rocky Mountain and 60,000 were Roosevelt elk.

Mule Deer Population Information

John Fremont reported few deer or other big-game species in southeastern Oregon during the 1840s. However, by the late 1850s, gold miners traveling from California to the Boise Basin found deer abundant in eastern Oregon. Vernon Bailey (1936) estimated Oregon's mule deer population to be 39,000 to 75,000 animals from 1926 to 1933. Mule deer populations increased through the 1930s and 1940s, peaking during the mid-1950s, mid-1960s, and mid-1970s. The estimated spring population in 1990 was 256,000 animals, 26 percent below the established statewide management objective of 344,900 as listed in the Oregon Mule Deer Plan (ODFW 1990). The estimated 2018 population was 190,500 and continues to remain below established MOs in 47 of 49 WMUs (Figure 8).

Black-tailed Deer Population Information

Black-tailed deer populations are declining in many areas of western Oregon. Habitat changes (resulting from changes in timber management practices including dramatic reductions in timber harvest on federal property), diseases (particularly deer hair loss syndrome), and predation (bobcats, coyotes and cougars) are factors contributing to recent declines. There are no MOs for black-tailed deer. In 1998, the black-tailed deer population was estimated at approximately 387,000. Current black-tailed deer population trend information is not available for all areas; but available information indicates the population has declined since that time. The current black-tailed deer population for Oregon is estimated at approximately 320,000 animals.

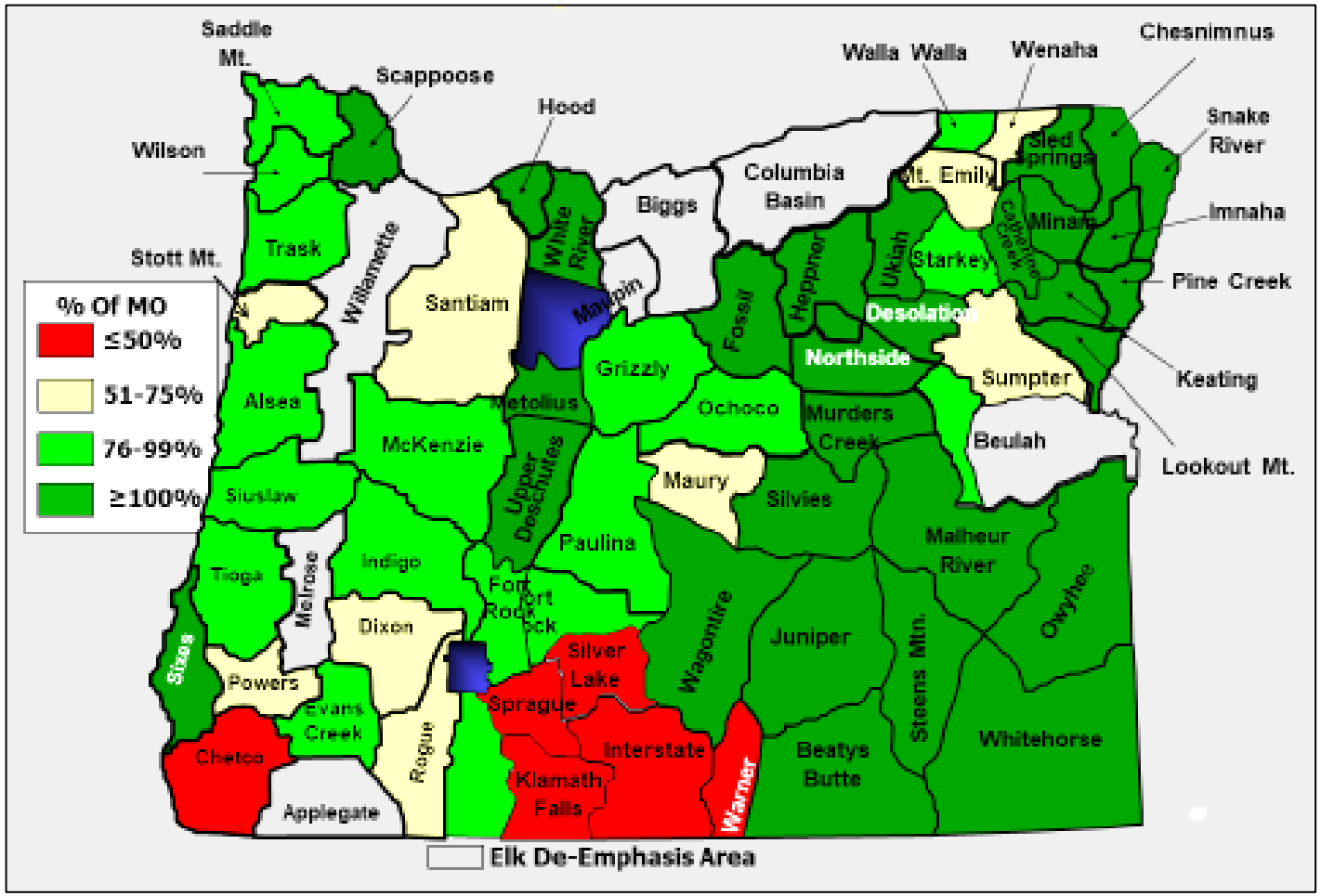

Figure 8. Status of elk population estimates by Wildlife Management Unit (Source: ODFW).

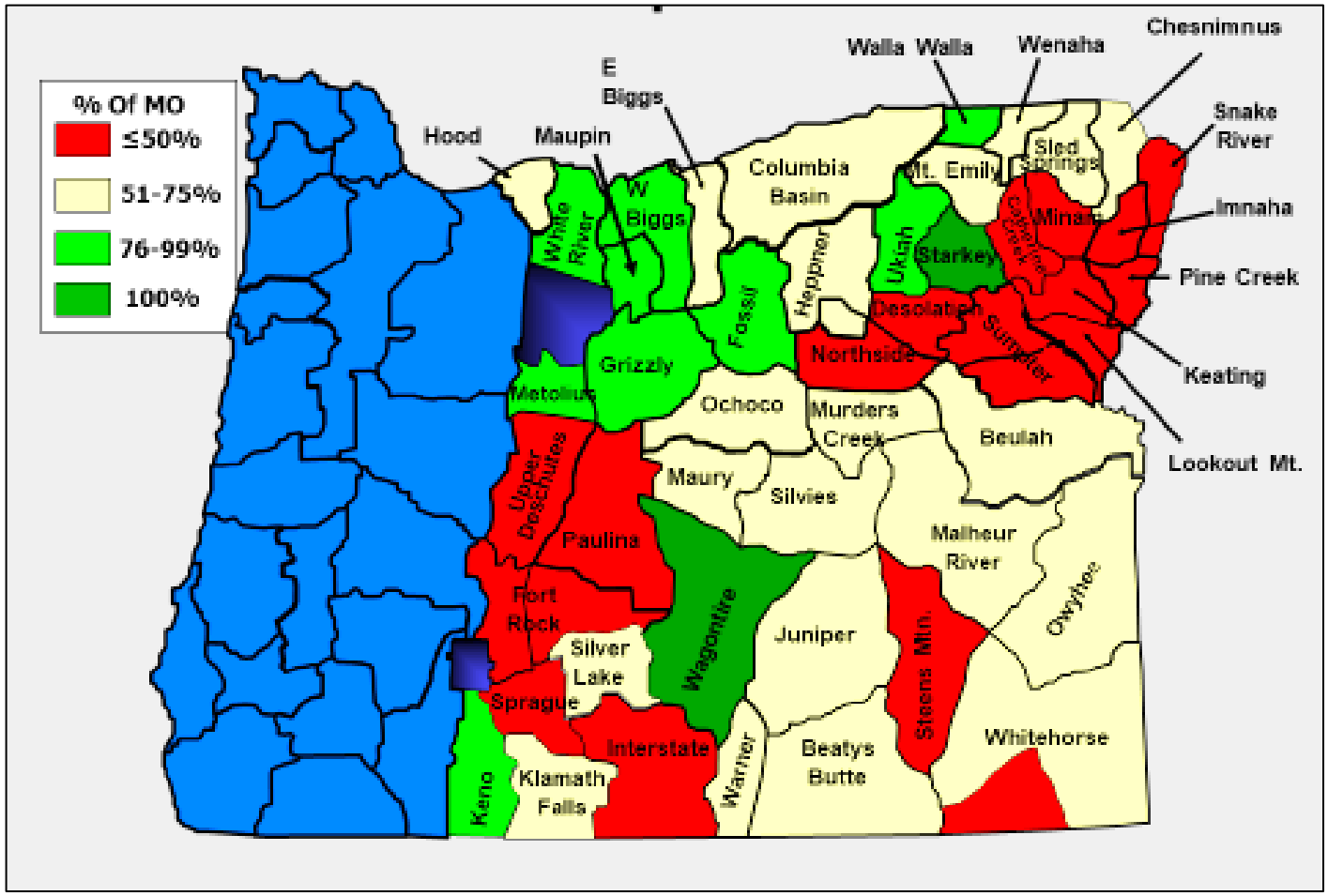

Figure 9. Status of mule deer populations by management unit. Black-tail deer estimates are not available for Westside units (ODFW).

White-tailed Deer Population Information

The Northwest white-tailed deer inhabits portions of northeastern Oregon and populations have been expanding geographically as well as numerically during the past 25 years. Preferred habitats include low elevation riparian areas, low elevation forested areas, and agricultural areas. The most abundant populations are located along the western edge of the Blue Mountains in Umatilla County as well as in portions of Union, Wallowa, and Baker counties. No population estimates are available at this time.

Two populations of Columbian white-tailed deer exist in Oregon, one in southwestern Oregon near Roseburg and the other on a series of islands and the mainland in the lower Columbia River. There have been no formal MOs adopted for this sub-species of white-tailed deer. Columbian white-tailed deer were listed as endangered by the federal government in 1973 and were included on the original state endangered list in 1987. Populations have been increasing to the degree that the Roseburg population was removed from the state endangered species list in 1995 and federally delisted in 2003. The lower Columbia River population remains listed under the federal ESA but populations are increasing to the point where a downlisting to threatened or delisting is being considered. Population estimates for the two populations are approximately 6,000 animals in the Roseburg population and 400-600 animals in the Columbia population, which includes animals found in Washington. Major threats to the population include disease (adenovirus and deer hair loss syndrome), predation, habitat loss, and major flooding in the Columbia River area. Trapping and transplanting is a major activity to repopulate historic range and to secure the populations' survival in case of a catastrophic event.

Pronghorn Population Information

Oregon's pronghorn population has increased during the last 25 years, with the majority of the animals occupying the arid sagebrush/grasslands of southeastern Oregon. Short-term fluctuations in population levels and recruitment have occurred during this time period. These fluctuations were primarily attributed to changes in coyote abundance and winter weather severity. The long-term population increase has been aided by development of irrigated alfalfa on private land, which has expanded and improved pronghorn habitat in many areas. The estimated pronghorn population for Oregon is 24,000 animals.

California Bighorn Sheep Population Information

California bighorn sheep were extirpated in Oregon by 1912. All 32 current herds were reestablished through transplants since 1954. Most herds in the state are stable to increasing. Factors affecting the four herds experiencing recent declines are thought to be predation (cougar and eagle), habitat issues (juniper encroachment and noxious weeds), and disease. California bighorn are susceptible to pasteurella pneumonia outbreaks, but most of the range does not have domestic sheep allotments, therefore the potential for infection is lower than in Rocky Mountain bighorn sheep populations. The current California bighorn sheep population in Oregon is estimated to be 4,200 animals.

Rocky Mountain Bighorn Sheep Population Information

Rocky Mountain bighorn sheep were reintroduced in 1971 after being extirpated from the state in the 1940s. A tri-state, multi-agency and private conservation group effort to reestablish bighorn

sheep in Hells Canyon was started in 1997 (Hells Canyon Bighorn Restoration Initiative). Ongoing research indicates disease (pneumonia) from domestic sheep and goats is the primary cause of mortality followed by cougar predation on adults. The population estimate in 2018 was 700 animals in 11 herds or subpopulations in Oregon

Rocky Mountain Goat Population Information

Rocky Mountain goats indigenous to the north central Cascades and northeast Oregon likely disappeared prior to European settlement. Restoration efforts began in 1950 with a release of five goats in the Wallowa Mountains. More recently, successful reintroductions have occurred in the Elkhorn Mountains, Wenaha, Cascade Mountains and Hells Canyon. Populations have exhibited good production and recruitment. Pioneering of vacant habitats has occurred in the Vinegar Hill, Mount Ireland and Strawberry Mountains areas. Future management will be focused on restoration efforts in suitable habitats. Oregon currently has an estimated 1,000 mountain goats for 2018.

D. Wolf Interactions with other Carnivores – Multiple Predator Systems

Several carnivores are known to prey upon deer and elk and interactions among these carnivores may affect the response of ungulates to predation. Wolves are generally dominant over other carnivores currently occupying Oregon at both kill sites and during direct interactions (Ballard et al. 2003, Ruth and Murphy 2010). Dominant carnivores may exclude or reduce the abundance of other carnivores through interference competition, such as direct killing, aggressive interactions, territorial marking, as well as exploitive competition in which carnivores compete for prey or other resources (Crabtree and Sheldon 1999, Crooks and Soule 1999, O'Neill 2002, Glen and Dickman 2005, Berger and Gese 2007b, Ritchie and Johnson 2009a). Competition between carnivores is likely to increase as dietary overlap increases (Donadio and Buskirk 2006, Ruth and Murphy 2010). These interactions are heightened as shared prey become scarce (Begon et al. 1996, Donadio and Buskirk 2006, Glen et al. 2007). In Oregon, wolves are likely to have a high degree of dietary overlap with cougars and likely to a lesser degree with coyotes. While black bears are known to kill ungulates, they are largely omnivorous and dietary overlap with wolves, which are obligate carnivores, is likely minimal.

Black Bear-Wolf Interactions

Black bears were observed to be subordinate to wolves at carcasses in Yellowstone National Park (YNP; Ballard et al. 2003). Wolves are also known to kill black bears and, in some cases, wolves have dug into winter dens to kill bears (Horejsi et al. 1984, Paquet and Carbyn 1986), but this is likely a rare occurrence and should have minimal population level effects. Bears have initiated interactions with wolves (Hayes and Mossop 1987) and wolves are occasionally killed by bears, but this has had minimal effects on wolf populations (Jimenez et al. 2008). Dietary overlap between wolves and black bears is probably less significant given that ungulates are typically only important in spring bear diets as neonates; bears' nutritional requirements are met through invertebrates and plant matter during the remainder of the non-hibernation period (Bull et al. 2001). Scavenging of wolf-killed carcasses may become an added source of protein for bears (bears scavenge a high degree of cougar-killed prey in NE Oregon; ODFW, unpublished data) and this could lead to direct competitive interactions between wolves and bears at kill sites. However, direct competition between wolves and black bears is limited, likely due to minimal dietary overlap (Ballard et al. 2003).

Coyote-Wolf Interactions

It has been shown that wolves can have demonstrable population effects on coyotes in areas of sympatry. For instance, within eight years of wolf recolonization of Isle Royale National Park, coyotes were completely eliminated from the island due to competitive interactions (Krefting 1969). Studies in the Greater Yellowstone Ecosystem (GYE) show that coyote densities were significantly lower in the presence of reintroduced wolves and transient coyotes dispersed out of sites where wolves were abundant (Berger and Gese 2007b). Within two years of reintroduction, wolves killed 23-33% of coyotes located in core wolf use areas and the number of coyote packs and pack size were also reduced (Crabtree and Sheldon 1999). In the years since wolf reintroduction, coyotes appear to have learned behaviors to reduce aggressive encounters with wolves (Merkle et al. 2009). The original decrease in the number of coyote packs returned to the pre-wolf average, but pack size remained smaller, indicating that the overall coyote population is less than during the pre-wolf period (Hebblewhite and Smith 2009). While coyotes in the GYE now have access to increased wolf-killed carrion (Wilmers et al. 2003), interference and exploitation competition between the two canids reduces the full effect of the subsidy provided by wolves (Arjo and Pletscher 1999, Switalski 2003b, Merkle et al. 2009).

Coyotes can be significant predators of deer, particularly fawns (Ballard et al. 2001). Consequently, reduced coyote densities in response to wolf presence may ultimately benefit deer populations. However, whether reduced coyote populations ultimately relieve the predatory pressure experienced by prey has only begun to be examined. For example, in the GYE, pronghorn antelope fawn survival rates were four times higher at sites with greater wolf densities and lower coyote densities (Berger et al. 2008). Mule deer appeared to respond positively to reductions in coyote density, but effects were influenced by abundance of alternative prey (e.g., small mammals), where survival was higher during years of high small mammal abundance, and climate, where survival was lower during severe winters (Hurley et al. 2011). Furthermore, experimental reductions of coyotes have had minimal effects on deer populations and deer are ultimately regulated by factors other than predation (Ballard et al. 2001, Bergman et al. 2015).

Cougar-Wolf Interactions

Wolves and cougars are both obligate carnivores that focus their predation on large ungulates, which suggests a high degree of competition is likely to occur between the species. Wolves are dominant to cougars in areas of sympatry, consequently, the recolonization of Oregon by wolves may influence cougar population size and distribution, habitat use, kill rates, and prey use, which are likely to have cascading effects on ungulate populations that will be difficult to predict. Kortello et al. (2007) found cougars avoided areas recently visited by wolves, but a gross-scale home range analysis showed a high degree of spatial overlap between the two predators. Akenson et al. (2005) also observed that radio-marked cougars moved to the perimeter of their home ranges when radio-marked wolves were present in their territories. In a comparison of pre- and post-wolf conditions, it was observed that cougars shifted to more rugged areas associated with the bottoms of steep river canyons (Buotte et al. 2005, Ruth et al. 2017). Cougars in YNP also condensed the size of their home ranges after wolves were restored, presumably to avoid interactions (Buotte et al. 2005). During winter, cougars and wolves were able to maintain distinct use of habitat, despite the fact that their home ranges converge as they seek prey that migrate to lower elevations or areas with milder conditions (Alexander et al. 2006). In Banff National Park (BNP) and other areas of the Canadian Rocky Mountains, wolves consistently used gentle-sloped valley bottoms associated with high elk densities, while cougars descended from higher elevations as winter progressed and rarely accessed the valley floor, opting instead to remain on the adjacent hillsides (Alexander et al. 2006).

Evaluation of wolf and cougar kill sites also provides evidence for spatial partitioning between the two carnivores. In the northern range of YNP, Kauffman et al. (2007) observed that in the winter, wolf hunting grounds were snow-covered, grassy areas of level terrain compared to cougars. Similarly, in the Madison Range, Montana, wolf kill sites occurred in open and gentle-sloped riparian habitat which is more suitable for long pursuits (Atwood et al. 2007). By contrast, sites of cougar kills were located on steeper terrain (>15% slope) and were more structurally complex, which would provide advantages for an ambush predator (Atwood et al. 2007). Similar topographical differences between the predators' kill sites were noted in the Salmon River Mountains, Idaho (Husseman et al. 2003). This spatial partitioning of habitat by wolves and cougars may change diets and prey use of cougars (Elbroch et al. 2015a), which could change predator-prey dynamics in Oregon, potentially in unanticipated ways.

As the dominant predator, wolves are effective in usurping cougar-killed prey. Wolves consistently scavenge cougar-killed prey, but cougars rarely visit or scavenge wolf-killed prey (Kunkel et al. 1999, Kortello et al. 2007). Although data are limited, similar results were observed in Oregon (ODFW, unpublished data). Usurping of cougar kills has the potential to increase kill rates of cougars as they must make additional kills in an attempt to meet their basic energetic requirements. Increased kill rates by cougars could have important implications for prey populations, especially if cougar predation is selective on a particularly important age class of ungulate or if cougars selectively prey upon a low density ungulate population. However, cougar kill rates appear to be relatively constant across a range of prey systems (see summary in Knopff et al. 2010) and were nearly identical in areas with (Knopff et al. 2010) and without wolves (Clark 2014). This likely occurs because kill rates are driven by energetic requirements of cougars (Knopff et al. 2010) and kleptoparasitism of cougar kills by wolves are relatively rare, at least in Oregon to date (ODFW, unpublished data). This suggests that cougars are likely to have similar kill rates following wolf colonization in Oregon.

Ruth (2004a) compared cougar diets before and after YNP's wolf reintroduction and revealed few differences, however this research concluded at the onset of dramatic elk declines (Yellowstone Center for Resources 2011). At the time of their study, Kunkel et al. (1999) did not note any changes in cougar prey selection after wolves recolonized and prey availability was declining in Glacier National Park (GNP); they speculated this was because there was still adequate prey biomass available for both carnivores. In contrast, interference and exploitation competition with wolves apparently altered cougars' diets in BNP (Kortello et al. 2007) and the GYE (Elbroch et al. 2015a). As elk populations declined, cougars increasingly predated mule deer and bighorn sheep, while wolves continued to specialize in elk (Kortello et al. 2007). In central Idaho, both wolves and cougars selected for juvenile elk, but cougars used adult elk and all age classes of deer in proportion to availability (Akenson et al. 2005). In Oregon, cougars in the Mt. Emily Wildlife Management Unit had similar diets before (Clark 2014) and after (ODFW, unpublished data) wolves colonized the area. Cougars in northeast Oregon have a strong limiting effect on elk populations in the absence of wolves (Clark 2014) and the addition of wolves could lead to increased predation pressure on elk from two predators if cougar population size is not influenced by wolf recolonization.

Wolf-killed cougars have been documented in a number of locations. In YNP, Ruth (2004a) discovered that 23% of cougar mortalities were attributed to wolves. Cougars killed by wolves have also been documented in GNP (Boyd and Neale 1992, Kunkel et al. 1999, Ruth 2004b) and BNP (Kortello et al. 2007). Wolves also demonstrated non-lethal aggressive behavior towards cougars. For instance, cougars have been chased and treed by wolves (Ruth 2004b, Akenson et al. 2005; ODFW, unpublished data). Observations of cougars killing wolves are rare (Ruth 2004a, Jimenez et

al. 2008) and cougars only prevailed in interactions involving solitary wolves (Ruth and Murphy 2010). In Oregon, wolves have killed young (<3 month) cougar kittens, but have not yet been observed to kill adult cougars (ODFW, unpublished data). Although significant competition between wolves and cougars was noted in the northern range of YNP, cougar survival rates 10 years after wolf reintroduction remained unchanged from the pre-wolf time period (Ruth et al. 2011). Conversely, Kortello et al. (2007) noted depressed cougar survival rates (0.51) in BNP, and Akenson et al. (2005) observed decreased cougar populations after the return of wolves in north central Idaho, but other factors such as large-scale fire may have influenced this finding. (Ruth 2004b) speculated that the pre-wolf cougar population size would not be supported in the GNP region as prey declines continued. In all study areas where wolves co-existed with cougars, necropsies of dead cougars revealed severe malnourishment (Ruth 2004b, Akenson et al. 2005, Kortello et al. 2007). Orphaning, malnutrition, and wolf-caused mortality of cougar kittens occurred more frequently following recolonization of the northern range of YNP by wolves (Ruth et al. 2011). Without emigration from nearby source areas, cougar populations may decline as a result of direct wolf-induced mortality, starvation resulting from prey competition, and slowed reproduction and recruitment (Kunkel et al. 1999, Ruth 2004a, Kortello et al. 2007). However, the degree to which this is directly related to wolf recolonization is not well understood and further research is needed.

E. Strategies to Address Wolf-Ungulate Interactions

Objective

- Ensure that conservation and management of wolves is conducted using an adaptive management approach which recognizes the importance of Oregon's ungulate populations to both wolves and humans and strives to meet management objectives for both wolves and ungulate species.

Strategies

- Monitor and evaluate population-level influence of wolves on ungulate species by applying Oregon-specific wolf and ungulate monitoring information – identify trends, and areas of further investigation or closer monitoring.
- In Phase I and II, if ODFW determines that wolves are a major cause of the population not meeting established ungulate objectives or herd management goals in a WMU, non-lethal management actions including transrelocating wolves to other suitable habitat may be used on a case-by-case basis.
- In Phase III, if ODFW determines that wolves are a major cause of the population not meeting established ungulate objectives or herd management goals in a WMU, active management (e.g., non-lethal methods or lethal removal) of wolves may be used. Actions involving lethal removal by controlled take, which requires Commission approval through a separate public rulemaking process, will be considered on a case-by-case basis (*see* Chapter III) only as follows:
    - Any take will not impair wolf population viability or reduce overall wolf population health factors within the region.
    - ODFW has determined that the controlled take action is expected to allow the affected ungulate population to meet established objectives or herd management

goals.
    - Controlled take would be administered with special permit authorization by the public and targeted at wolves in a specific location involved with the above-mentioned conditions that warrant a management response (*see* Chapter III).
- Active management (e.g., non-lethal or lethal removal) of wolves may be initiated in areas where ungulate species have been transplanted to supplement or expand their historic range, if wolves are determined to be affecting the success of the transplant goals and the Commission determines that such take of wolves would remedy the situation, while not affecting the wolf population viability or health factors within the region. In this situation, lethal removal of wolves will be an option only when in Phase III.
- Active management (e.g., non-lethal or lethal removal) of wolves may be initiated in important ungulate winter ranges or winter feeding sites that congregate elk in specific areas or that serve to draw ungulates away from agricultural lands, and may attract wolves. Lethal options under this strategy are only available when in Phase III, and if ODFW determines that wolves are a major cause of ungulate populations not meeting established range or area objectives.
- Implement situation-specific monitoring to assess the effectiveness of management actions conducted as part of this chapter, and use monitoring results to inform future actions.

VI. WOLF-HUMAN INTERACTIONS

Addressing public safety concerns and providing information on wolf behavior are important to wolf conservation. Human-wolf interactions occur in a number of ways. This chapter covers: background on human safety; general public and wolves; hunters and trappers and wolves; dogs and wolves; illegal, incidental and accidental take of wolves; and strategies to address wolf-human interactions.

A. Human Safety[4]

Compared to other wildlife-human interactions, attacks by wolves on humans are rare. A review worldwide of wolf attacks from 1950 up to early 2000 identified only eight records of non-rabid wolves in Europe and Russia combined involved in human fatalities (Linnell et al. 2002), while the wolf population in Europe and Russia is estimated at 50,000 animals (The Wildlife Society 2012). While rare, injurious and fatal attacks by wolves have occurred and include rabid wolves (Linnell et al. 2002, McNay 2002b); as well as attacks by wolves on humans resulting from starvation, health-related conditions, human guarding of livestock where conditions have deprived wolves of wild prey (notably India), wolf habituation to humans and defense behavior associated with food source, and when cornered or trapped (Linnell et al. 2002, McNay 2002a, Fritts et al. 2003, Krithivasan et al. 2009, Butler et al. 2011).

In comparison, an estimated 25 attacks by black bears on humans occur each year in North America, with one being fatal every third year (Conover 2001). From 1890 to 2001 in North America, there have been 17 fatal and 72 non-fatal verified attacks by cougars (Beier 1991, Fitzhugh unpublished, Linnell et al. 2002). Domestic dogs in America are responsible for 4.7 million bites and 15-20 fatalities per year[5] (Sacks et al. 1996). Domestic dogs also are the single most important vector for transmission of rabies to humans (Moore et al. 2000). See Conover, 2001, for an overview of other species attacks, bites or stings on humans.

Fatal wolf attacks on humans in North America have been rare despite the presence of 70,000 wolves in Canada and Alaska and over 6,200 wolves in the contiguous United States (Linnell et al. 2002, McNay 2002a;b, The Wildlife Society 2012). McNay (2002b) compiled 80 documented wolf-human encounters, none fatal, in Alaska and Canada from 1900 to1996 with one unprovoked instance of wolf aggression from 1900 to 1969, but 18 instances of unprovoked wolf-human encounters during 1969 to 2000. The author identified increases in wolf protection; along with increases in wolf numbers and increases in human activity in wolf habitat to coincide with the rise in unprovoked attacks. An overview and review of 80 specific instances in Alaska and Canada is provided in McNay (2002a, 2002b).

Habituation of wolves to human presence may be a factor that can increase the occurance of wolf attacks. For example, five wolf attacks, by healthy but likely habituated wolves, on humans occurred in Algonquin Provincial Park, Ontario, Canada between 1987 and 2000, a location that previously had never reported such attacks (Schmidt and Timm 2007). Since 2000, the Algonquin Provincial

[4] Information in this section was used with permission from California Department of Fish and Wildlife's December 2015 Draft Conservation Plan for Gray Wolves in California.
[5] www.dogbitelaw.com 2004.

Park has had procedures to deal with fearless wolves including monitoring, posting warnings, aggressive aversive conditioning, and, if necessary, dispatching habituated wolves (Stronks 2015). Techniques such as these should be considered to minimize habitution of wolves and reducing risk of wolf attacks on humans.

Attacks on humans are more likely to occur when wolves are injured or diseased. For example, in August 2013, a teenager camping in Minnesota was bitten in the head by a wolf, requiring stitches. The injuries were not life threatening. After wildlife officials killed the wolf, which had been reported hanging around the campground in the weeks preceding the encounter, a necropsy was performed. The one-and-a-half year-old wolf had only fish spines and scales in its stomach and had severe facial deformities and dental abnormalities (likely caused by traumatic injury as a pup), and brain damage caused by infection, prompting wildlife officials to speculate that these malformations predisposed it to be less wary of people and human activities than what is normally observed in healthy wild wolves and also affected its ability to effectively capture wild prey (Minnesota Department of Natural Resources 2013).

Attacks by healthy wild wolves on humans are a rare event, and fatal attacks are even more uncommon. After no documented human fatalities between 1900 and 2000, two such cases have occurred since the early 2000's in North America. In 2005, a 22-year-old man in northern Saskatchewan was killed by gray wolves (Alaska Department of Fish & Wildlife 2008), which were known to be feeding/scavenging at an unregulated garbage dump (Patterson 2007). In 2010, a 32-year-old woman in Chignik Lake, Alaska was attacked and killed while jogging along a road. An exhaustive investigation by the Alaska Department of Fish and Game (Butler et al. 2011) concluded that four to six wolves, which were likely healthy, were responsible for this fatality.

Despite the rare occurance of human mortalities or injuries caused by wolves, as large carnivores, wolves are fully capable of inflicting serious harm to humans. As such, wolves should be respected for their capabilities and humans should avoid close contact at all times. In the rare occurance that defense of human life from a wolf is required, the federal ESA provides that a person is not liable for take of a listed species if the person takes the animal based on a good faith belief that the person is acting to protect someone from bodily harm. Similarly, Oregon's criminal code provides a defense that may justify an otherwise illegal take if the act was necessary to avoid imminent, grave injury to a person (ORS 161.200).

B. Interactions with the Public

It is important that people who are most likely to encounter wild wolves—hunters, trappers, livestock managers, rural residents, anglers, recreationalists, guides, packers, and forest workers—have a basic understanding of wolf behavior and how to help keep wolves wild and what to do in the unlikely event that a wolf threatens a person. Like any large carnivore, wolves can cause serious injury and humans should avoid close contact at all times.

Wolves generally avoid human interactions and a wolf will usually respond to most human encounters by running or trotting away. However, in some situations a wolf (especially a young wolf) will not flee but will stand and appear curious. This behavior is normal and does not indicate aggression. Additionally, it is common for wolves to bark or howl in response to detection of or disturbanceby humans. This behavior is often a fear response to an unfamiliar or startling encounter

and rarely indicates aggressive or threatening behavior. Barking is also common near den or pup rearing sites. Wolves which are simply passing near, watching, or otherwise behaving in a non-threatening manner should not necessarily be considered dangerous. In some situations hunters in camouflage have reported interactions with wolves, especially while using a big game or predator call. In all reports, the wolves left once the source of the sounds or smell was identified as human. At time of writing, only one wolf has been taken due to human safety in Oregon when in 2017 a hunter encountered wolves and shot one in self-defense believing his life was in danger.

Like all wildlife, wolves can lose fear of humans as a result of frequent interaction by direct contact (e.g., visual) or by indirect contact (e.g., food or garbage left behind). This is called habituation and the following are some guidelines to help keep wolves from becoming habituated to humans.

- Resist the temptation to approach wolves. Fewer contacts with humans help keep them wild.
- Do not approach fresh wolf kills, dens, or rendezvous areas.
- Don't feed wolves, including leaving food or garbage where wolves can find it after you've left the area. Wolves are naturally wary of people, but they can easily lose their fear of humans by associating them with food.
- Don't feed any wildlife. Attracting deer and other mammals can attract all large carnivores.
- Feed pets indoors. Don't leave pet food outside.
- When camping, secure all food from wildlife and sleep away from cooking areas.
- Keep dogs leashed or in close proximity when outdoors (*see* Section D, Dogs and Wolves).
- Avoid wolf pups and any young wildlife when encountered.
- Report odd wolf behavior to authorities – including wolves that appear tame or comfortable around humans.

During a close encounter, or if a wolf threatens a person:

- Stay calm, and do not turn or run away.
- If necessary, make noise, raise your voice and speak firmly, throw objects, or wave clothing while keeping eye contact.
- Back away slowly while facing the animal.
- Leave the wolf a way to escape.
- Pick up small children without bending down.
- Continue to move away from the area while keeping eye contact if possible.
- Report odd wolf behavior to authorities – including wolves that appear tame, comfortable around humans, or threatening.

Additional information regarding living with wolves can be found in the Wolf-Human Interactions section of the ODFW wolf website, www.odfw.com/Wolves/human_interactions.asp.

C. Hunters, Trappers and Wolves

Hunters and trappers may come in contact with wolves and should know the status of wolves in the state and the laws that protect them. Information on wolf identification is available in the Oregon Big Game and the Oregon Furbearer Trapping and Hunting Regulations and on the ODFW wolf website. Wolf status information is available on the website and by contacting a local ODFW office. Hunters have a responsibility to identify their target. Killing a wolf as a result of mistaking it for another species may be considered intentional, knowing, reckless or criminally negligent take, subject to criminal penalties.

As wolves can be attracted to traps set for other species, especially those set for coyotes, trappers have a responsibility to know the difference between wolves and coyotes and how to identify wolf sign. To reduce the chance of incidental wolf catch, trappers are asked to avoid trapping in areas with fresh wolf sign and learn how to improve trap sets (e.g., trap size, design) to avoid capturing wolves. This information is available in the Oregon Furbearer Trapping and Hunting regulations. Additionally, trappers should immediately notify ODFW, OSP or USFWS if a wolf is caught in a trap. Since the Wolf Plan was first enacted in 2005, licensed or authorized trappers have incidentally caught seven wolves in legal foothold traps or snares. In these cases, the trapper immediately reported the incident, the wolf was safely released, and each one was fitted with a radio collar.

Hunters and trappers are ideally suited to help monitor wolf populations due to their abilities to recognize wildlife sign, recreating (often undetected) through all Oregon habitats, and regularly using tools such as trail cameras. They are always encouraged to continue to submit wolf observations via the ODFW website: https://www.dfw.state.or.us/Wolves/wolf_reporting_form.asp.

D. Dogs and Wolves

Wolves are territorial by nature and guard their territory from other canids, including coyotes and domestic dogs. They are especially protective around active dens and rendezvous sites. Although most wolf-dog altercations in the western states have occurred in remote locations, wolves have occasionally fought with dogs near homes, even when people were nearby (Wiles et al. 2011).

Hunting dogs and dogs used to protect livestock are at increased risk of wolf-dog conflicts, but anyone with a dog in wolf country should take steps to limit potential conflicts. Fortunately, this advice is good for reducing dog conflicts with most wildlife and in general:

- If possible, know if you are in an area of known wolf activity (AKWA). These areas are shown on the ODFW wolf website and are based on actual wolf data and information that has been verified by ODFW. Additionally, the public may contact their local ODFW office to get information regarding wolf activity in the area.
- Keep dogs in close proximity and in view.
- Place a bell or a beeping collar on wider ranging dogs to indicate they are not wild canids.
- Talk loudly to the dog or use whistles to show the dog is associated with a human.
- Control the dog so that it stays close to you. Dogs which range away from their owner in wolf country are at increased risk of wolf confrontation.
- Place the dog on a leash if wolves or fresh sign are seen.
- Train companion dogs not to chase or approach wildlife, and to return on command.
- Remember, it is illegal to shoot at, attempt to injure or kill a wolf even if it is attacking your dog, except under certain circumstances with livestock working dogs.
- See Chapter IV for information on working dogs used to protect livestock.

E. Illegal, Incidental, and Accidental Take

All unexpected take is investigated by Oregon State Police and where applicable, USFWS Law Enforcement.

House Bill 4046, which was enacted in the 2016 Oregon Legislative Assembly Regular Session, increased penalties for the unlawful taking or killing of wildlife. The Fish and Wildlife Commission requested this increase at the time the wolf was delisted from the state ESA. The bill added gray wolf to the list of game mammals for which the Commission may institute suit for recovery of damages and increased the penalty for unlawful killing of a gray wolf to $7,500 from $1,000 (ORS 496.705).

Illegal Take

The gray wolf is protected from illegal take under federal and state laws. As of this writing, wolves are federally listed as endangered in the western three quarters of the state and are protected from illegal take statewide by state law. Under state law, illegally killing a wolf, is a Class A misdemeanor crime and someone convicted of illegally killing a wolf may be imprisoned for up to one year and fined $7,500 (ORS 496.992, 498.002). Persons convicted of violating the wildlife laws also may lose hunting privileges for a period of 36-60 months, or permanently, and may be subject to forfeiture of property used in the commission of violating the wildlife laws.

Incidental Take

Federal law defines incidental take as take that results from, but is not the purpose of, an otherwise lawful activity. Federal and state laws do not distinguish between incidental and illegal take for purposes of determining criminal or civil sanctions. If an incidental take permit has been issued under federal or state law, and a person violates the terms of that permit, that violation could be an additional basis for civil or criminal sanction. At the time of writing, no wolves have been taken in Oregon under coverage of a federal or state incidental take permit (ITP).

Accidental Take

Neither federal nor state law define "accidental" take, but presumably it would include situations where the take is not reasonably foreseeable by a person carrying out an otherwise lawful activity—for example, an individual, who lawfully driving a car, strikes and kills wildlife.

If a person did not intend to kill an animal (or act recklessly or with criminal negligence) then, under the Oregon wildlife laws, misdemeanor and felony penalties generally would not apply. Civil sanctions, including damages, could be sought. However, as a practical matter, civil sanctions are rarely if ever sought in accidental situations. The law does provide reporting requirements, even for accidental take.

F. Strategies to Address Wolf-Human Interactions

As wolf populations expand, increases in wolf-human contact can be expected. The Plan's objective is to minimize the potential for negative wolf-human interactions through development and implementation of a comprehensive public education program. The following strategies support this objective.

- Implement a comprehensive education program that supports co-existence with wolves and wolf conservation within the parameters of the Plan.
- Wolves found living within or near communities and could result in conflict with humans or harm to the wolf shall be considered candidates for relocation. However, wolves that are known or suspected to have depredated livestock or pets will not be relocated.
- Inform the public about ways to avoid wolf interactions and appropriate responses to encounters with wolves.
- Share information regarding areas of known wolf activity with the public as appropriate.
- Ensure agencies respond to reported wolf-human interactions in a timely manner and develop response protocols for reported wolf-human conflicts similar to those used for human interactions with cougars and black bears.
- Discourage activities that lead to habituation of wolves to humans.
- Inform and educate the public about staying away from sick or debilitated animals and reporting them to ODFW.
- Reports of wolf-human interactions will continue to receive high attention for investigation by ODFW and animal control authorities.

VII. INFORMATION AND EDUCATION

Objective

- To inform and educate the public through a comprehensive information and education program that fosters two-way communication between wildlife managers and others with an interest in wolves.

Strategies

- Implement a communications plan which emphasizes easy access to information and transparency in regard to wolf management activities, and includes the following:
  - A comprehensive wolf website as part of the ODFW site containing information on the biology and behavior of wolves, wolf use areas, pertinent wolf related documents and updates of recent events.
  - An annual report on management activities that is distributed through the website, at Commission meetings, group meetings, and by request.
  - Productive media relations, including news releases, timely response to queries, and use of social media.
  - Information on the importance of public wolf reports and how to report wolf sightings.
  - Participation in meetings about wolves hosted by interested organizations as staff time allows.
  - Wolf identification and protection information in Oregon Big Game Regulations and Oregon Furbearer Trapping and Hunting Regulations.
  - Information for livestock producers about non-lethal and legal lethal wolf management techniques and areas of known wolf use.
  - Information about wolf conservation and co-existing with wolves.
  - Inform citizens about wolf encounters and human safety in wolf country.
  - Inform hunters and trappers how to avoid taking wolves while hunting or trapping other species of wildlife.
  - Coordinate information and education efforts with other agencies and non-governmental organizations to ensure that accurate information is disseminated to interested parties and that costs are kept to a minimum.

A coordinated communications effort has supported the Wolf Plan since it was first adopted in 2005. A variety of strategies and channels are used to engage a wide range of audiences, including private landowners, public land managers, hunters, trappers, ranchers, conservationists, recreationists, and other groups and organizations. Legislators and local governments are provided with information proactively and as requested. ODFW staff and partners—USFWS, Oregon State Police, the Department of Agriculture, Wildlife Services, Native American tribes, other state fish and wildlife agencies, and others—are in regular communication regarding wolf management. Media contacts are proactive and media requests receive timely response. Oregonians can access information about wolves in the state and subscribe to receive wolf and wolf-livestock updates through the ODFW website at: http://odfw.com/wolves.

VIII. REPORTING AND EVALUATION

Objective

- Document and report the annual activities related to wolf conservation and management, and evaluate program effectiveness toward meeting the Plan's goals and strategies and maintaining consistency with state and federal laws.

Strategies

- Develop and distribute an annual report that describes the activities related to implementation of this Plan.
- Continue to maintain a comprehensive wolf website as part of the ODFW site, which offers open and transparent information and updates regarding the implementation of this Plan for the public, partner agencies, organizations, tribes, and the Commission.
- Continue to implement a periodic evaluation of the effectiveness of this Plan on a 5-year basis.
- Continue to develop and refine measures to track progress toward meeting the objectives of this Plan.
- Incorporate feedback received from the public and stakeholder groups into the periodic evaluation of this Plan.

Because of the intense interest in wolves and the implementation of this Plan, an annual report will continue to be written that summarizes management activities and results of wolf conservation and management in Oregon. The annual report will be made available to the Commission, elected officials and any others who request it to keep them informed about Oregon's results. Upon request, the Oregon Fish and Wildlife Commission and Oregon Legislature shall be briefed and updated regarding the Plan's implementation. The public demand for current information continues to increase. To meet this demand, ODFW's wolf website will continue to be relied on as a means of providing up-to-date reporting about wolf management in the state.

Much is left to be learned about wolf conservation and management in Oregon. This is why an adaptive management approach will be used and why measurable objectives must be part of the feedback mechanism. While benchmarks measure results, not effort, monitoring those results can help determine whether to modify program objectives or management practices. Evaluation will include assessing how each portion of the Plan has been implemented, and its effectiveness. Evaluation and public and stakeholder engagement may be most appropriate following release of the annual report.

ODFW will continue to evaluate the effectiveness of implementation every five years as practicable and recommend any changes to the Commission, similar to other wildlife species Plans. Two events could trigger an evaluation before the five year review: a change of the wolf's legal status at the state or federal level or statutory changes to the Oregon ESA. The completion of any formal evaluation could result in a decision by the Commission to enter into rulemaking and amend the Plan. Measures that track progress toward meeting the Plan's objectives will aid in evaluating where the Plan is succeeding and where improvement is needed as implementation progresses. The Commission may consider forming a committee to evaluate the effectiveness of wolf conservation and management in Oregon.

IX. RESEARCH AND INFORMATION MANAGEMENT

Objective

- Improve the conservation and management of wolves and the other species, ecosystem processes, and resources they affect in Oregon using science-based information derived from research.

Strategies

- Implement research projects, as financial and logistical resources allow, which are responsive and adaptive to management and conservation needs of wolves and other wildlife and resources they affect.
- Assess and develop science based monitoring programs to ensure effective conservation and management of wolves.
- Develop effective collaborations and partnerships with other state and federal agencies, universities, and other cooperators to identify potential research projects and improve rigor and scientific approach when conducting wolf-related research in Oregon.
- Publish research conducted by ODFW and other collaborators in peer-reviewed scientific journals.
- Where applicable, apply research conducted in other areas to Oregon to improve management.
- Disseminate research findings developed in Oregon to ensure stakeholders and other interested parties are educated on wolf research conducted in Oregon.

Research and information management will continue to be an essential component of this Plan, and will be strategically focused on questions that will affect short and long-term management decisions. In addition, this program should synthesize and utilize existing information generated from other areas, and this will best be achieved through continued collaborations and partnerships with other state and federal agencies, universities, and other entities.

While a multitude of wolf-related research projects are possible, financial and logistical constraints will ultimately limit the ability to conduct potentially relevant research. Consequently, research activities will be focused on areas that will provide managers with science-based findings that will improve conservation and management of wolves and the resources they interact with. Broadly, research conducted in Oregon may focus on: 1) wolf ecology, monitoring, population estimation, and population dynamics, 2) effects of wolves on native ungulates, 3) effects of wolves on other carnivores, and 4) methods to identify areas of wolf conflict and approaches to reduce potential conflicts.

As wolf populations increase and expand their range in Oregon, it will become logistically and financially prohibitive for ODFW to continue current wolf monitoring efforts. Additionally, models used to predict the number of breeding pairs (Mitchell et al. 2008) rely on knowing pack sizes, which are difficult to obtain as wolf populations increase. Consequently, development and refinement of additional monitoring techniques will be important to address over the next five years of this Plan's

implementation. Recently developed approaches such as surveying predicted rendezvous sites (Ausband et al. 2010, Stansbury et al. 2014) or patch occupancy modeling (Miller et al. 2013, Rich et al. 2013) may prove to be useful alternatives for monitoring Oregon's wolf populations in the future. Alternatively, recent advances in genetic and modeling techniques may allow application of non-invasive genetic monitoring (Morin et al. 2016) or camera trap surveys (Chandler and Royle 2011, Sollmann et al. 2013) to effectively monitor wolf populations in the future. ODFW will continue to assess alternative monitoring approaches and develop new approaches to meet monitoring needs in the future.

While using GPS-collars and aerial surveys to census wolf populations in the future may not be logistically feasible in all situations (*see* Chapter II), ODFW will continue to capture and radio-collar wolves to obtain important biological information as part of future research projects. Information gathered from GPS-collars is critical for estimating survival (Pollock et al. 1989, Smith et al. 2010), dispersal routes and corridors (Horne et al. 2007, Chetkiewicz and Boyce 2009), home range or territory size, and habitat use (Johnson et al. 2004, Oakleaf et al. 2006b), all of which are critical for effective management and conservation of wolves. In addition, both GPS- and VHF-collars can provide researchers and managers the ability to quickly detect when mortalities occur from a variety of causes.

During the next five years of Plan implementation, ODFW will continue to study wolves and conduct analyses to determine territory sizes, habitat use, movement rates, and survival rates of wolves in Oregon. Over time, this information will be updated and revised as additional data across Oregon is collected and available for use. Additionally, information gained from GPS-collars will be useful in development of spatially explicit population models (Maletzke et al. 2016), developing models that incorporate habitat use and mortality to estimate population size (Robinson et al. 2015), or models that document the probability of persistence of wolves on the landscape (Oakleaf et al. 2006b).

The complex interactions of habitat, climate, and predation on ungulate population dynamics (Crête 1999, Melis et al. 2009, Griffin et al. 2011, Brodie et al. 2013, Johnson et al. 2013), makes it difficult to predict any effects that re-established wolves may have on Oregon's ungulates. Consequently, identifying and prioritizing research for wolf effects on ungulates will be ongoing and will be responsive to potential issues that arise. There is a large body of literature to draw upon (*see* Chapter V) in guiding wolf and ungulate management and identifying knowledge gaps that could be supplemented by research in Oregon. Additionally, ongoing research in other areas will help guide Oregon wolf and ungulate management. For example, research is currently being conducted in Washington to determine the effects of recolonizing wolves on mule deer and white-tailed deer and to assess the effects wolves have on coyote populations and subsequent effects on mule deer fawns (http://www.predatorecology.com/current-lab-members.html, accessed January 11, 2019). In Montana, research is being conducted to understand the role of nutrition and predation from wolves, cougars, and black bears on elk populations (http://fwp.mt.gov/fishAndWildlife/management/elk/bitterroot/, accessed January 11, 2019).

ODFW in cooperation with Oregon State University is currently conducting research to document wolf diets in northeast Oregon and preliminary results suggest wolf diets are largely comprised of elk (ODFW, unpublished data), as seen in other areas wolves and elk co-occur (Mech and Peterson 2003). Specific research projects regarding effects of wolves on elk and other ungulates may be

necessary if wolves are thought to be contributing to ungulate population declines or where clear knowledge gaps exist that would be informative to management.

Identifying the effects of wolves on other carnivores is not only important for management of carnivores, but also for the prey they consume. Cougars are an important predator of ungulates in Oregon (Clark 2014), and cougar home ranges, habitat use (Buotte et al. 2005, Ruth et al. 2017), prey use (Kortello et al. 2007, Elbroch et al. 2015b), and populations may ultimately be affected by wolves, which may influence ungulate population dynamics (*see* Chapter V). However, little is known about wolf-cougar interactions at this time. To investigate these interactions, ODFW in collaboration with Oregon State University implemented a research project to determine potential effects of wolves on cougars in 2013. This follows research which investigated cougar ecology in the Mt. Emily WMU before the re-establishment of wolves (Clark 2014, Clark et al. 2014, Clark et al. 2015). The current project aims to compare cougar prey use, habitat use, survival rates, densities, and population dynamics before and after wolves colonized the landscape and link these changes to ungulate population dynamics where applicable. Additional research is being initiated in Washington to investigate wolf-cougar interactions (http://www.predatorecology.com/current-lab-members.html, accessed January 11, 2019) and will provide additional information on this topic to inform management of wolves, other carnivores and their prey.

As wolves continue to increase in population and distribution in Oregon, they will have increased encounters with livestock, which could lead to increases in depredation. Identifying and developing approaches that will minimize livestock depredation will be critical for the long-term conservation of wolves in Oregon. ODFW will play an important role in determining effective approaches for coexistence of wolves in areas with livestock, but can also draw from research being conducted in other areas. A multi-state effort is underway, which includes data collection in Oregon, to determine the effectiveness of various breeds of livestock guard dog breeds to deter wolf depredations (J. Young, USDA, APHIS, Wildlife Service, personal communication). Several additional wolf-livestock projects are being conducted in Washington including: 1) assessing livestock mortality rates in wolf occupied areas, calculating livestock kill rates by wolves, determining effectiveness of non-lethal techniques to reduce wolf depredations, and 2) a retrospective analysis to determine effects of environmental factors on wolf depredation. In Montana, ongoing research is being conducted to evaluate the effects of wolf removals and public harvest in areas of recurrent depredation, and evaluate the effectiveness of range riding to reduce livestock depredations (J. Gude, Montana Fish, Wildlife, and Parks, personal communication).

Engaging in partnerships and cooperative research projects ensures a rigorous and sound scientific approach when conducting wildlife research. ODFW has a demonstrated history collaborating with universities (Oregon State University, University of Idaho, and University of Nevada, Reno), U.S. Forest Service Pacific Northwest Research Station, National Council for Air and Stream Improvement, and statistical consultants. Additionally, ODFW has participated in the Western Elk Research Collaborative, which is a collaboration of state agencies and universities, to conduct meta-analyses of range-wide elk data (Griffin et al. 2011, Brodie et al. 2013). Future collaborations that utilize range-wide wolf data should be investigated and initiated to better inform wolf conservation and management. Currently, as part of ongoing research investigating wolf-cougar interactions, ODFW has partnered with Oregon State University. ODFW will continue to partner with external collaborators on future wolf research to ensure effective management and conservation of wolves occurs.

X. BUDGET FOR IMPLEMENTATION

A secure funding source is necessary to fully implement the goal, objectives, and strategies contained within this Plan. This chapter focuses on the cost of wolf conservation and management in Oregon and identifies current funding sources. As the wolf population has increased, the costs associated with management have also increased. Though this was predicted in earlier versions of this Plan, managers in the future will face continual challenges to streamline management costs and to find/maintain funding sources to implement this Plan.

Federal funding for implementation of this Plan of wolf management in Oregon has shifted from federal State Wildlife Grant (SWG) to federal funds from the Pittman-Robertson Federal Aid Program (PR)– a change made possible when wolves were made a special status game mammal in 2009 by the Oregon Legislature. The change in status was called for in the 2005 Plan and allows ODFW to use more stable PR funds to support wolf management within the state. The PR funds are derived from a tax on ammunition and firearms used for sport hunting.

Since 2005, the federal government has shared in the fiscal responsibility of wolf management in Oregon, in part because the state has contributed to the success of the federal ESA. Since 2012, ODFW received approximately $300,000 in federal support funds to support management, monitoring and research of wolves. These funds were expended in June 2017 and is consistent with the 2005 Plan's expectation that with federal delisting in part of the state, the USFWS would likely decrease its federal support. To offset the loss of these federal support funds while maintaining the management level anticipated in this Plan, ODFW increased PR funding approximately $50,000/year for the 2017-2019 biennium.

Currently, ODFW's implementation of the Plan is primarily conducted by two wolf-specific biologists, district wildlife biologists, a carnivore-furbearer coordinator, and the ODFW Wildlife Research Program. Funding for the wolf program, which includes the two wolf-specific biologists, for the 2017-2019 biennium consists of federal funds from PR. This federal source provides 75% of the wolf program funding. This federal grant requires state match which comes from a combination of Oregon Department of Fish and Wildlife license dollars (9.5%) and wildlife lottery funds (15.5%). The total budget allocation for the 2017-2019 biennium is $678,223 and funds the two full-time wolf program positions, program supplies (e.g., vehicles, cameras, collars), two seasonal student interns, and various contract services (e.g., aircraft, DNA and serology analysis)to implement wolf management in Oregon. From the 2009-2011 to 2017-2019 biennium, on average the cost of the wolf program increased by approximately 7% per biennium.

The wolf population and the associated management requirements have grown beyond the capacity of the two wolf-specific biologists in the wolf program and the additional workload has been placed on ODFW's district wildlife biologists. These positions are funded by license dollars (75%) and state general fund (25%). In some months, as much as 50% of a district's field staff time is spent on the urgent requirements of wolf livestock depredation investigations and mitigation. As Oregon's wolf population continues to increase, a more comprehensive, statewide effort will be needed for ODFW to continue to monitor wolves on a larger landscape, collect population data, capture/radio-collar wolves, and address wolf-livestock conflicts. This effort must also be expanded to meet the public demands for wolf information including satisfying non-ODFW needs dependent on wolf information (i.e. Wolf Depredation Compensation and Financial Assistance Grant Program mentioned below).

ODFW will continue to seek solutions for meeting these growing needs including adding more biologists to adequately implement all aspects of the Wolf Plan.

The annual budget of the ODFW Wildlife Research Program is approximately $3,000,000 and about 75% of program funding comes from PR funding, with remaining portions from in-kind contributions, grants, and sales of hunting licenses and tags. Funding for wolf research identified in this Plan will occur within the current research program and budgets while balancing research needs for other species of management or conservation concern.

The Oregon Department of Agriculture's Wolf Depredation Compensation and Financial Assistance Grant Program is another source of funding for wolf conservation and management in Oregon. The compensation program was created in 2012 and provides four types of financial assistance options; 1) direct depredation payment for loss, and 2) missing livestock payment, and 3) preventative measures, and 4) program implementation costs. Livestock producers receive funds through participating county governments, and a total of 10 counties were awarded $252,570 in grant funds in 2017 and $160,890 in 2018. The total budget for the 2015-17 biennium was approximately $376,000 and the estimated 2017-19 biennium is $274,000-350,000, pending federal grant proposals. Because of the large portion of general fund that supports this program, continued state general fund allocation will be key to the future of the compensation program in Oregon.

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APPENDIX A: GLOSSARY OF TERMS

Breeding pair: an adult male and an adult female wolf with at least two pups that survived to December 31 of the year of their birth.

Confirmed loss: a depredation loss where there is physical evidence that an animal was actually killed by a wolf.

Controlled take: Commission approved action for wolf population management that allows the take of a wolf by special permit (on public or private lands) to address long term, recurring wolf-livestock conflicts, ungulate population objectives, or winter range or feeding area objectives.

Delist: to remove a species from the list of endangered or threatened species.

Depredation: an incident or event that results in the confirmed injury or death of lawfully present livestock or working dogs on federal, state, tribal, or other public lands, or private lands by one or more wolves.

Dispersal: generally refers to the natural movement of an animal from one area to another.

Fladry: a method of non-lethal wolf control that involves attaching numerous strips of flagging material along a fence or other device for the purpose of keeping wolves out of an area occupied by livestock.

Fur-bearing mammal: as defined by Oregon law, beaver**,** bobcat, fisher, marten, mink, muskrat, otter, raccoon, red fox, and gray fox [ORS 496.004(8)].

Game mammal: as defined by Oregon law, antelope, black bear, cougar, deer, elk, moose, mountain goat, mountain sheep, silver gray squirrel, and gray wolf as a special status mammal defined by commission rule [ORS 496.004(9)].

Guard dog: any dog actively used to defend livestock from depredation.

Lethal take: management actions resulting in the death of a wolf or wolves. Lethal take may be initiated under the following circumstances: threat to human safety, to stop a wolf in the act of attacking livestock or to stop chronic wolf depredations on private or public lands.

Management Objective: a specific minimum population level of animals for management purposes; for this Plan, wolf population objectives are defined by the number of breeding pairs of wolves present in the population.

Northern Rocky Mountain Wolf Recovery Plan: a document prepared by a team of individuals with expertise regarding the biological and habitat requirements of the wolf, outlining the tasks and actions necessary to recover the species within parts of its former range in the Rocky Mountain Region. The original Plan was completed in 1980. The revised Recovery Plan was approved August 3, 1987.

Oregon Endangered Species Act: law passed by the Oregon Legislature in 1987 that provides for listing and protection of threatened and endangered fish and wildlife species [ORS 496.171-192].

Other wolf-livestock conflict: for purposes of this Plan, other wolf-livestock conflict means testing, chasing, or otherwise disrupting livestock.

Pack: a group of wolves, usually consisting of a male, female and their offspring from one or more years. For purposes of monitoring, a pack may be defined as a group of four or more wolves traveling together in winter. Ongoing and future wolf research may refine this definition for monitoring purposes.

Pursuit: for purposes of this Plan, pursuit of wolves is limited to pursuing adult wolves (greater than six months old) by foot, horseback, non-motorized or motorized vehicle for non-lethal injurious harassment.

Species: as defined by Oregon law, any species or subspecies of wildlife [ORS 496.004(15)].

Sporting dog: any dog used to aid a hunter in the legal pursuit of wildlife during an authorized hunting season.

State endangered species: any native wildlife species determined by the Commission to be in danger of extinction throughout any significant portion of its range within this state; and any native wildlife species listed as an endangered species pursuant to the federal Endangered Species Act of 1973 (P.L. 93-205, 16 U.S.C. 1531), as amended [ORS 496.004(6)].

State threatened species: any native species the Commission determines is likely to become an endangered species within the foreseeable future throughout any significant portion of its range within this state; and any native wildlife species listed as a threatened species pursuant to the federal Endangered Species Act of 1973 (P.L. 93-205, 16 U.S.C. 1531), as amended [ORS 496.004(17)].

Suitable habitat: (e.g., high, medium, low suitability) for purposes of this Plan, is defined by factors including availability of natural prey, level of human occupation, level of livestock activity and density of open roads.

Take: as defined by Oregon law, to kill or obtain possession or control of any wildlife [ORS 496.004(16)].

Ungulate: any of the species deer, elk, bighorn sheep, pronghorn, moose, and mountain goat.

Wildlife: as defined by Oregon law, fish, shellfish, wild birds, amphibians and reptiles, feral swine as defined by Oregon Department of Agriculture rule, and other wild mammals [ORS 496.004(19)].

Wildlife Management Unit (WMU): a geographic unit used in managing Oregon's big game animals. The state has been divided into 77 different units each with a name and a number for reference purposes.

Wolf Management Zone (WMZ): for purposes of wolf conservation and management in Oregon, two regions, one east and one west of a line defined by U.S. Highway 97, U.S. Highway 20 and U.S. Highway 395 were created. Each region has separate population goals for wolves.

Working dog: guarding and herding dogs used to actively aid in the herding or protection of livestock.

APPENDIX B: WOLF BIOLOGY, ECOLOGY, AND DISEASES

Appendix B was present in the 2010 Oregon Wolf Conservation and Management Plan and includes a description of wolf biology and ecology that was adapted from the Montana Gray Wolf Conservation and Management Plan (2002) and a summary of wolf disease. Only disease information in this Appendix was revised in this Plan update, therefore other resources should be considered for more up-to-date information on biology and ecology.

WOLF ECOLOGY IN THE NORTHERN ROCKIES

NOTE: This section was adapted from the Montana Gray Wolf Conservation and Management Plan August 2002 with permission.

Physical Characteristics

Male gray wolves in Montana weigh 90-110 pounds, and females weigh 80-90 pounds. Wolves in the Greater Yellowstone Area (GYA) are slightly heavier. Smith et al. (2000) reported that in 1999 winter-captured adult females averaged 108 pounds, while female pups averaged 96 pounds. Male pups averaged 107 pounds. About half of the wolves in Montana are black and the remainder gray. Both color phases may be found in a pack or in one litter of pups. White wolves, usually old animals, are occasionally seen. Tracks are normally 4.5 to 5.5 inches long (Harris and Ream 1983).

Wolves may resemble coyotes, particularly when wolves are young. Wolves also may be confused with some large domestic dog breeds. Wolves are distinguished from dogs by their longer legs, larger feet, wider head and snout, narrow body, and straight tail. Other distinguishing characteristics require closer examination than is possible in field settings with live animals. In many instances, behavior distinguishes between wild wolves, wolf-dog hybrids and domestic dogs (Boyd et al. 2001, Duman 2001).

Pack Size

The gray wolf is a highly social species that lives in packs. Packs are formed when male and female wolves develop a pair bond, breed and produce pups. The pack typically consists of a socially dominant breeding pair (alphas), their offspring from the previous year and new pups. Other breeding-aged adults may be present, but they may or may not be related to the others. Cooperatively, the pack hunts, feeds, travels and rests together. The pack also shares pup-rearing responsibilities, including hunting and tending pups at the den or at a series of rendezvous sites. Pack size is highly variable (USFWS et al. 2001). In northwest Montana, it ranges from two to 11, and averages five to seven. In the GYA, pack sizes range from five to 27 and average 9.3. Average pack size is larger inside Yellowstone National Park (YNP) (14.6 individuals) than outside (5.8 individuals) (Smith et al. 2000).

Reproduction

Wolves normally do not breed until at least 22 months of age (Mech 1970). Breeding usually occurs only between the dominant male and female in a pack. In the northern Rockies, the breeding season peaks in mid- to late February (Boyd et al. 1993). Wolves localize their movements around a den site and whelp in late April, following a 63-day gestation period. Wolves may be sensitive to human disturbance during the denning season. After the pups are about eight weeks old, they are moved to a series of rendezvous sites. In northwest Montana, maximum litter size averaged 5.3 (range 1-9) from 1982 to the mid 1990s. By December, average

litter size declined to 4.5 (Pletscher et al.1997). In central Idaho, average litter size was 5.1 from 1996-1998 (Mack and Laudon 1998).

Pup survival is highly variable and is influenced by several factors, including disease, predation and nutrition (Mech and Goyal 1993, Johnson et al. 1994). In northwestern Montana from 1982-1995, 85 percent of pups survived until December, though survival varied year to year (Pletscher et al. 1997). Pup mortality in the first eight months of life was attributed to human causes (8 of 20 mortalities, 40 percent), unknown causes (2 of 20, 15 percent), and disappearance (9 of 20, 45 percent). In YNP, during the first four years, 133 pups were born in 29 litters and 71 percent were believed to still be alive in 1998 (Bangs et al. 1998). Pup survival varied between 73 and 81 percent from 1996-1998. However, canine parvovirus was strongly suspected as a contributing factor in the low pup survival (45%) in 1999. In 2000, pup survival rebounded to 77% (Smith et al. 2000). In central Idaho, 92-99 pups were produced between 1995 and 1998 (Mack and Laudon 1998).

Occasionally, more than one female in a pack may breed, resulting in more than one litter per pack (Ballard et al. 1987). This phenomenon has been documented in YNP (Smith et al. 2000, USFWS et al. 2000, USFWS et al. 2001). In 1999, one pack had two litters. In 2000, 13 wolf packs produced 16 litters. Occasionally this phenomenon leads to the formation of a new pack (Boyd et al. 1995).

Food Habits

The gray wolf is an opportunistic carnivore and is keenly adapted to hunt large prey species such as deer, elk and moose. Wolves may scavenge carrion or even eat vegetation. In Montana white-tailed deer, mule deer, elk and moose make up the majority of wolf diets. In northwestern Montana white-tailed deer comprised 83 percent of wolf kills, whereas elk and moose comprised 14 percent and 3 percent, respectively (Kunkel et al. 1999). However, 87 percent of wolf kills in YNP during 1999 were elk (Smith et al. 2000). In central Idaho elk (53 percent) and deer (42 percent) were the most frequently detected species in scat samples collected in summer 1997 (Mack and Laudon 1998). Ungulate species compose different proportions of wolf diets, depending on the relative abundance and distribution of available prey within the territory.

Wolves also prey on smaller species such as rabbits or beaver. Wolf scat collected in YNP in 1998 contained voles, ground squirrels, snowshoe hares, coyotes, bears, insects and vegetation (Smith 1998). Earlier work in northwestern Montana also documented non-ungulate prey species such as ruffed grouse, ravens, striped skunks, beavers, coyotes, porcupines and golden eagles (Boyd et al. 1994).

Wolves also scavenge opportunistically on vehicle- or train-killed ungulates, winterkill and on kills made by other carnivores, particularly mountain lions. Wolves in northwestern Montana scavenge the butchered remains of domestic livestock or big game animals at rural bone yards or carcass disposal sites. Wolves also may kill and feed upon domestic livestock such as cattle, sheep, llamas, horses, or goats. They also may kill domestic dogs but usually do not feed on the carcass.

Movements and Territories

A pack establishes an annual home range or territory and defends it from trespassing wolves. From late April until September pack activity is centered at or near the den or rendezvous sites, as adults hunt and bring food back to the pups. One or more rendezvous sites are used after pups emerge from the den. These sites are in meadows or forest openings near the den, but sometimes are several miles away. Adults will carry small pups to a rendezvous site. Pups travel and hunt with the pack by September. The pack hunts throughout its territory until the following spring.

Pack boundaries and territory sizes may vary from year to year. Similarly, a wolf pack may travel in its territory differently from one year to the next because of changes in prey availability or distribution, intraspecific conflict with nearest neighbors, or the establishment of a new neighboring pack. Because the

attributes of each pack's territory are so unique (elevations, land use, land ownership patterns, prey species present and relative abundance), it is difficult to generalize about wolf territories and movements.

After recolonizing the Glacier National Park (GNP) area in the 1980s, individual wolves dispersed and established new packs and territories elsewhere in western Montana. Wolves demonstrated a greater tolerance of human presence and disturbance than previously thought characteristic of the species. It previously was believed that higher elevation public lands would comprise the primary occupied habitats (Fritts et al. 1994). While some packs have established territories in backcountry areas, most prefer lower elevations and gentle terrain where prey is more abundant, particularly in winter (Boyd-Heger 1997). In some settings, geography dictates that wolf packs use or travel through private lands and co-exist in close proximity with people and livestock. Since the first pack established a territory outside the GNP area in the early 1990s, packs in northwestern Montana negotiated a wide spectrum of property owners and land uses. These colonizers also settled across an array of rural development.

With the exception of GNP packs, wolves in northwest Montana move through a complex matrix of public, private and corporate-owned lands. Landowner acceptance of wolf presence and the use of private lands is highly variable in space and time. Given the mobility of the species and the extent to which these lands are intermingled, it would not be unusual for a wolf to traverse each of these ownerships in a single day. Land uses range from dispersed outdoor recreation, timber production or livestock grazing to home sites within the rural-wildland interface, hobby farming/livestock, or full-scale resort developments with golf courses.

Private land may offer habitat features that are especially attractive to wolves so the pack may use those lands disproportionately more often than other parts of their territory. Land uses may predispose a pack to conflict with people or livestock, although the presence of livestock does not make it a forgone conclusion that a pack will routinely depredate. Domestic livestock are present year round within the territories of many Montana packs. For example, since the late 1980s, the Ninemile and Murphy Lake packs encountered livestock regularly, but caused conflict only sporadically.

The earliest colonizing wolves had large territories. Ream et al. (1991) reported an average of 460 square miles. In recent years average territory size decreased, probably as new territories filled in suitable, unoccupied habitat. In the Northwest Montana Recovery Area during 1999 the average territory size was 185 square miles for eight packs. Individual territories were highly variable in size, with a range of 24-614 square miles (USFWS et al. 2000).

Territories in the GYA were larger, averaging 344 square miles with 11 packs. Individual pack territories ranged from 33 to 934 square miles. Central Idaho wolf packs had the largest average territory size of 360 square miles with 13 packs, with individual pack territories ranging from 141 to 703 square miles (USFWS et al. 2000).

Dispersal

When wolves reach sexual maturity, some remain with their natal pack while others leave, looking for a mate to start a new pack of their own. These individual wolves are called dispersers. Dispersal may be to nearby unoccupied habitat near their natal pack's territory or it may entail traveling several hundred miles before locating vacant habitat, a mate, or joining another pack. Animals may disperse preferentially to areas occupied by conspecifics (Ray et al. 1991). This appears true for the gray wolf, a species that uses scent marking and howling to locate other wolves (Ray et al. 1991). Boyd and Pletscher (1999) indicated that the dispersers in their study moved toward areas with higher wolf densities than found in their natal areas, in this case northward towards Canada. This has important implications for wolves in Montana, which now have conspecifics to the south and west in central Idaho and YNP. Dispersal already has resulted in the formation of several new packs in Montana (Fig. 2) (Boyd et al. 1995, USFWS et al. 2001). Wolves probably will

continue dispersing from the core areas and slowly occupy landscapes between the Canadian border, central Idaho and northwestern Wyoming (USFWS et al. 2000).

Ultimately this will yield a meta-population capable of genetic exchange across the northern Rocky Mountains (Forbes and Boyd 1996, 1997).

Boyd and Pletscher (1999) studied wolf recovery in northwestern Montana from 1979 to 1997. Male wolves dispersed at an average age of 28.7 months and traveled an average of 60 miles from their natal territory before establishing a new territory or joining an existing pack. Females averaged 38.4 months old at dispersal and traveled an average of 48 miles. Males and females, combined, traveled an average of 60 miles (range 10 - 158 miles). A captured sample of males and females dispersed at rates proportional to their occurrence. There were two peaks of dispersal: January-February (courtship and breeding season) and May-June.

The Yellowstone Wolf Project documented 36 dispersal events (18 females and 18 males) from 1995to 1999 (Smith et al. 2000). Males dispersed an average of 54 miles and females dispersed an average of 40 miles. The longest recorded dispersal of a Yellowstone wolf to date was 221 miles. This Yellowstone-born male ultimately settled in central Idaho.

Increasingly, dispersal is being documented among and between all three recovery areas in the northern Rockies (Bangs et al. 1998, Mack and Laudon 1998, Smith et al. 2000). Combined, there were 21 known dispersal events in 2000 and 19 in 1999 (USFWS et al. 2000). Dispersal paths crossed international boundaries, state boundaries, public and private land boundaries, different land uses, and agency jurisdictions.

Mortality

Wolves die from a variety of causes, usually classified as either natural or human-caused. Naturally caused mortalities result from territorial conflicts between packs, injuries while hunting prey, old age, disease, starvation or accidents. In an established Alaskan wolf population largely protected from human-caused mortality, most wolves were killed by other wolves, usually from neighboring packs (Mech et al. 1998). However, in the northern Rockies, natural mortality probably does not regulate populations (USFWS 2000). Humans are the largest cause of wolf mortality and the only cause that can significantly affect populations at recovery levels (USFWS 2000). Human caused mortality includes control actions to resolve conflicts, legal and illegal killings, and car/train collisions.

Pletscher et al. (1997) studied survival and mortality patterns of wolves in the GNP area. Total annual survival for this semi-protected population was a relatively high 80 percent. The survival rate for resident wolves was even higher (84 percent), but dispersers had a 64 percent chance for survival. Despite the high survival rates, humans accounted for the vast majority of wolf deaths. Of the 43 deaths investigated from 1982 to 1995, 88 percent were human-caused (56 percent legal, 32 percent illegal). Three wolves died of natural causes and two died of unknown causes.

More recent mortality data are available from the USFWS et al. (2001). In the Northwest Montana Recovery Area, there were at least 18 mortalities in 2000. Cause of death was known for 15. At least seven wolves were illegally killed, four died in agency control actions, and four died from vehicle /train collisions. In the GYA, at least 20 wolves died in 2000, and the cause of death is known for 15. Nine wolves died due to human causes (six control actions, two vehicle collisions, one illegal) and six died from natural causes. Five additional mortalities were documented, but the causes were not readily apparent. These either were classified as unknown or unresolved pending further investigation. In the Central Idaho Recovery Area, 17 human-caused mortalities were documented in 2000. Control actions removed 10. One wolf died of natural causes and five more died from unknown causes.

Genetics

In recent years the application of genetic techniques to the study of wildlife populations has permitted managers to address issues of genetic diversity and population viability with increased confidence. These techniques have yielded information relevant to wolf conservation and management in the northern Rockies. Wolf recovery in the northern Rockies advanced from the combination of recolonization of northwestern Montana by relatively few wolves from Canada and the reintroduction of wolves into YNP and central Idaho. In northwestern Montana the founding population was small enough that inbreeding among closely related individuals was possible. Fortunately, the genetic variation among the first colonizers was high (Forbes and Boyd 1996). The combination of high genetic variation among colonizers and ongoing natural dispersal to and from Canadian populations was adequate to ensure long-term population viability, provided that genetic exchange continued.

Similar concerns existed for the relatively small founding population reintroduced to YNP and central Idaho. But wolves were trapped from two distinct source populations in Canada. The genetic variation among reintroduced wolves (and the source populations from which they came) also was high (Forbes and Boyd 1997). Overall, heterozygosity was similar among samples of natural recolonizers, reintroduced individuals, and the Canadian source populations. Field studies of wolf dispersal and migration distances supported the genetic results (Ream et al. 1991, Boyd et al. 1995, Boyd and Pletscher 1999). Wolf populations in the northern Rockies should not suffer from inbreeding depression.

An underlying tenant of the wolf recovery and restoration program is that each state's wolf population is functionally connected so that genetic material can be exchanged among all three. In isolation, none of the three populations could maintain its genetic viability (USFWS 1994a, Fritts and Carbyn 1995).

Population Growth

Wolf populations increase or decrease through the combination and interaction of wolf densities and prey densities (Keith 1983, Fuller 1989). Actual rates of change depend on whether the wolf population is pioneering vacant habitat (as in YNP and central Idaho) or whether the population is well established (as in northwestern Montana). The degree and type of legal protection, agency control actions, and regulated harvest also influence population trends. Once established, wolf populations can withstand as much as 45 percent mortality from all sources (National Academy of Sciences 19XX), with some studies indicating that established populations may withstand as much as 28-35 percent mortality from humans exclusive of natural mortality factors (Keith 1983, Fuller 1989).

If protected, low density wolf populations can increase rapidly if prey is abundant. Keith (1983) speculated that a 30 percent annual increase could be the maximum rate of increase for any wild wolf population. Once densities were high enough, social interactions probably intensify. Intraspecific conflict and increased competition for food eventually cause the population to level off or decline (Keith 1983, Fuller 1989).

Wolf populations in the GNP area (northwestern Montana and southeastern Alberta) increased an average of 23 percent annually from 1986 to 1993 (Fritts et al. 1995). After 1993 the population leveled off (Pletscher et al.1997). Those packs produced dispersers that eventually colonized vacant habitats in western Montana (USFWS unpubl. data). Some packs which formed in the Northwestern Montana Recovery Area since the early 1990s persisted, but others did not. Packs have been lost due to illegal mortality, control actions where livestock depredation was chronic, and for unknown reasons.

The average annual rate of increase from 1992 to 2000 in northwestern Montana was 4.7 percent (USFWS et al. 2001). In 1992 the minimum mid-winter count (including pups) was 41 wolves. Sixty-two wolves were counted in 2000. The highest count was 70 wolves at the end of 1996. The population grew in some years, but declined in others. Some of the variation probably reflects true changes wolf numbers, but some variation may be due to monitoring inaccuracy or decreased monitoring effort.

Prey populations influenced recent wolf population dynamics in northwestern Montana. White-tailed deer populations expanded from the late 1970s through the mid 1990s, in part precipitating and sustaining increases in wolf numbers and distribution. However, the winter of 1996-1997 was exceptionally severe, and white-tailed deer populations declined significantly (Sime, unpubl. data).

Other prey populations also declined, with poor recruitment attributed to winterkill. The USFWS believes the significant decline in natural prey availability led to the record high number of livestock depredations and subsequent lethal control. Wolf depredations on livestock in 1997 alone accounted for 50 percent of all depredations in northwestern Montana between 1987 and 1999. Smaller prey populations likely translated to decreased wolf pup survival in 1997 and 1998, compared to 1996. Ungulate populations rebounded in recent years and the wolf population also is nearing its 1996 level.

Wolf populations in the GYA and central Idaho areas exceeded all expectations for reproduction and survival (Bangs et al. 1998). Populations became established in both areas within two years, rather than the predicted three to five years. Pup production and survival in the GYA has been high. The average annual growth rate for the GYA from 1996 to 2000 is 35 percent, based on the minimum count as of December 31 and including pups (USFWS et al. 2001). However, population growth in the GYA slowed in 1999 after the rapid increase in the first three years post-reintroduction (Smith et al. 2000). The average annual growth rate for this population is 36 percent, based on minimum counts on December 31 and including pups (USFWS et al. 2001).

It is likely that population growth rates will slow for both the core Yellowstone and central Idaho populations because of declining availability of suitable, vacant habitat. However, these populations will be a source of founders for new packs outside YNP, central Idaho, Wyoming and Montana. While population growth slows or levels off in core areas, wolf numbers and distribution outside core areas are expected to increase rapidly in the next few years as wolves born in the initial pulse sexually mature and disperse to colonize vacant habitats elsewhere.

Pack membership typifies the predominant manner in which a wolf exists in the wild. The pack is the mechanism by which wolves reproduce and populations grow. However, in most wolf populations, some lone, nomadic individuals exist as dispersers -- looking for vacant habitat, waiting to be found by a member of the opposite sex within a new home range, or searching for an existing pack to join. Up to 10-15 percent of a wolf population may be comprised of lone animals.

This is a temporary transition. Wolves in northwestern Montana usually found other wolves in an average of 66 days (range 2-202 days) (Boyd and Pletscher 1999). Occasionally, lone wolves get into conflict with people and/or livestock, ultimately being lost to the population through legal or illegal means. For a wolf to make a contribution to the population, it must affiliate with other wolves. Until they affiliate with a pack, lone wolves generally are counted separately or omitted from population counts altogether because they do not contribute to population growth.

DISEASES AND WOLVES IN OREGON

The arrival of wolves into northeastern Oregon was from populations in western Idaho and the arrival of this charismatic species has raised questions among different stakeholders about their effect on not only livestock, but also management of other wildlife species, and pathogens they may carry or are infected with from prey they consume in Oregon. The effects of disease associated with this top carnivore and other wildlife, pets, livestock, and humans are largely unknown in Oregon. However, based on the literature and past events and current populations in other regions, the risk of negative consequences from disease is predicted to be

minimal if not extremely low. The founding populations in Idaho are not presently noticeably impacted by any epidemic or epizootic diseases.

Wolves (*Canis lupus*) are exposed to a variety of viral, bacterial, fungal and parasitic diseases throughout all areas of their range. Due to the naturally low densities of this top carnivore species, the large home range and distribution among packs within populations, and relatively secretive nature of wolves, large die-offs from disease might go undetected unless specific populations are being intensively monitored (Brand et al. 1995). From a management perspective, ODFW, through our wildlife health program, monitors and conducts surveillance for emerging or re-emerging diseases in Oregon, and we evaluate the effects endemic Oregon diseases have on a new host like the wolf. We are also vigilant in surveillance for pathogens that might prove infectious to people should they come in contact with infected wildlife.

Several publications provide extensive overviews of the known diseases that affect free-ranging wolves (Brand et al. 1995, Mech 1970). This summary identifies diseases carried by wolves that may be associated with Oregon populations. Portions of this summary are adapted from a recently published chapter on wolf diseases by ODFW veterinarian, C. Gillin with D. Hunter in Reading et al. 2010. The following pathogens are a list of those occurring throughout the range of the wolves in western North America, including several pathogens shared with domestic dogs and other wild canids.

Viruses

Viral diseases are most important to carnivores from an epizootic perspective. Viral diseases affecting wolves in North America include rabies, canine parvovirus, canine distemper, infectious canine hepatitis, and oral papillomatosis. Of these, epidemic and endemic rabies is predicted to be capable of causing population declines in wolves and other wild carnivores. Canine parvovirus is another virus that may affect wolf pup recruitment based on evidence in a captive wolf colony in Minnesota where 11 of 12 pups succumbed to the disease (Mech and Fritts 1987). Such poor pup survival has the potential to severely impact recruitment in wild populations.

Brand et al. (1995) and others (Johnson (1995), Mech (1970), Murie (1944), and Cowan (1949)) identified rabies as a disease that could potentially limit population numbers. Rabies is a virus that is generally confined to one species in a geographic area, although extension to other species is not uncommon. However, the role that rabies may play in regulating wolf populations is unknown (Brand et al. 1995). Historic and recent accounts of rabies in wolves (Ballard et al. 1997) indicate that this disease will likely remain in wolf range for extended periods and several authors have shown wolf packs being reduced due to the incidence of rabies (Chapman 1978, Davis et al. 1980, Theberge et al. 1994).

North American wolves are not considered reservoirs of rabies virus. In published cases, wolves were suspected of contracting the disease from other canid species including red foxes (*Vulpes vulpes*) and arctic foxes (*Alopex lagopus*) (Mech 1970, Rausch 1973, Ritter 1981, Theberge et al. 1994). The spread of rabies by wolves, though generally contained within individual packs (Chapman 1978), can occur when infected animals contact members of adjacent packs at their territory boundaries or via dispersing individuals. In Oregon, as of 2010, rabies is limited to strains associated with bats and is considered a very low disease risk in wolves.

Canine parvovirus was first detected in domestic dogs in 1978 and had spread worldwide by 1980 (Pollock 1984). Parvovirus is very stable in the environment and spread by direct contact and fecal contamination of the habitat. Once infected, canids are capable of periodically shedding the virus for many years. Based on retrospective studies of serological data, canine parvovirus likely entered wild coyote (*Canis latrans*) and wolf populations in North America sometime during 1978-79 (Barker et al.

1983, Thomas et al. 1982) and possibly as early 1975 (Goyal et al. 1986). Canine parvovirus occurs worldwide and in Oregon is most frequently diagnosed in domestic dogs.

[6]Parvovirus may limit some wolf populations through pup mortality. A decline in the wolf population of Isle Royale National Park, Michigan in the 1980s coincided with an outbreak of CPV among dogs in the region, and the subsequent appearance of antibodies against CPV in sampled wolves indicated exposure to the virus (Peterson 1995 as cited in Kreeger 2003). However, Mech (2011) noted that the evidence for a CPV caused decline was sparse and that malnutrition and intra-specific strife offered a more cogent explanation for the decline (Mech, 2011; Peterson and Page 1988). A correlation between increased antibody levels indicative of exposure and fewer pups over a 30-year period suggested that CPV limited growth of a Minnesota wolf population through pup mortality (Mech et al. 2008). Re-examination of 35 years of data in this population indicated that the effect of CPV on pup survival waned after seven years, despite continued high prevalence of antibodies, suggesting that once CPV became endemic and produced its peak effect on the study population, that population developed enough immunity to withstand the disease (Mech and Goyal, 2013). Exposure to CPV in young and adult wolves in YNP was 100% with no evidence of any correlation with pup mortality (Almberg et al. 2009).

[7]Three wolf mortalities have been directly attributed to CPV infection: a 9-month-old female from Minnesota in 1993 (Mech et al. 1997), a yearling female and male pup from the same pack in Oregon in 2013 (ODFW 2014) and a male pup in a neighboring pack area in 2018 (ODFW, unpublished data). These deaths demonstrate that CPV can also kill older wild wolves, not just pups.

Historic exposure (months to years) to CPV can be determined by the presence of immunoglobulin G (IgG). In Oregon, 32 of 38 Oregon wolf samples tested between 2010 and 2016 tested positive for IgG antibodies to CPV (86.8% prevalence). A positive test for this antibody means that the wolf was likely exposed to the virus at some point in their lives. Acute exposure to CPV is usually evaluated by testing for the presence of a rapidly produced antibody, immunoglobulin M (IgM) that persists from days to weeks. Only 4 of 38 tested were negative for both IgM and IgG antibodies to CPV, confirming the prevalent and persistent nature of the CPV virus in the environment. More recently, 13 of 14 of those wolves testing positive for IgM antibody for CPV were from serum collected between 2014 and 2016 indicating that more active infections or exposures were being documented during this time.

Canine distemper (CDV) is another important viral disease of wolves and other carnivores. This disease affects domestic dogs at three to nine weeks of age (Gillespie and Carmichael 1968) and morbidity and mortality can be high in exposed, unvaccinated animals. Despite the ubiquitous distribution of canine distemper, there are only two reports in the literature of mortality occurring in wild populations (Carbyn 1982 and Peterson et al. 1984). Because recruitment in North American wolf populations is generally good, canine distemper cannot be considered a significant mortality factor (Brand et al. 1995). Canine distemper virus occurs throughout the state of Oregon, most frequently identified in raccoon and skunk populations west of the Cascade Range.

[8]Exposure, as diagnosed by the presence of antibodies in the blood of an animal, to CDV in North American wolves is variable over time and among populations. Studies from Canada and Alaska

[6] Paragraph from Conservation Plan for Gray Wolves in California Part II, December 2016, used with permission
[7] Paragraph from Conservation Plan for Gray Wolves in California Part II, December 2016, used with permission
[8] Paragraph from Conservation Plan for Gray Wolves in California Part II, December 2016, used with permission

suggested that approximately 17% of wolves were exposed to CDV (Choquette and Kuyt 1974; Stephenson et al. 1982; Zarnke and Ballard 1987; Bailey et al. 1995; Brand et al. 1995). Exposure to distemper has increased over time in Montana's wolf population from 2007 through 2013, becoming quite prevalent (Sime et al. 2011; Bradley et al. 2013, 2014). Monitoring data from YNP showed that in contrast to other viruses to which wolves were constantly and commonly exposed, the number of sampled wolves exposed to CDV varied greatly over time and that high CDV exposure prevalence in wolf pups was correlated with years having poor pup survival (Almberg et al. 2009). Although the findings suggest that CDV may have contributed to pup mortality in YNP, mortalities due to CDV were not confirmed during the study period and the number of wolf pups sampled each year was small. It is not known if wolves maintain CDV within their population or whether the periodic peaks in exposure are due to spillover transmission of the virus from other carnivore hosts in the YNP ecosystem (Almberg et al. 2009).

Oregon wolves sampled between 2010 and 2016 show a relatively low (7.9%), but increasing prevalence of positive antibody titers to CDV (ODFW Data). None of the 19 wolves sampled between 2010 and 2013 tested positive for CDV antibiodies, but 3 of the 19 wolf samples collected between 2014 and 2016 tested positive for IgG antibodies to CDV (15.8% prevalence).

Infectious canine hepatitis (ICH) is another important viral disease in domestic dogs and has been reported in Alaskan (Zarnke and Ballard 1987, Stephenson et al. 1982) and Canadian (Choquette and Kuyt 1974) wolves. In Alaskan populations, annual prevalence has reached 100% with up to 42% of the exposed animals being pups, suggesting exposure at an early age. Although, infectious canine hepatitis appears to be enzootic in wolf populations, the percentage of wild wolves that test positive for exposure to this disease is uncorrelated with its occurrence in domestic dogs. No mortality from this disease has been reported in wolves. Serology of the 38 Oregon wolf samples tested between 2010 and 2016 revealed 24 wolves with detectable titer levels indicating exposure to the virus in the past and have likely built up an immune response to the virus (ODFW, unpublished data).

Oral papillomatosis virus has been reported in wild populations of wolves and coyotes (Samuel et al. 1978). Although this disease causes severe oral tumors in coyotes (Trainer et al. 1968), it has not been documented to cause mortality in wild wolves or other canids and is not considered a threat to those populations. The occurrence, distribution, and risk to wolf populations of this virus in Oregon are unknown.

Bacterial and Fungal Diseases

The most noted bacterial disease threats in Oregon and North American populations of wolves are Lyme disease (*Borrelia burgdorferi*), leptospirosis (*Leptospira* spp.), tularemia (*Francisella tularensis*), and plague (*Yersinia pestis*). Of these, Lyme disease and plague are spread through the bite of infected fleas and ticks, whereas the other diseases are passed primarily through the exposure to, or consumption of, mammalian prey.

Lyme disease has the potential to infect wolves but clinical disease has never been demonstrated (Kazmierczak et al. 1988). The bacterium is spread through the bite of infected ticks, principally of the genus *Ixodes damnii.* It is passed to other species through transmission via a life cycle involving small mammals such as the white-footed deer mouse (*Peromyscus leucopus*) that host immature ticks and then to deer, the host of the adult ticks. In one study, two of 78 wild wolves sampled in Wisconsin and Minnesota tested positive to exposure, though disease or clinical signs were not

apparent (Kazmierczak et al. 1988). Recent research suggests exposure has greatly increased in Wisconsin (Jara et al. 2016). Lyme disease occurs in Oregon providing a potential for wolves to be exposed to this bacteria through an infected tick bite.

Leptospirosis infection, of the bacterium *Leptospira* spp., is endemic in domestic hogs, cattle, and horse herds in parts of Minnesota and in moose (*Alces alces*) populations (Khan et al. 1991). Signs of disease in domestic animal populations range from undetectable to mortalities depending on the species, type of microorganism, and host (Brand et al. 1995). Wolves in Alaska (Zarnke and Ballard 1987) and in northern Minnesota (Khan et al. 1991) have tested positive for exposure to the disease. However, clinical disease has not been documented in wild canids. The disease is spread among carnivores primarily through infected urine or via consumption of infected food (Reilly et al. 1970). ODFW has documented exposure to this bacterium in multiple wildlife species throughout the state. Of the 38 wolf samples tested between 2010 and 2016, two wolves had positive serological titers at a level of 1:200 to the serovar *L. grippotyphos*a resulting in an overall prevalence of 5.3%. This titer level is not necessarily indicative of a current infection.

Tularemia (*Francisella tularensis*) is present in many rabbit and rodent populations. The disease has caused clinical signs in coyotes and foxes (*Vulpes* spp.) including diarrhea, loss of appetite, and difficulty in breathing (Bell and Reilly 1981). However, clinical disease has not been documented in wolves, although some Alaskan populations have shown exposure. It is thought that most wild canids are fairly resistant to the disease (Zanke and Ballard 1987).

In many areas where tularemia is found, the plague bacterium (*Yersinia pestis*) is also present. Similar to tularemia, canids have demonstrated an apparent resistance to infection with *Y. pestis*. Plague is maintained in wild rodent populations. Clinical disease has not been reported in wolves, although antibody titers exist in regions of wolf range where plague is found in their prey. The plague organism is spread by fleas and can be devastating in some rodent populations including prairie dogs (*Cynomys ludovicianus* and *C. gunnisoni*) in the Western United States. Both tularemia and plague occur throughout Oregon, but are unlikely to have an impact on the overall wolf population.

One undocumented disease threat to wolves is salmon poisoning disease (SPD), a fatal disease of dogs including wild species such as coyotes and fox that occurs on the western slopes of the Cascade Mountains from northern California to central Washington. The disease, first recognized by white settlers in the early 19th century (1814), was named salmon poisoning disease because dogs became sick after eating salmon.

SPD is caused by a bacterium called *Neorickettsia helminthoeca* that is carried by a parasitic fluke which has a complicated life cycle involving both snails and salmonid fish. The fluke harbors the bacteria throughout its life including immature fluke stages which are released from the snails and then infect fish. The immature flukes encyst in salmonid fish (and some non-salmonid fish and Pacific giant salamanders) and are then consumed by fish-eating mammals such as canids, bears, and raccoons. Wild and domestic canine species become severely ill when the developed and mature fluke releases the bacteria into the dog's intestine, from which the bacteria spreads to lymph nodes, spleen, liver, thymus, and brain. Although wolves do not currently occupy suitable habitat west of the Cascade Range, this disease could cause clinical signs, illness and death in wolves consuming infected salmon.

Fungal diseases do not appear to play an important morbidity or mortality role in wild wolf populations. The only reported fatal case occurred in a wolf in Minnesota from the fungal disease

blastomycosis (*Blastomyces dermatitidis*) (Thiel et al 1987). This disease is enzootic and limited to the region encompassing Minnesota and Wisconsin and is most commonly diagnosed in domestic dogs in those states (Archer 1985). In Oregon, infection with *Cryptococcus neoformans* and *C. gatti* may also pose a risk to individual wolves. This pathogen has been documented in elk in western Oregon.

Internal Parasites

Holmes and Podesta (1968), Mech (1970), and Archer et al. (1986) describe an array of parasites for which wolves serve as an important host species. These parasites include three species of spiny-headed worms (acanthocephala), nine species of flukes (trematodes), 21 species of tapeworms (cestodes), and 24 species of roundworms (nematodes). As a general observation, the majority of parasite infections cause little pathology among wolves and apparently are not a factor in regulating populations (Brand et al. 1995). Several species of note are described below.

Dog heartworm infection (*Dirofilaria immitis*) is caused by a nematode that inhabits the heart and pulmonary arteries of canid and several felid species, but is most prominent in domestic dogs. Several case history accounts of dog heartworm infection and fatalities have occurred in wolves held in zoo collections where the parasite occurs enzootically (Hartley 1938, Coffin 1944, Pratt et al. 1981). This disease may have been partially responsible for the decline of red wolves (*Canis rufus*) in the southeastern U.S. (McCarley and Carley 1979). Mech and Fritts (1987) have expressed concern over the potential effects of *D. immitis* infection in free-ranging wolves in heartworm enzootic areas. Heartworm infection is presently not likely a population risk factor for Oregon wolves as the parasite occurs primarily in isolated areas of western Oregon.

Dog hookworm (*Ancylostoma caninum)* is another internal parasite of canids that causes intestinal ulcerative lesions through its blood-feeding activities. In domestic dogs, emaciation accompanied by a deficiency of red blood cells, diarrhea and occasionally death can occur. Although this parasite has not been reported in gray wolves, it has been suspected of causing infection and death in red wolves (McCarley and Carley 1979, Custer and Pence 1981) and coyotes (Mitchell and Beasom 1974). Similar morbidity and mortality may occur in areas inhabited by gray wolves where the parasite is enzootic (i.e., endemic) (Brand et. al 1995).

Wild canids, including wolves, harbor a wide variety of Cestodes (tapeworm) populations, particularly from the genera *Taenia* and *Echinococcus*. From an individual animal and population perspective, tapeworms do not cause known negative pathologic changes because they do not feed on the host, but rather use nutrients of passing ingested food in the intestinal tract of the host.

Wolves and other carnivore species serve as definitive hosts to tapeworms. *Taenia* tapeworms are fairly common in all wild canids with the eggs passed in the host's feces. The eggs are ingested by an intermediate host like a deer or elk where they hatch in the animal's small intestine. The emerging larvae migrate to muscle where it encysts. A carnivore host then ingests the infected meat and the encysted larvae matures in the predator's intestine to an adult worm and begins reproduction of eggs. Oregon deer and elk are commonly diagnosed with encysted tapeworm larvae.
Similarly, the tapeworm *Echinococcus granulosus* requires two hosts to complete its life cycle. Ungulates (deer, elk, moose, domestic sheep, and domestic cattle) are intermediate hosts for larval tapeworms which form hydatid cysts in the body cavity. Canids (dogs, wolves, coyotes, foxes) are definitive hosts where larval tapeworms mature and live in the small intestine. Definitive hosts are exposed to larval tapeworms when ingesting infected ungulates. Adult tapeworms, 3-5 mm long, produce eggs

which are expelled in canids feces. Intermediate hosts ingest the eggs while grazing, where the eggs hatch and develop into larvae.

[9]*E. granulosus* has a worldwide distribution (Gottstein 1992). There are two recognized biotypes of the parasite – the northern or sylvatic biotype that circulates between canids (wolf, dog) and cervids (moose, caribou, reindeer, deer, and elk) and is present above 45th parallel which passes through northern Oregon, bisects Montana and Wyoming, and roughly corresponds to the border with Canada across the Midwest and eastern United States. The northern biotype does not appear to cross-infect domestic livestock (Rausch 1986 as cited in Drew 2010). The southern or domestic biotype is comprised of at least nine different strains and circulates between domestic dogs and domestic ungulates, especially sheep (Jones and Pybus 2001). The southern biotype is endemic (i.e., regularly found) in most sheep raising areas of the world including the southwestern United States, specifically Arizona, California, New Mexico, and Utah (Schwabe et al. 1971; Foreyt et al. 2009).

In North America, *E. granulosus* in wolves had been reported previously in Alaska and Minnesota in the United States, and Alberta, British Columbia, Northwest Territories, Ontario, and Yukon Territory in Canada (Jones and Pybus 2001). From 2006-2008 adult tapeworms were detected in 39 of 63 wolves (62%) collected in Idaho, and 38 of 60 wolves (63%) collected in Montana (Foreyt et al. 2009). The parasite has also been detected in the digestive tracts of wolves that have died in Oregon (ODFW, unpublished data).

Hydatid cysts were found in domestic sheep from Idaho sent to California for slaughter in the late 1960's and early 1970's. In Oregon, hydatid cysts were documented in a deer carcass from Grant County in 1977 and have also been documented in Montana and Idaho wild ungulates and wolves (Foreyt et al. 2009). In Oregon, the parasite is possibly maintained in wild coyote and fox populations.

[10]Based on available information, the health risks associated with *E. granulosus* to wildlife and livestock is low. Heavy infections in wildlife may be related to poor body condition. In ungulates, the presence of large numbers of hydatid cysts in the lungs can lead to respiratory difficulty. The presence of hydatid cysts in livestock at slaughter is generally not of concern, and if present, is trimmed from the carcass. *E. granulosus* already exists in both wild and domestic species in California, thus recolonization of the state by wolves would not introduce the disease to California. Only people who have close contact with feces or fur of infected wolves without taking any prevention measures (i.e., wearing gloves, not washing hands after working) would be at risk of *E. granulosus* infection. Despite the parasite being present in wolves, no reports could be found of humans being infected by *E. granulosus* contracted from wolves in the contiguous 48 states.

Control of parasite infections in wild animals is difficult to unfeasible. However, because most human infections are associated with infected domestic dogs, not wildlife, regular deworming treatment of domestic dogs and good hygienic practices by humans in contact with dogs are the best methods of control and prevention. Dog owners should not allow their dog to consume uncooked meat or organs from wild or domestic ungulates or to touch or disturb wolf, coyote, or fox scat.

[9] Paragraph from Conservation Plan for Gray Wolves in California Part II, December 2016, used with permission
[10] Two paragraphs from Conservation Plan for Gray Wolves in California Part II, December 2016, used with permission

Hunters should wear gloves when field dressing a canid carcass, and wash any body part that may have come into contact with feces or contaminated fur.

[11]*Echinococcus multilocularis*, a closely related tapeworm to *E. granulosus*, utilizes slightly different hosts for its life cycle. The most common definitive hosts (which consume cysts in the infected intermediate hosts and can shed the tapeworm eggs in feces) are small carnivores (coyotes and foxes) (Jones and Pybus 2001). Domestic dogs and cats may also serve as definitive hosts, especially in areas where the parasite is present in urban/suburban fox and coyote populations (Eckert 2004; Catalano et al. 2012). Instead of ruminants (as in *E. granulosus*), a wide variety of small mammals serve as intermediate hosts including voles, mice, lemmings, shrews, and muskrats (Jones and Pybus 2001). In North America *E. multilocularis* is found primarily in the north central region from eastern Montana to central Ohio, as well as Alaska and Canada (Centers for Disease Control and Prevention 2012; Catalano et al. 2012). Natural *E. multilocularis* infection was recently documented in wolves from Canada (Schurer et al. 2014), but has not been reported in wolves from the U.S. *E. multilocularis* can cause alveolar (vacuolated) cysts in the tissues of people that accidentally ingest the tapeworm eggs (Moro and Schantz 2009). Although rare, alveolar hydatid infection can be severe in people and measures to prevent human infections are similar to those for *E. granulosus* (Moro and Schantz 2009). *E. multilocularis* has not been reported in the western United States (Centers for Disease Control and Prevention 2012).

One other parasite of note is the small, single celled parasite known as *Neospora caninum*. This parasite can cause severe clinical disease in dogs, cattle, and other animals (Dubey 2003; Dubey and Thulliez 2005). The most common clinical sign associated with cattle with neosporosis is abortion. Dogs and coyotes are important in the epidemiology of this parasite because they are the only known definitive hosts where the parasite can complete its entire lifecycle in a single host animal (Gondim et al. 2004). Wolves may also serve as definitive hosts. However, other species such as deer and raccoons can carry and shed the disease and may play an important role in the disease's spread and sylvatic cycle (Gondim 2006; Lindsay et al. 2001). Cattle frequently become infected via the ingestion of feed contaminated with oocysts or eggs shed transiently in the feces of acutely infected dogs (Barber et al. 1997). This disease has been in Oregon for a number of years and occurs in the state, generally associated with dairy operations. In a 2007 study conducted by Tufts University School of Veterinary Medicine (Lawrence and Pokras, unpublished), 40% of the coyotes and 10% of the dogs associated with selected dairies indicated previous exposure to the Neospora parasite. The risk of infection from wolves to cattle in Oregon is considered extremely low when compared to farm dogs and other wild canids living in proximity to cattle operations.

External Parasites[12]

Various ectoparasites including ticks, fleas, biting flies (Itamies,1979, as cited in ODFW 2010), lice, and mange mites have been reported on wolves (Table 7.8 in Kreeger 2003). The two ectoparasites that can cause illness and mortality in wolves are lice and mange mites.

Infestation with the dog louse (*Trichodectes canis*) can cause illness in wolves but there is little evidence that the parasite causes negative effects on populations (Schwartz et al. 1983; Mech et al. 1985; Jimenez et al. 2010a). The louse is transmitted by direct contact between infected and uninfected

[11] Modified excerpt from Conservation Plan for Gray Wolves in California Part II, December 2016, with permission
[12] This section is excerpted from Conservation Plan for Gray Wolves in California Part II, December 2016, with permission

animals. Infected animals show varying degrees of hair loss, skin infection, and inflammation that causes severe itching of the skin (pruritis). An outbreak of lice occurred in Alaskan wolves from 1981-1983, with affected wolves having hair loss (alopecia) and seborrhea (crusts and oily skin resulting from excessive sebaceous gland discharge) present on up to 75% of their body surface (Schwartz et al. 1983; Taylor and Spraker 1983; Zarnke and Spraker 1985). Lice have also caused clinical disease in individual wolves in Idaho and Montana (Jimenez et al. 2010a).

Sarcoptic mange (scabies) is a highly contagious skin disease caused by the mite *Sarcoptes scabiei*. Burrowing into the epidermis by mites and the subsequent allergic response by the host to excretions from the mites causes intense itching (pruritis), leading to progressive skin damage as the infested animal bites, scratches, and rubs the affected areas. Infested animals can suffer from alopecia, abnormal thickening of the skin (hyperkeratosis), excessive discharge of sebum from sebaceous glands in the skin (seborrhea), scabs, and ulcerations. Severe infestations can affect the animal's entire body, leading to emaciation, poor body condition, and death from secondary infections or the inability to maintain normal body temperature in winter due to hair loss (Bornstein et al. 2001). Mites are transmitted by direct contact between infested and non-infected individuals, contact with mite-contaminated denning and bedding areas, and contact with contaminated rubbing or scratching objects.

Sarcoptic mange can result in high mortality, especially in pups and may have a role in reducing local population numbers (Todd et al. 1981 and Pence and Custer 1981 as cited in Kreeger 2003; Jimenez et al. 2010b). Between 1991 and 1996, 27% of live-trapped Wisconsin wolves exhibited symptoms of mange. During the winter of 1992-93, 58 percent showed symptoms and a concurrent decline in the Wisconsin wolf population was attributed to mange-induced mortality (Wisconsin Department of Natural Resources 1999). During that same period, mange was the third-most common cause of death in Wisconsin wolves, behind trauma (usually vehicle collisions) and illegal shooting (Wisconsin Department of Natural Resources 1999). Sarcoptic mange was confirmed in 16 wolves in Montana and six wolves in Wyoming from 2002 through 2008, and clinical signs were observed in an additional 40 wolves in Montana and 30 wolves in Wyoming (Jimenez et al. 2010b). Mange-infested wolves continue to be documented in southwest Montana and in at least one pack in Wyoming (Bradley et al. 2014; Wyoming Game and Fish Department et al. 2014). This mange mite occurs naturally throughout Oregon in many species of wildlife.

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FEDERAL/STATE COORDINATION STRATEGY FOR OREGON WOLF PLAN IMPLEMENTATION

WHERE WOLVES REMAIN FEDERALLY LISTED

April 2019

Coordinating Agencies:

FEDERAL/STATE COORDINATION STRATEGY

FOR OREGON WOLF PLAN IMPLEMENTATION

Communication and Support on Wolf Management
Where Wolves Remain Federally Listed

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Purpose and Need

The purpose of this document is to describe how state and federal wildlife management agencies will collaborate on wolf management activities in central and western Oregon where the gray wolf (*Canis lupus*) remains federally listed under the U.S. Endangered Species Act (ESA). This April 2019 version replaces the March 2011 version.

The Oregon Department of Fish and Wildlife's (ODFW) Oregon Wolf Conservation and Management Plan (Oregon Wolf Plan) was first adopted by the Oregon Fish and Wildlife Commission in 2005 and is currently being updated with adoption of the new plan anticipated sometime in 2019. It provides comprehensive management direction for conserving and managing Oregon's wolves, including population objectives, monitoring plans, and a framework for managing conflicts between wolves and other resource values (www.dfw.state.or.us/Wolves/ management_plan.asp). ODFW is the lead agency for implementing the Oregon Wolf Plan.

The U.S. Fish and Wildlife Service (USFWS) is the lead federal agency responsible for recovery of ESA-listed wildlife. USFWS fully supports ODFW's implementation of the Oregon Wolf Plan and on March 15, 2019 formally proposed removing the gray wolf from the ESA list across much of the country, including all of Oregon (FR 9648). Until gray wolves are federally delisted in Oregon, USFWS aims to assist ODFW in its successful implementation of the Oregon Wolf Plan in areas of the state where wolves remain federally listed. Federal ESA protections affect some aspects of wolf management and thus coordination between federal and state agencies is needed to ensure the Oregon Wolf Plan is implemented in a way that complies with all applicable laws.

Prompt sharing of information between agencies and with affected stakeholders is a key element of successful wolf management and thus the focus of this document is on whom to notify when different wolf-related events occur. To better facilitate information exchange, this version of the coordination strategy has a much-expanded directory of "key contacts" across the state.

This strategy pertains only to management of wild wolves. It does not pertain to domestically-raised wolves, wolf-dogs, and wolf hybrids, which are not protected under the Federal ESA. This Coordination Strategy will be reviewed and updated as needed to address changes such as the gray wolf's ESA status, Oregon Wolf Plan management phase, and potential transfer of additional management authorities to the State of Oregon.

Legal Status of Wolves in Oregon – April 2019

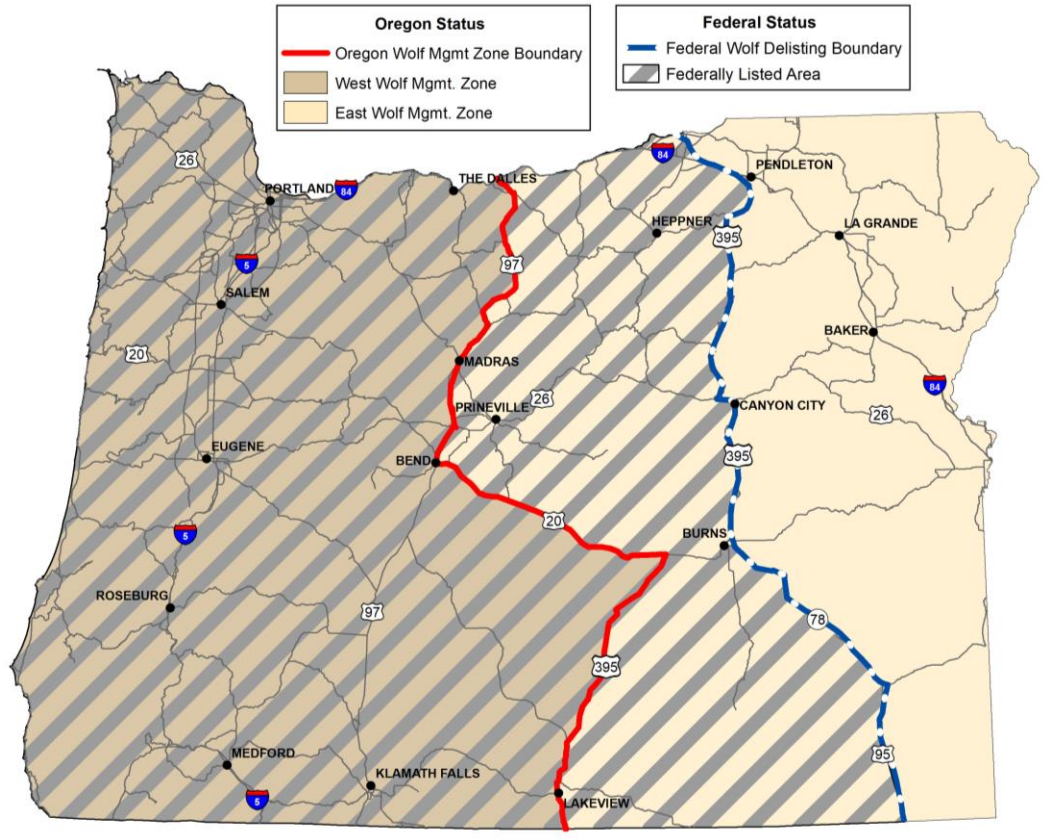
Currently, the gray wolf is federally listed as an endangered species in approximately the western 3/4^{ths} of Oregon; that is, west of a boundary delineated by Highway 395 from the Washington border south to Burns, then southeast along Highway 78 to Burns Junction, and

finally south on Highway 95 to the Nevada border (Figure 1). On March 15, 2019, the USFWS formally proposed removing the gray wolf from the list of endangered and threatened wildlife by issuing a proposed rule in the Federal Register (FR 9648). A final rule is expected sometime in early 2020. If finalized, gray wolves would no longer be federally listed in Oregon.

When the Oregon Wolf Plan was first adopted in 2005, the gray wolf was also State-listed as an endangered species, and the Plan established population thresholds for considering delisting. Rapid growth of the wolf population in eastern Oregon resulted in those thresholds being exceeded by 2014. This prompted ODFW to conduct a status review in 2015, and after an extensive public rulemaking process, the Oregon Fish and Wildlife Commission determined in November 2015 that the gray wolf in Oregon had met the state delisting criteria and removed them from the State Endangered Species List.

The Oregon Wolf Plan calls for different management guidelines in the East and West Wolf Management Zones (WMZ) based on the number of breeding pairs in those areas. Currently, the West WMZ is designated to be in Phase I, the East WMZ moved into Phase III in early 2017.

Figure 1. Current wolf management boundaries in Oregon. Wolves occurring east of the blue line are not federally listed and completely under ODFW's jurisdiction. This coordination strategy applies to wolves occurring west of the blue line, where they are federally listed as endangered and managed under the joint jurisdiction of ODFW and USFWS.



Roles and Jurisdictions

This Coordination Strategy applies only in portions of the wolf's range in Oregon where they remain a federally-listed species under the ESA. Implementation of Federal ESA responsibilities and the Oregon Wolf Plan will be a coordinated effort between USFWS and ODFW. An existing cooperative agreement between the USFWS and ODFW gives ODFW the authority, under Section 6 of the ESA, to implement most elements of the Oregon Wolf Plan in the listed area, including capture and handling, radio-collaring, relocating, and implementation of non-lethal measures to minimize livestock depredations.

ODFW has primary responsibilities for implementing the Oregon Wolf Plan within the sideboards of federal ESA regulations. Agency staff in Salem and wolf specialists in La Grande are the primary contacts for overall Wolf Plan administration, with ODFW's district wildlife biologists assuming field-level wolf management duties in their areas of jurisdiction.

USFWS is the lead agency responsible for administering the recovery of wolves under federal ESA and has primary responsibilities for ensuring management actions in the Oregon Wolf Plan comply with ESA regulations. The Oregon Fish and Wildlife Office in Portland has jurisdiction for most of the State. Part of southcentral Oregon along the California border is within the jurisdiction of the Klamath Falls Fish and Wildlife Office.

Wildlife Services (USDA-APHIS) is the lead federal agency for managing wildlife damage problems. They have field staff based in most Oregon counties who work closely with livestock producers to reduce predator-related losses. Wildlife Services (WS) agents' expertise in investigating livestock depredations and their strong presence in rural parts of Oregon working closely with producers make them an important asset for wolf management. Wildlife Services' Oregon State Office is in Portland.

Tribal reservation lands are self-governed by Tribal governments who have primary responsibilities for managing wildlife on those lands. Any wolf management activities within or near Tribal Reservations need to be closely coordinated with the appropriate Tribal representatives.

The following is a description of how ODFW, USFWS, and Wildlife Services intend to coordinate and collaborate on wolf management activities in parts of Oregon where wolves are federally-listed. Agency wolf coordinators are the initial contacts and will take responsibility for most of the identified coordination tasks, however, agency personnel in local field offices will handle some coordination duties.

Wolf Monitoring

Monitoring activities include surveys to confirm and document new wolf activity, investigating public wolf reports, capturing and radio-collaring wolves, and tracking known wolf packs and individuals for annual counts or population estimation. As the wolf population increases, this aspect of wolf management is becoming a more time-consuming task.

Agency Roles and Responsibilities

USFWS: USFWS monitors wolves in areas where wolves remain federally-listed by investigating reports of new wolf activity, monitoring known wolves, and assisting with collaring and tracking work.

ODFW: ODFW monitors wolves as they implement the Oregon Wolf Plan. ODFW personnel are authorized to capture, handle, and monitor federally-listed wolves through the agency's cooperative agreement with the USFWS, under Section 6 of the ESA. They maintain an online reporting system for the public to submit wolf sightings, investigate reported sightings, monitor disease, analyze genetics, and capture and radio-collar wolves to monitor their activity. They also maintain a database of wolf locations and depredation investigations.

Wildlife Services: Wildlife Services assists in monitoring wolf activity when requested. County personnel work closely with livestock producers and in the course of their work receive reports or find direct evidence of possible wolf activity.

Coordination on Wolf Monitoring

Coordination and information sharing on wolf activity between the three agencies has been ongoing for many years and it will be important to continue and expand these coordination efforts as wolves appear in new areas.

ODFW's online wolf reporting site (www.dfw.state.or.us/Wolves/wolf_reporting_form.asp) is a valuable tool for getting information from the public on possible wolf activity. Agency personnel should encourage people to use this system when they think they've seen wolves or wolf sign. The web-based form is also appropriate for other USFWS and ODFW staff and WS field staff to use to inform USFWS and ODFW wolf personnel of information they have collected.

When Wolves Are Found In a New Area

Confirmation of wolves residing in a new area is a significant development for local stakeholders (e.g., county officials, livestock producers, Tribes) and resource management agencies and thus requires prompt dissemination of information to those who could be affected. Stakeholders, officials, and agencies are notified by USFWS and ODFW staff after those agencies confirm that wolves are spending time in an area and not just rapidly moving through.

Because of the high mobility and frequent movement tendencies of lone wolves (i.e., active dispersers), it is important to try to distinguish active dispersers from wolves that are remaining in an area for weeks, months, or longer. Location data from radio-collared wolves show that wolves that have left their natal pack typically move rapidly across the landscape, spending at most one to three days in a given area , and making substantial movements (10-30 miles or more) each day.
Attempting to immediately alert stakeholders that were in the path of an actively dispersing wolf is only possible if the wolf is wearing a collar capable of transferring locations via satellite, but even then information is not instantaneous with new locations being hours to days old by

the time they are received. This is extremely difficult due to the amount of area wolves pass through and rarely helpful since the wolf is usually long gone by the time the information can be disseminated. Also, wolves that are rapidly-moving rarely threaten livestock.

Therefore, the amount and scope of information shared will be based on the amount of wolf presence known. A single documented wolf location should be shared between USFWS, ODFW, and Wildlife Services but may or may not be appropriate to share with all producers in a large area until the wolf is determined to be present in the area over a period of time.

When new resident wolf activity is confirmed in an area, the following actions should be taken:

- **Agency Notifications**.

	Lead for contacting:
○ Appropriate USFWS and Wildlife Services contacts	USFWS
○ State Agencies: ODFW, Oregon Dept. of Agriculture (ODA)	ODFW
○ Forest Service/BLM/NPS units near the location of wolf activity	USFWS
○ Local Tribes if wolf activity is near Tribal lands	USFWS
○ Adjacent State Wildlife Agencies when near state borders.	ODFW

- **Livestock Producer Information.** Both USFWS and ODFW will enlist help from appropriate state and federal partner agencies, and local livestock producer organizations to identify potentially affected livestock producers in the vicinity, inform them of the new wolf activity and provide information on actions they can take to protect their livestock.

- **Assess need for Tribal government consultations.** If wolf activity is within or immediately adjacent to an Indian Reservation, government-to-government discussions with the affected Tribe shall be initiated by USFWS.

- **Interested Parties Notification via ODFW updates and website.** ODFW has a distribution list, which people can subscribe to, for sharing wolf information via email updates. ODFW posts maps and information about resident wolf activity on their website.

Livestock Depredation Investigations and Follow-up

When injured or dead livestock are found and wolf depredation is suspected, a prompt investigation following the livestock owners request is needed to determine if wolves were involved. If determined to be confirmed or probable wolf depredation, follow-up monitoring and deployment of preventative measures to deter subsequent depredations are necessary.

Agency Roles and Responsibilities

When depredation is suspected, Wildlife Services, ODFW, and USFWS (or any combination of these agencies) personnel will do the initial investigation of possible wolf-livestock depredations when requested. The agency which receives a request for an investigation will immediately contact the other two agencies. Initial investigations will be completed on-site, but prior to making a final agency determination or providing public notification on whether a wolf or wolves were responsible (unless it is clear that wolves were not involved), the investigating agency(s) will confer with USFWS (and ODFW if they were not involved in the on-site investigation) to review and discuss the evidence found.

USFWS: USFWS is the lead agency for decisions on control actions that have the potential to injure or kill wolves. USFWS will be proactive in assisting affected landowners and livestock producers to install and maintain preventative measures to deter future wolf attacks and on monitoring wolf activity in the area.

ODFW: ODFW will implement direction in the Oregon Wolf Plan regarding depredation investigations and advising and assisting affected landowners on deterrence and preventative measures to minimize livestock depredation. Oregon's Wolf Depredation Compensation and Financial Assistance County Block Grant Program stipulates that affected livestock producers cannot pursue compensation payment for losses through ODA unless ODFW or a designated agent find that wolf depredation was the probable or confirmed cause for the death or injury.

Wildlife Services: As the primary Federal agency that works with livestock producers to control wildlife predation, Wildlife Services' personnel are experienced at investigating dead livestock and are often whom livestock producers call when they suspect predation. They will frequently be involved in depredation investigations and have been expanding their capabilities to assist landowners with installing and maintaining preventative measures to deter future wolf attacks.

Livestock Depredation Response

When a livestock depredation investigation is requested by the livestock owner a response should be taken as soon as possible to utilize time-sensitive evidence. The following actions should be undertaken:

- **Document specific location where depredation occurred and immediately notify ODFW or USFWS wolf contacts;**
- **Dispatch a trained investigator (from ODFW, Wildlife Services, or USFWS) to the scene to investigate the depredation.** Personnel from any of these agencies can lead the on-site investigation provided they have had training on investigation procedures and how to look for physical evidence of a wolf attack. The following steps should be taken to protect the site and carcass prior to the investigation:
    - Take several photographs of scene as it occurs before proceeding with any investigation;
    - Minimize human disturbance in and around the area;
    - Keep dogs and other animals from the area to protect evidence;
    - Place tarp over carcass;

- If possible, use cans or other objects to cover tracks and scats that can help confirm the presence of specific predators/scavengers;

- **Determine need for Tribal government consultations**; if the incident is within or immediately adjacent to an Indian Reservation, government-to-government discussions with the affected Tribe shall be initiated by USFWS and Tribal contacts will be consulted on all of the subsequent response coordination steps.

- **An official determination on cause of death should not be made during the initial investigation. The on-site investigator will confer with appropriate agency contacts to review and discuss the evidence prior to making a final determination.** If possible, this should occur on the next business day. ODFW makes every effort to post the final determination on its website within two business days of the initial on-site investigation.
- **Initiate response preparations** – this may include remote camera setups, assessing which preventative measures are appropriate at that location, and preparing capture equipment. ODFW and USFWS will lead these efforts.

If investigation concludes it is a "Confirmed" or "Probable" wolf depredation:

- **Agency Notifications**.

	Lead for contacting:
o Appropriate USFWS and Wildlife Services contacts	USFWS
o State Agencies: ODFW, Oregon Dept. of Agriculture (ODA)	ODFW
o Forest Service/BLM/NPS units near the location of wolf activity	USFWS
o Local Tribes if wolf activity is near Tribal lands	USFWS
o Adjacent State Wildlife Agencies when near state borders.	ODFW

- **Provide information updates to livestock producers in the area** and describe what they can do to protect their livestock.
- **Notify Interested Parties via ODFW updates & website.** ODFW will determine when updates will be posted.
- **Refer media inquiries** to ODFW & USFWS Public Affairs.
- **Identify and begin implementation of appropriate deterrence measures**. Depending on the species depredated and the site, non-lethal tools like fladry, permanent fencing, bone pile clean-up, foxlights, or night patrol should be considered.

Depredation Deterrence

The USFWS's current direction is that lethal control of wolves will not be authorized while they are Federally-listed as endangered. Therefore, guidance in the Oregon Wolf Plan that pertains to determining when chronic depredation situations exist and related triggers for authorization of lethal control actions are not currently applicable in the federally-listed area.

In areas where wolves are present and pose a threat to livestock, personnel from the three wildlife agencies actively work with landowners and producers to deter wolf damage to livestock. Non-injurious measures are always tried first to manage depredation problems, and in many cases these are effective and the problems are resolved for the time being. However, in some cases, depredations continue despite the use of various preventative measures.

Guidance on Injurious Harassment

The USFWS supports ODFW's implementation of Oregon Wolf Plan guidance, but ESA protections do impose limitations on the use of injurious harassment. USFWS will make all decisions on the use of injurious harassment, in close coordination with ODFW. Wildlife Services may assist with implementation of injurious harassment actions, should their involvement be requested by the USFWS.

Non-lethal injurious harassment primarily involves the use of firearm ammunition (e.g., cracker shells, rubber bullets, bean bag projectiles) that can potentially injure but not kill a wolf. These may be used as a measure to modify wolf behavior when they are repeatedly returning to pastures and stalking livestock. These munitions can be effective at deterring wolves from returning to specific areas. Other activities that, under certain circumstances, are considered to be injurious harassment include pursuit-oriented hazing, such as chasing a wolf or wolves using a motorized vehicle.

USFWS has provided authorization for ODFW personnel to use injurious harassment measures when warranted. However, ODFW's issuance of permits to livestock producers or their designated agents to use injurious methods, as described in the Oregon Wolf Plan, does not apply at this time in the federally-listed area.

Handling Injured, Dead, or Inadvertently Captured Wolves

Wolves found injured, dead, or held in a trap need to be handled properly and all cases of possible unauthorized take should be investigated by law enforcement personnel. Injured or live-trapped wolves need to be assessed to determine if they can be released on site. If determined releasable, consideration should be given to: (1) radio-collaring the animal prior to release, and (2) if in an area where wolves had not previously been documented, coordination with potentially affected parties in area where it will be released. If determined that the injured or trapped animal is not releasable and needs treatment or euthanasia, USFWS will be consulted to determine a course of action on a case-by-case basis.

Agency Roles and Responsibilities

USFWS: USFWS will respond to these situations, if available, and is the lead authority for decision making. USFWS Law Enforcement needs to be notified when trapped, dead or injured wolves are found to investigate possible criminal wrongdoing.

ODFW: ODFW has authority under its Section 6 permit to evaluate and treat an injured or trapped wolf, release and collar it if appropriate.

USFWS Law Enforcement and OSP: USFWS Law Enforcement is the lead agency for investigating possible violations of the Federal ESA and Oregon State Police is the lead agency for investigating possible violations of State wildlife laws.

Wildlife Services: Wildlife Services personnel should notify appropriate ODFW or USFWS personnel if they find or receive a report of an injured or dead wolf. If Wildlife Services personnel are involved in the accidental capture of a wolf, they are responsible for notifying USFWS and/or ODFW immediately.

Response Coordination

When an injured, dead, or trap-held wolf is found, the following actions should be taken as soon as possible.

INITIAL RESPONSE:

- **Get detailed description of the incident location from the caller**. Ask about specific directions on how to reach the scene (road names, landmarks, gates, etc.).
- **Provide on-site person with the following instructions on protecting the scene**:
  - If animal is alive, take actions to keep self and onlookers safe;
  - If animal is dead, treat area as a potential crime scene, do not touch carcass, keep all people and animals from the area, and if directed to, carefully place tarp or similar covering over the wolf carcass;
- **Notify State and Federal agency primary wolf contacts.**
- **Contact USFWS Law Enforcement and Oregon State Police**. Relay information provided by the caller and request that an officer be dispatched to the scene.

IF THE WOLF IS DEAD: Law enforcement personnel will take over the investigation and determine all subsequent aspects of the response.

IF THE SITUATION INVOLVES A LIVE WOLF (INJURED OR TRAPPED):

- **Arrange for a rapid response by nearby ODFW or USFWS biologist, veterinarian, or other qualified individual to evaluate and provide initial care to the animal**, while continuing coordination with person on-site.

- Determine condition of animal. Arrange for immediate veterinary care and/or transportation to a veterinary facility if needed.
- If the wolf's injuries are not life-threatening, USFWS or ODFW will make decision on whether to release it on site. USFWS will also determine, with input from ODFW, where the animal should be released if it is removed from the site for treatment.
- If decision is made to release on site:
    - If possible, have a radio transmitter brought to scene so it can be collared before release.
    - Notify potentially affected parties (i.e., livestock producers in the area) if it is in a new area of wolf activity.

- **Determine need for Tribal government consultations**; if the wolf is within or immediately adjacent to an Indian Reservation, government-to-government discussions with the affected Tribe shall be initiated by USFWS and Tribal contacts will be consulted on all of the subsequent response coordination steps.

Key Contacts Phone Directory

PRIMARY USFWS & ODFW WOLF PERSONNEL

John Stephenson	USFWS	Wolf Specialist, Oregon Bend	(541) 786-3282 cell
Roblyn Brown	ODFW	Wolf Coordinator La Grande	(541) 962-1850 (541) 805-8967 cell
Nate Libal	ODFW	Asst. Wolf Coordinator La Grande	(541) 962-1826 (541) 736-6271 cell
Jim Thrailkill	USFWS	Supervisory Wolf Coord., Roseburg	(541) 957-3470 (503) 703-9753 cell
Mike Asch	USFWS	Fish and Wildlife Biologist, Roseburg	(541) 957-3469 (503) 807-6195 cell
Derek Broman	ODFW	Carnivore Coordinator Salem	(503) 947-6095 (503) 991-3776 cell
Jeanne Spaur	USFWS, Region 8	Wolf Specialist, Klamath FWO (see map pg 15)	(541) 885-2501 (541) 891-1142 cell
Elizabeth Willy	USFWS, Region 8	R8 Wolf Coordinator (see map pg 15)	(541) 885-2525 (541) 891-2174 cell

PUBLIC INFORMATION OFFICERS, ODFW & USFWS (Statewide)

Michelle Dennehy	ODFW	Public Info Officer, Salem	(503) 947-6022
Elizabeth Materna	USFWS	Public Info Officer, Portland	(503) 807-6196

USFWS LAW ENFORCEMENT PERSONNEL (Statewide)

Eric Marek	USFWS	Resident Agent In Charge, Redmond, WA	(206) 512-9329
Paul Montuori	USFWS	Special Agent, Wilsonville	(503) 682-6131
Kathy Spengler	USFWS	Special Agent, Wilsonville	(503) 682-6131
Rebecca Roca	USFWS	R8 Resident Agent in Charge, Sacramento, CA	(916) 569-8444

WILDLIFE SERVICES OREGON STATE SUPERVISORS

Dave Williams	WS	Oregon State Director, Portland	(503) 326-2346 (971) 404-6717 cell
Kevin Christensen	WS	Asst. State Director, Portland	(503) 326-2346 (503) 329-9819 cell
Paul Wolf	WS	Southwest District Sup., Roseburg	(541) 679-1231 (503) 593-1719 cell
Brian Thomas	WS	Northwest District Sup.	(503) 399-5814 (541) 221-7582 cell
Patrick Smith	WS	Eastern District Sup.	(541) 963-7947 (541) 805-0128 cell

USFWS OREGON FISH & WILDLIFE FIELD OFFICE SUPERVISORS

Paul Henson	USFWS, R1	State Supervisor, Portland	(503) 231-6988
Bridget Moran	USFWS, R1	Bend Field Office	(541) 312-6423
Marisa Meyer	USFWS, R1	La Grande Field Office	(541) 962-8597
Jim Thrailkill	USFWS, R1	Roseburg Field Office	(541) 957-3470
Daniel Blake	USFWS, R8	Klamath Falls Field Office	(541) 885-2512
Vacant	USFWS, R1	Newport Field Office	(541) 867-4558

TRIBAL CONTACTS

CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

Carl Scheeler	Wildlife Program Manager	(541) 429-7242 (541) 969-3117 cell

CONFEDERATED TRIBES OF THE WARM SPRINGS INDIAN RESERVATION

Doug Calvin	Wildlife Biologist	(541) 553-2043
Austin Smith, Jr	Wildlife Biologist	(541) 553-2046

U.S. FOREST SERVICE & BLM REGIONAL BIOLOGISTS (Statewide)

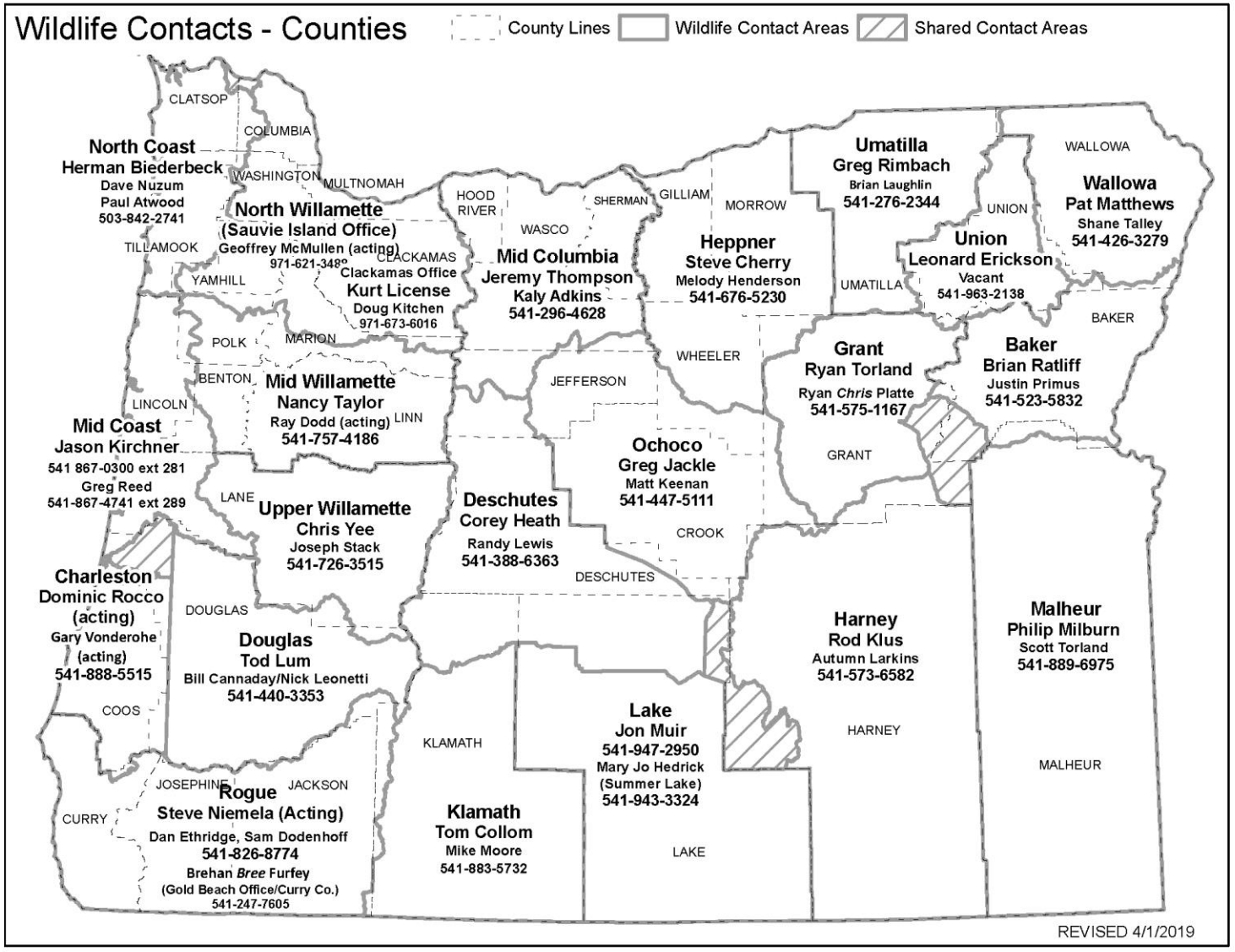
John Chatel	USFS	TES Species Program	(503) 808-2972 office
Bruce Hollen **Todd Thompson**	BLM BLM	Wildlife Biologist Wildlife Biologist	(503) 808-6604 office (503) 808-6326 office

NATIONAL FOREST & BLM CONTACTS BY UNIT

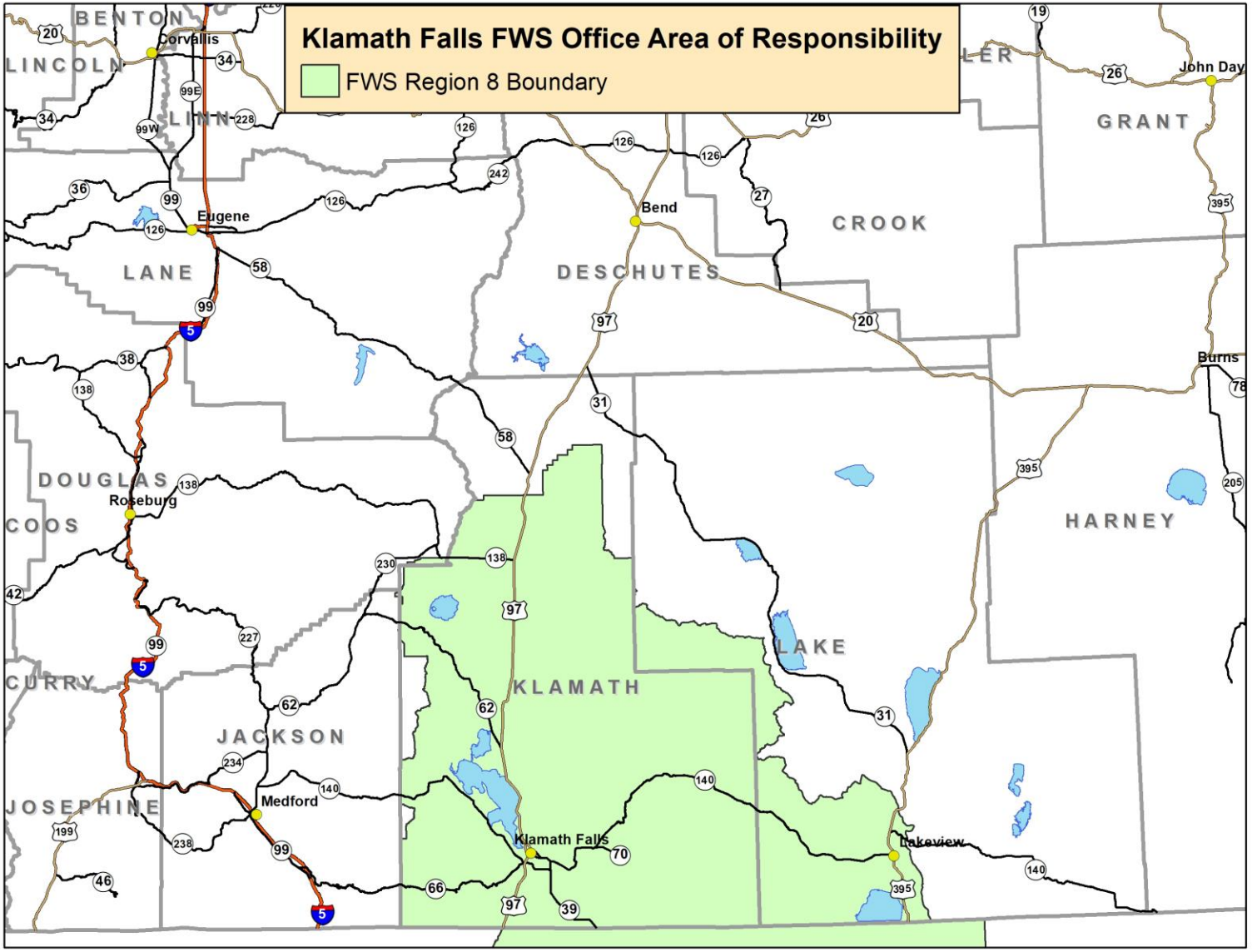
NATIONAL FOREST	FOREST WILDLIFE BIOLOGIST	PHONE NUMBER
Malheur	Clark Reames	541-575-3474
Umatilla	Lizzy Berkley	541-278-3814
Ochoco	Monty Gregg	541-416-6508
Deschutes	Lauri Turner	541-383-5640
Fremont-Winema	Cheran Cavanaugh (acting)	541-947-2151
Rogue River-Siskiyou	Dave Clayton	541-618-2054
Umpqua	Justin Hadwen	541-957-3260
Siuslaw	Deanna Williams	541-750-7013
Willamette	Joe Doerr	541-225-6433
Mt. Hood	Chuti Fiedler	503-308-1750
Columbia River Gorge NSA	Brett Carre	541-308-1718

BLM DISTRICT	DISTRICT WL BIO	PHONE NUMBER
Burns	Matt O'Bradovich	541-573-4447
Prineville	Stephanie McKinney	541-416-6712
	Larry Ashton	541-416-6738
Klamath Falls	Steve Hayner	541-885-4126
Lakeview	Kate Yates	541-947-6282
Medford	Robin Snider	541-618-2496
Roseburg	Rex Mcgraw	541-464-3273
Coos Bay	Carol Aron	541-751-4326
Northwest (Eugene/Salem)	John DeLuca	541-683-6229

MAP OF ODFW REGIONS AND DISTRICT WILDLIFE BIOLOGISTS



MAP OF USFWS REGION 8 IN OREGON



USDA, WILDLIFE SERVICES CONTACTS BY COUNTY – CENTRAL/EASTERN OREGON

Use OSP dispatch, dial*OSP (*677) from mobile phone or 1-800-442-2068 (southern command center) for state enforcement contacts and after hours contacts for ODFW staff listed on wildlife contacts map.

DESCHUTES COUNTY	County	Office phone	Cell phone	Location
Zack Perdue			541-655-0059	
GRANT COUNTY / BAKER COUNTY				
Nick Lulay			541-224-3210	
HARNEY COUNTY				
Rod Curtis			541-589-2667	Burns
HEPPNER - GILLIAM, MORROW, & northern WHEELER counties				
Ryan Christensen	Gilliam		541-709-4082	
Chris Lulay	Morrow		541-303-3722	
KLAMATH COUNTY				
Andy Cleland			541-810-8185	Klamath Falls
MALHEUR COUNTY				
Scott Phillips			541-709-7284	Ontario
MID-COLUMBIA - HOOD RIVER, WASCO, & SHERMAN counties				
Jon Belozer	Wasco		541-460-2069	Maupin
OCHOCO - CROOK COUNTY & parts of WHEELER & JEFFERSON counties				
Zack Perdue	Crook		541-655-0059	
Jon Belozer	Jefferson		541-460-2069	Maupin
UMATILLA COUNTY				
Ken Mitchell			541-969-6759	Pendleton
UNION COUNTY, WALLOWA COUNTY				
Patrick Smith (District Supervisor)		541-963-7947	541-805-0128	La Grande
Curt Mattson			541-805-5256	

USDA, WILDLIFE SERVICES CONTACTS BY COUNTY – WESTERN OREGON

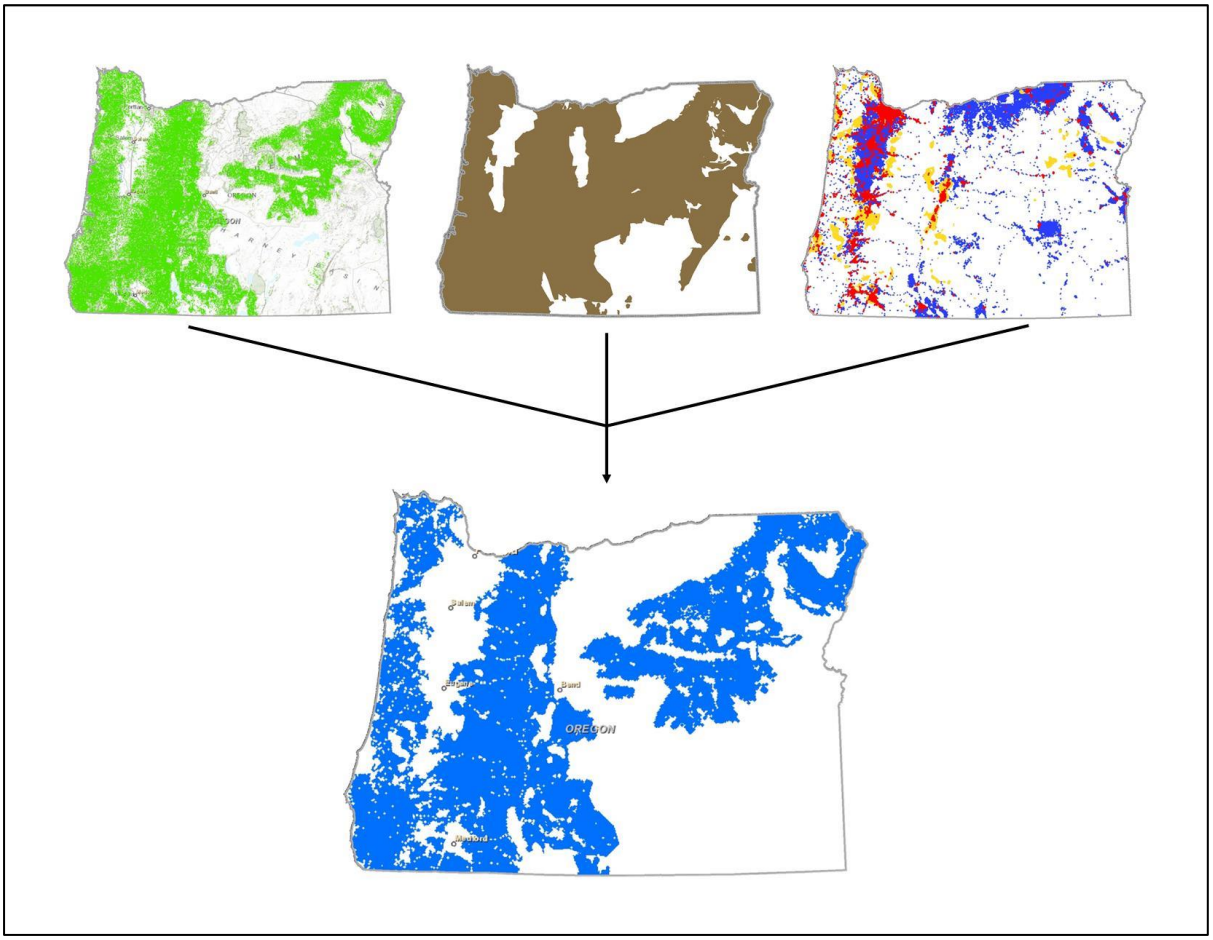
Use OSP dispatch, dial*OSP (*677) from mobile phone or 1-800-442-2068 (southern command center) for state enforcement contacts and after hours contacts for ODFW staff listed on wildlife contacts map.

	County	Office phone	Cell phone	Location
CHARLESTON - COOS COUNTY				
Dan Godfrey	Coos		541-223-2947	
Trapper Spencer	SW		541-670-8608	
DOUGLAS COUNTY				
Paul Wolf (District Supervisor)		541-679-1231	503-593-1719	Roseburg
Jim Godfrey			541-670-0357	
Ty Nichols			541-863-9222	
Mark Dowdy			541-784-5026	
ROGUE - JACKSON, JOSEPHINE, & CURRY counties				
Cricket Peyton	Jackson		541-630-0050	Medford
Jim Dougherty	Curry		541-655-0845	
UPPER WILLAMETTE - LANE COUNTY				
John Brooks			541-520-7772	
Micah Bell			541-315-6048	
MID WILLAMETTE - BENTON, LINN, MARION, & POLK counties				
Brian Thomas (District Supervisor)		503-399-5814	541-221-7582	Salem
Landon Schacht	Benton and Polk		541-517-9513	
Trevor Lock	Marion		503-881-9381	
Jim Schacht	Linn		541-508-8783	
MID COAST - LINCOLN COUNTY, western LANE COUNTY				
Rod Perkins	Lincoln		541-961-3921	
NORTH WILLAMETTE - COLUMBIA, CLACKAMAS, MULTNOMAH, WASHINGTON, YAMHILL counties				
Phil Weaver	Washington		503-201-5547	
Matt Alex	Portland		503-530-6445	
Mark Lytle	Clackamas		503-201-3778	
NORTH COAST - CLATSOP COUNTY, TILLAMOOK COUNTY				
Nick Searfus	Northwest		503-509-0341	

APPENDIX D: WOLF RANGE MAPPING

Note: This Report was originally presented as Appendix A to the Oregon Fish and Wildlife Commission as part of the November 2015 Biological Status Review for the gray wolf in Oregon and evaluation of criteria to remove the gray wolf from the List of Endangered Species under the Oregon Endangered Species Act.

Mapping Potential Gray Wolf Range in Oregon



This report is presented as Appendix A to the Oregon Fish and Wildlife Commission as part of the 2015 Biological status review for the gray wolf in Oregon and evaluation of criteria to remove the gray wolf from the List of Endangered Species under the Oregon Endangered Species Act.

*Suggested citation:*Oregon Department of Fish and Wildlife. 2015. Mapping potential gray wolf range in Oregon. Oregon Department of Fish and Wildlife, 4034 Fairview Industrial Drive SE. Salem, OR 97302

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INTRODUCTION AND METHODS

As part of a biological status review of gray wolves (*Canis lupus*) in Oregon, we developed a map of potential wolf range in Oregon and calculated the amount of potential range currently occupied by wolves. To develop our map of potential wolf range, we used landscape predictor variables similar to Larsen and Ripple (2006) who predicted wolf abundance and distribution in Oregon from wolf data collected in other states. Our approach was to create a simple 1-category map at a course resolution (1 km^2), indicating where wolves could potentially occur in Oregon. The 5 main predictors of wolf habitat from previous research are 1) forested areas (Mladenoff et al. 1995, Larsen and Ripple 2006, Oakleaf et al. 2006, Benson et al. 2015), 2) public ownership (Mladenoff et al. 1995, Carroll et al. 2003, Larsen and Ripple 2006), 3) prey availability (Mech and Peterson 2003, Peterson and Ciucci 2003, Larsen and Ripple 2006, Oakleaf et al. 2006), 4) low human presence (Belongie 2008), and 5) low road density (Mech et al. 1988, Kohn et al. 2001, Carroll et al. 2003, Larsen and Ripple 2006, Belongie 2008, Zimmermann et al. 2014, Benson et al. 2015). We used all these predictors for Oregon, except public ownership, because data from Oregon indicate that wolves use both private and public lands with forested cover. Our mapping process included extracting and merging spatial data related to land cover type, elk ranges, human population density, road density, cultivated or other land types altered by humans. A short description of each data source and steps used to develop a potential wolf range map follows.

Potential Wolf Range

Forested Areas – We obtained land cover data for Oregon from the National Land Cover Database (NLCD, Jin et al. 2013). We generalized the original data set from a 0.09 km^2 resolution to 1.0 km^2 resolution (1000-m x 1000-m cell size). We then extracted land cover types identified as forested (Fig. 1). We buffered these forested areas by 2,000 meters to include forest edge habitats that we expect are used by wolves.

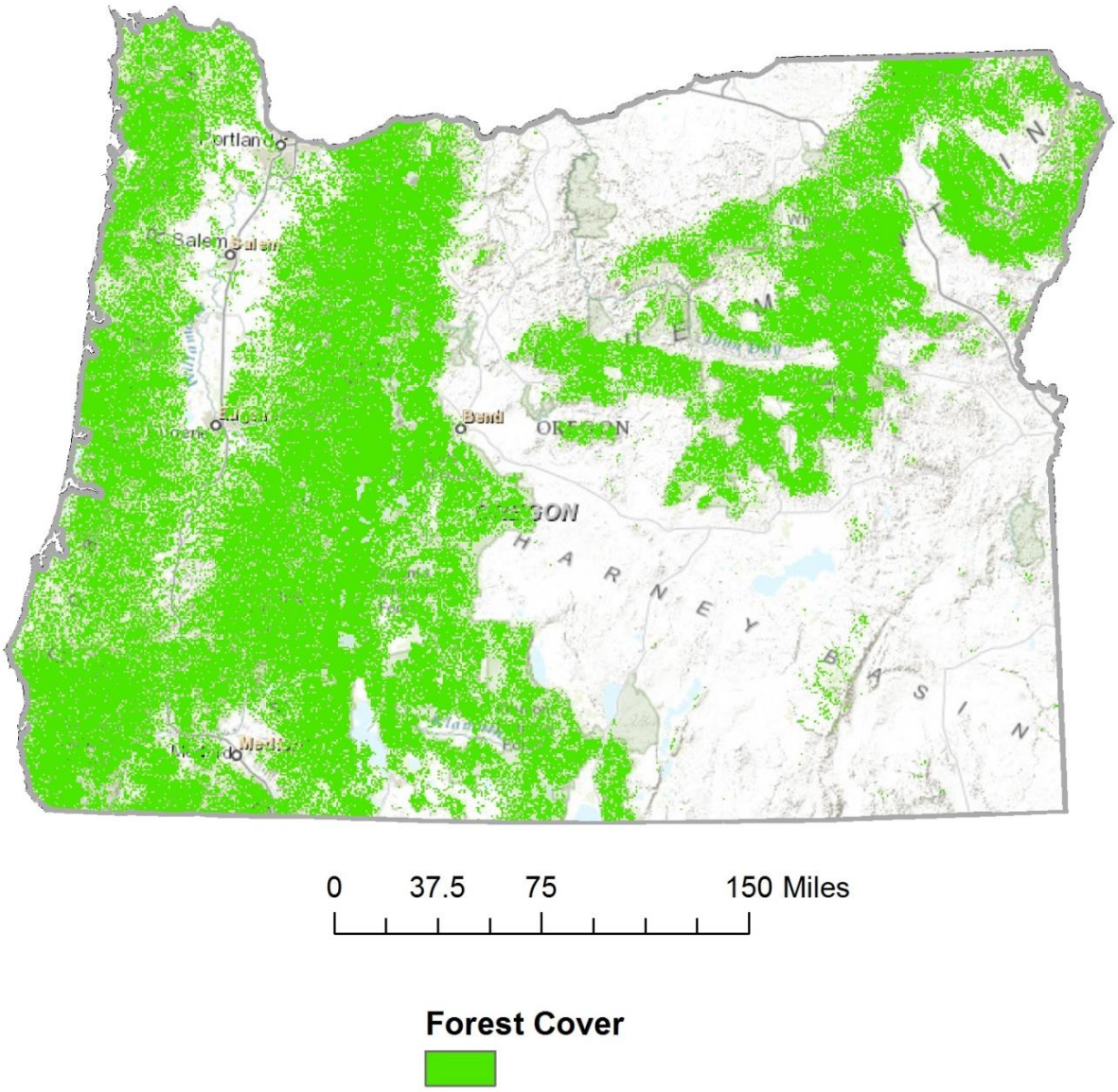

Figure 1. Distribution of forested land cover types, generalized to a 1 km^2 resolution, in Oregon. Data obtained from the National Land Cover database.

Elk Ranges – The second step of our analysis accounted for prey availability. Where elk and wolves coexist, elk serve as the primary prey for wolves (Mech and Peterson 2003). Consequently, we used elk range maps (Fig. 2, ODFW and Rocky Mountain Elk Foundation, unpublished data) as a surrogate for prey availability. We did not account for deer ranges in our analysis because deer are present in all elk ranges. Furthermore, we did not account for quality of deer and elk habitat or abundances of deer and elk within defined range boundaries. We overlaid elk ranges with our map of forested areas, keeping only areas where both forested areas and elk range overlapped. The subsequent map was retained for further analysis.

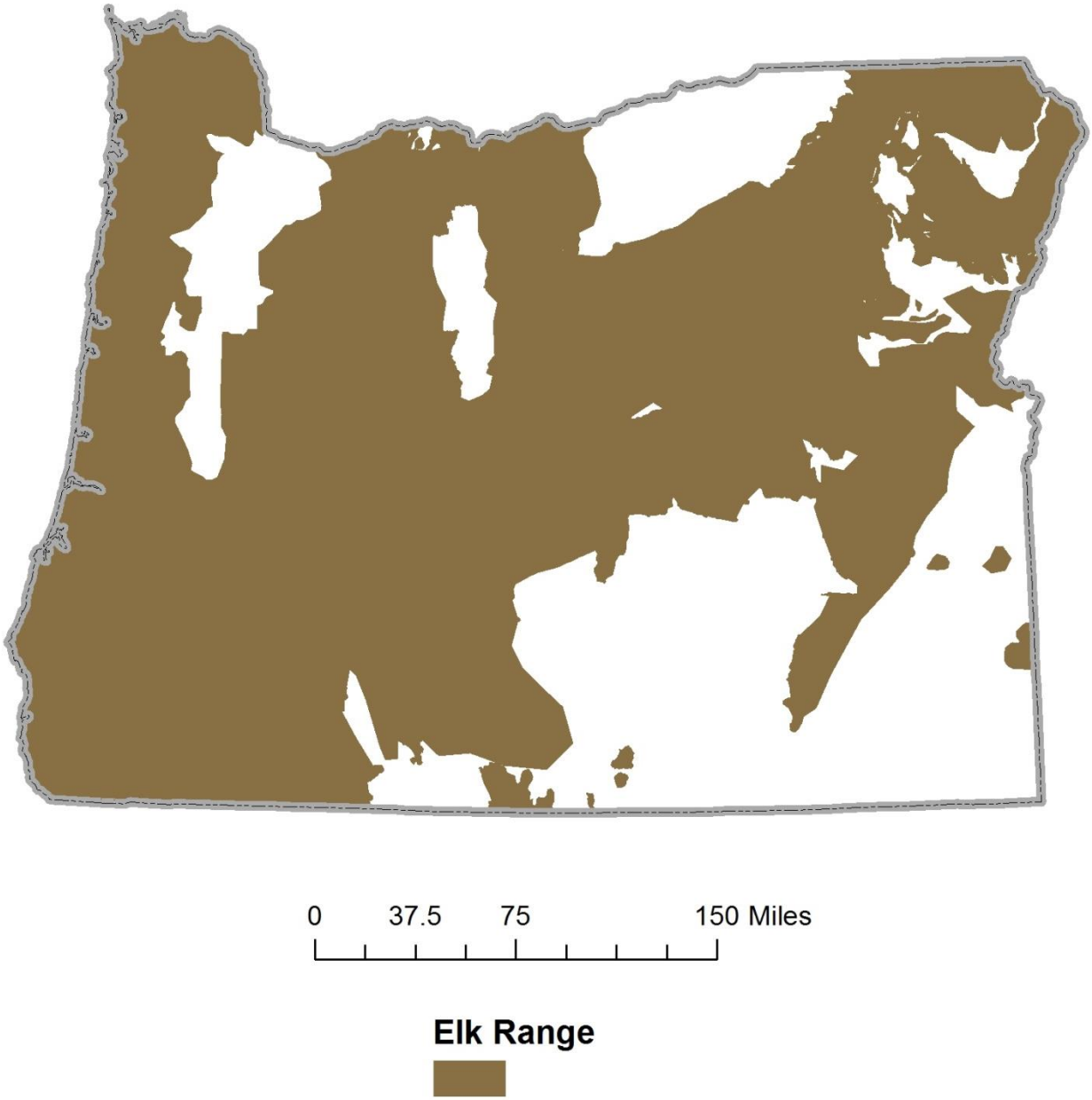

Figure 2. Boundaries of elk range in Oregon. Data were obtained from maps developed by the Oregon Department of Fish and Wildlife and Rocky Mountain Elk Foundation.

Contracted Range

Once we identified potential wolf range we then identified "contracted range", areas no longer available to wolves because they are dominated by human habitation, roads, or agriculture.

Human Population – We obtained human population information from U. S. Census block data (Oregon Geospatial Enterprise Office 2015) and we calculated human density across Oregon. We extracted areas with human densities > 4 humans / km^2 (Belongie 2008) and we applied a buffer of 1600-m around these areas.

Road Density - We calculated road density from publically available data (Bureau of Land Management 2015). We used areas of known wolf activity (AKWA) in Oregon to estimate a threshold value of road density above which wolves did not currently occur. Our analysis suggested wolves did not currently occur in areas where road densities exceeded 3.5 km of road/ km^2.

Developed, cultivated, and pasture lands – We extracted land types from the NLCD layer identified as developed, cultivated, or hay/pasture and we applied a buffer of 1,000 meters around these areas.

We combined all the above described areas that were impacted by human activities to identify contracted range. In total, contracted range represented approximately 24.2% (60,746 km^2) of the total land area in Oregon (Fig. 3).

Contiguous Potential Range

After removing areas of contracted range, we then removed contiguous areas of potential range < 500 km^2, which was the mean territory size of wolf packs in the Greater Yellowstone Ecosystem (Carroll et al. 2003). We took this approach to remove small, isolated patches of potential range that would not be capable of supporting a pack of wolves. In Oregon, mean territory size of 13 wolf packs determined from GPS locations was 1,030 km^2. Consequently, our final map of potential wolf range (Fig. 4) is conservative because it includes areas of potential range smaller than the currently observed territory sizes of wolves in Oregon.

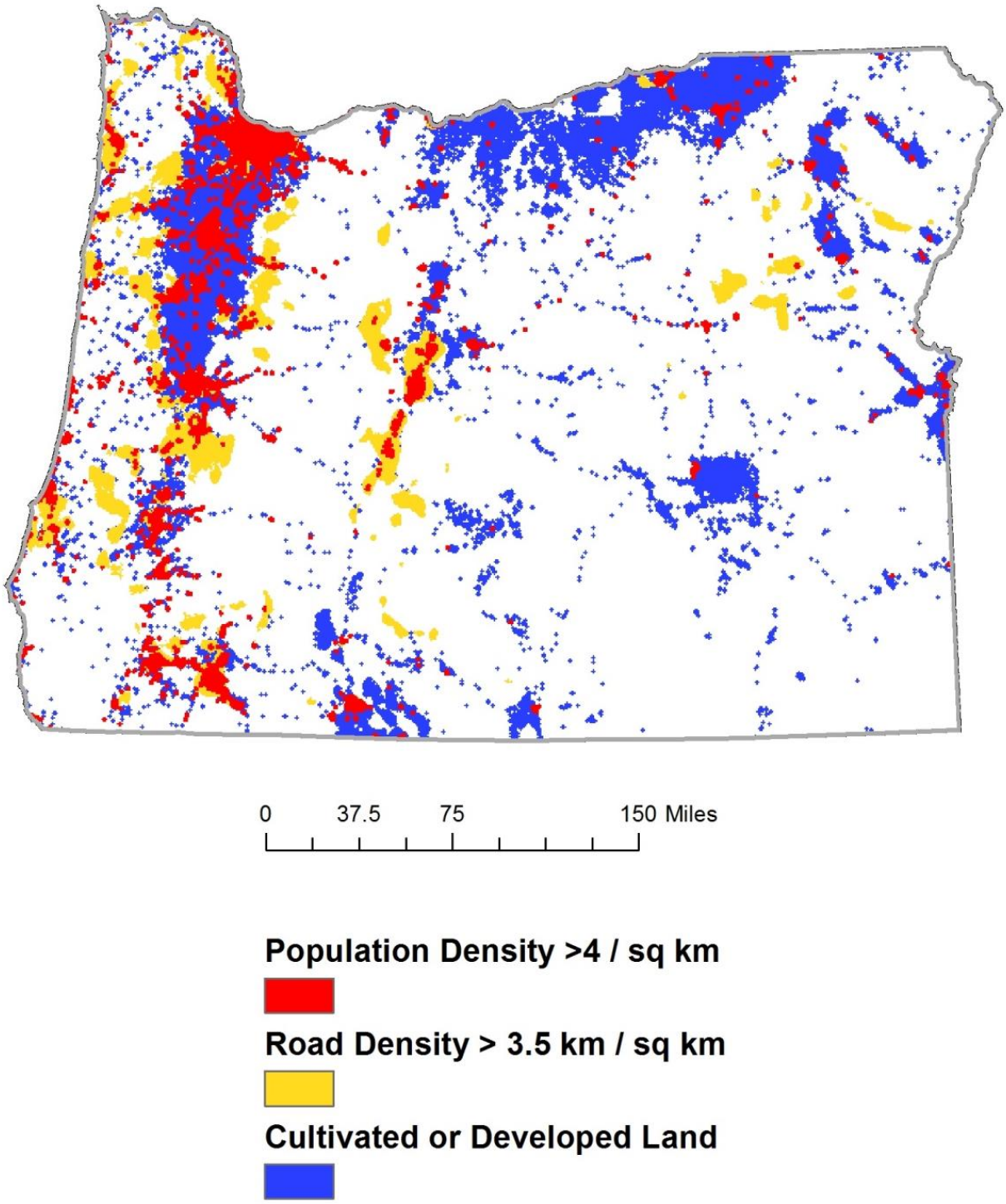

Figure 3. Distribution of contracted range, separated by human activities that prevent the area from being classified as potential wolf range.

RESULTS AND SUMMARY

Our mapping process identified 106,853 km^2 of potential wolf range in Oregon (Fig. 4; Table 1). Overlaying AKWAs with our potential range map suggested our map corresponded well with known wolf distributions (Fig. 5). The exception is an area used by the Imnaha and Chesnimnus packs in northeast Oregon, whose AKWAs encompasses a large area of non-forested habitat known as the Zumwalt Prairie. This area is a remnant prairie which is productive and remote enough to support large elk herds in a non-forested environment. However, this habitat type is not present in significant amounts elsewhere in Oregon.

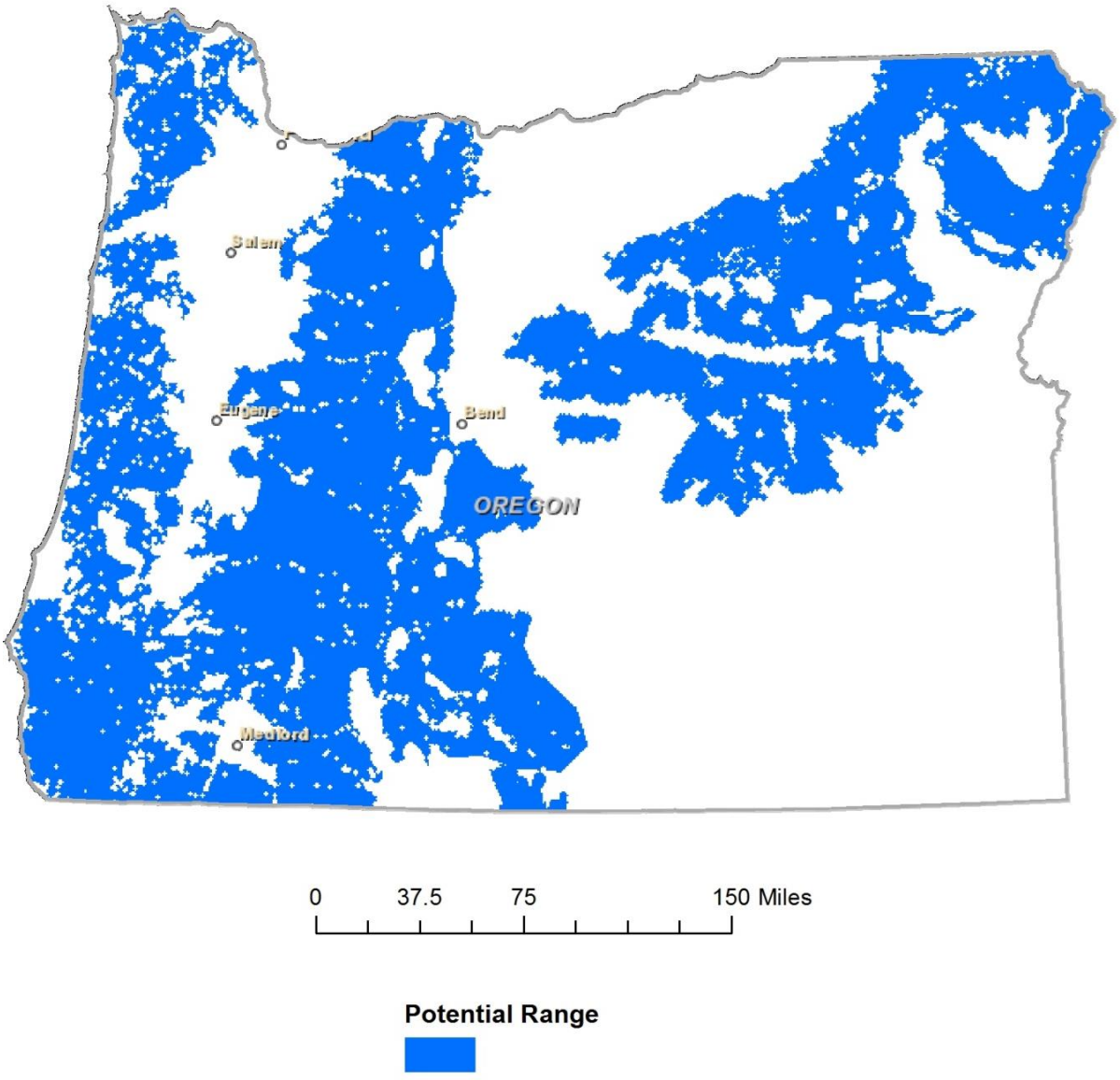

Figure 4. Distribution of potential wolf range in Oregon as determined by spatial analysis conducted by Oregon Department of Fish and Wildlife.

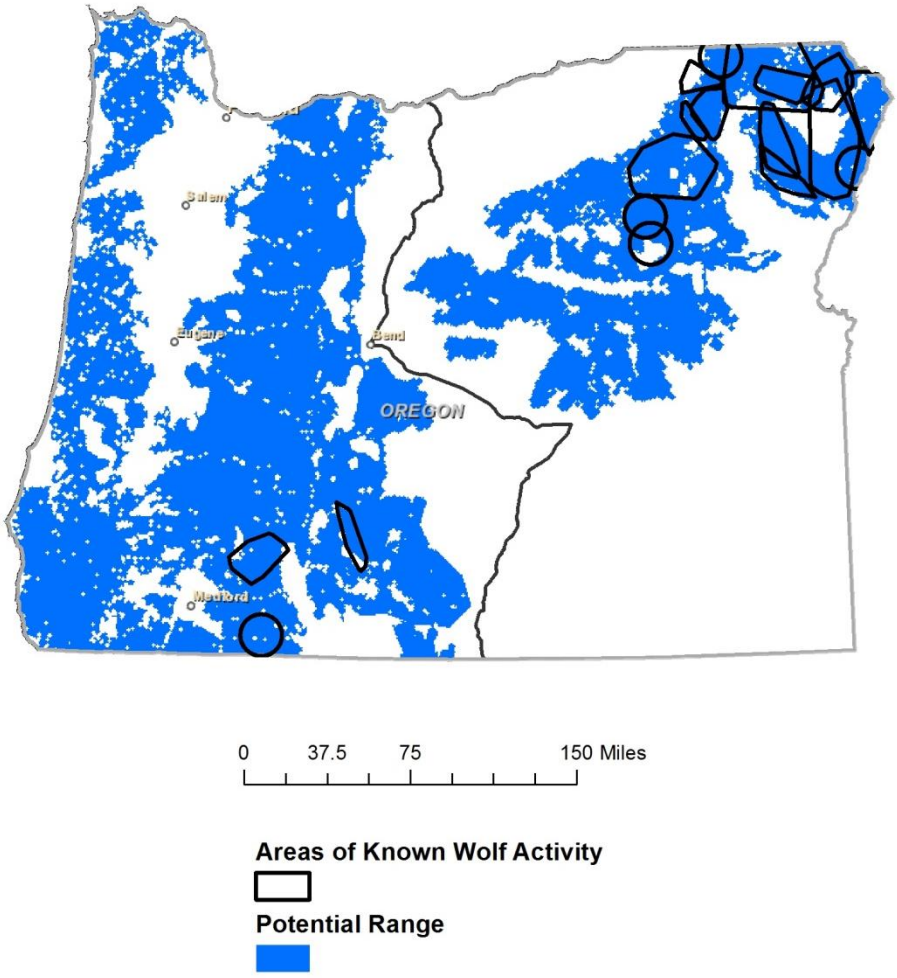

Figure 5. Current distribution of areas of known wolf activity compared to potential wolf range in Oregon.

Table 1. Summary of area of potential wolf range by wolf management zone in Oregon and amount of potential range currently occupied by wolves.

Management zone	Potential range (km^2)	Currently occupied range (km^2)
West	71,011	1,909
East	35,842	11,313
Total	106,853	13,222

Our map of potential wolf range indicates more potential range occurs in the west management zone (71,011 km^2) than the east management zone (35,842 km^2). Currently, wolves occupy 31.6% of potential wolf range in the east management zone (11,313 km^2 out of 35,842 km^2 of potential range; Fig. 6). In contrast, wolves currently occupy approximately 2.7% of potential range in the west management zone (1,909 km^2 out of 71,011 km^2 of potential range).

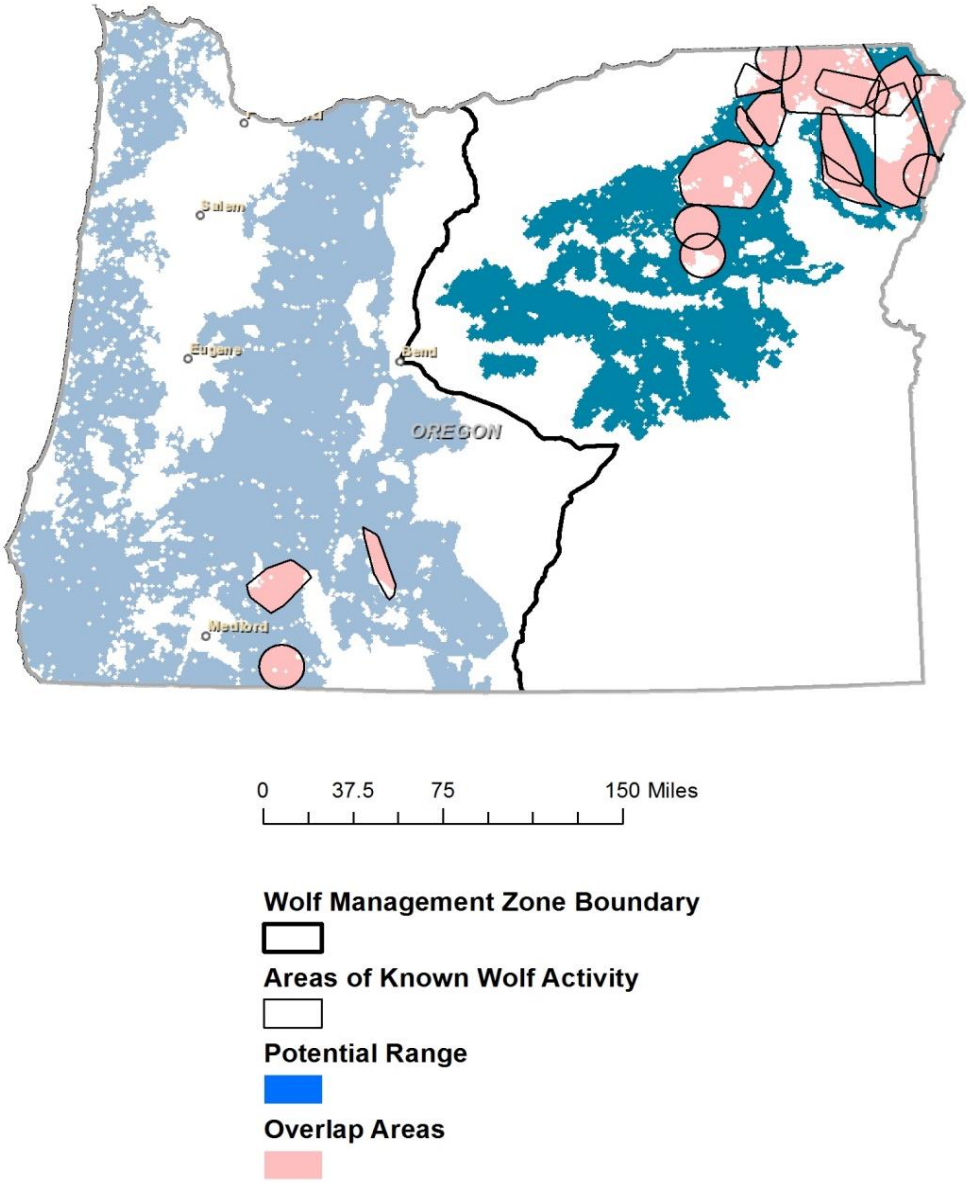

Figure 6. Potential wolf range by wolf management zone and currently occupied potential range in Oregon.

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APPENDIX E: THE CHANGING CLIMATE

Note: While deliberating adopting this Plan during the June 7, 2019 Commission Meeting, a motion was passed by the Commission to include an overview of potential impacts on wolf conservation from climate change and biodiversity influences. The following content satisfies that requirement, but as the text was not formally approved or adopted by the Commission, it occurs as an appendix and is not adopted into rule. The content of this appendix may be inserted elsewhere into the Plan during a future update and adoption of the Plan.

The Changing Climate

Oregon is already experiencing the impacts of a changing climate. Some of the key atmospheric observations of this phenomenon include warming average temperatures in all seasons, increased precipitation in the winter, declining precipitation in the summer, reduced spring snowpack, and increased risk of catastrophic fires (Mote et al. 2019). Predicting the potential effects of these changes on Oregon's wolf population is difficult for a number of reasons. One challenge is that a lot of research on climate change and future biodiversity is theoretical with limited occurrences of applied research to understand the adaptive capacity of species, including wolves. Shortcomings of empirical data and applied research are highlighted by limited data on direct effects on wolves from ongoing changes to climate and poorly understood indirect effects on wolves from potential changes to disease vectors and invasive species, among others. Because gray wolves are a habitat generalist species that have successfully adapted to a wide range of environmental conditions, it is likely that the species is more adaptable to these changes than habitat specialist species.

Previous research outside Oregon, however, has identified some possible effects on wolf populations. Changes to climate have the potential to influence wolves both directly, through behavioral, phenotypic, and genetic responses, and indirectly through effects at other trophic levels. Behaviorally, increases in winter snow on Isle Royale via the North Atlantic Oscillation were correlated to larger hunting pack size, and higher moose predation rates (Post et al. 1999). Similarly, but in an indirect relationship, analysis of the North Pacific Oscillation's influence on wolf predation of elk in Banff National Park found that increasing winter severity and snow depth was correlated with increased wolf predation of elk (Hebblewhite 2005). Long-term data from Yellowstone National Park suggests that environmental changes that cause variation in phenotypic and/or genetic characteristics in the wolf population may also have population-level effects such as changes to population size and fertility (Coulson et al. 2011). While research has suggested general changes to wolf populations due to climate variability, predicting specific effects to Oregon's wolf population is currently not possible. It is likely that any observed effects would not only be dependent on the degree of climatic changes, but also the population size of wolves (Ellis and Post 2004), the local vegetation and ungulate communities (Post and Forchhammer 2001, Mech 2004, Latham et al. 2013), and other, possibly unknown, factors. Documenting or predicting climate-driven changes to Oregon landscapes, habitats, and primary wolf prey species (elk, deer) may provide insight on impacts to Oregon wolves.

The impacts of the changing climate may exacerbate other Conservation Threats. A frequently projected impact of warmer winters is the emergence or arrival of new pathogens or disease vectors (Hoffmeister et al. 2010). Disease monitoring activities identified in this plan are well-positioned to rapidly identify potential new threats.

Considering the strong influence of human behavior and attitudes on wolf populations, understanding potential human responses to climate change may also provide insight in to future wolf conservation threats. Recently, social scientists have suggested that the Pacific Northwest could experience an influx of human migrants seeking relief from undesirable or inhospitable climate conditions in more arid regions (Whitely Binder et al. 2016). Continued public attitude surveys and future updates to the habitat suitability mapping will increase our understanding of the changing risk to Oregon's wolf populations.

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