

Colorado Wolf Restoration and Management Plan Technical Working Group (TWG) to Colorado Parks and Wildlife (CPW)

Final Report on Technical and Experiential Feedback on Wolf Management Considerations August 2022

Background & purpose

This document summarizes the Wolf Restoration and Management Plan Technical Working Group (TWG) discussions regarding technical and experiential feedback on a variety of wolf management issues, including perspectives on biological relevance, ability to quantify and/or measure impacts, impact on technical outcomes, feasibility for managers, and experiences with and/or in implementing programs in other states.

This document is not intended as a literature review nor as a definitive set of recommendations regarding wolf management in Colorado. Rather, it offers a consensus-based synthesis of key takeaways from the TWG – based on its in-depth knowledge and practice of biological science and wolf management – to help inform the wolf restoration and management plan that will be developed by Colorado Parks and Wildlife.

The TWG recognizes that there are various social considerations for impact-based management that the Stakeholder Advisory Group (SAG) has discussed in informing an impact-based management plan for Colorado. A recurrent theme across many topics is to consider trust – including trust in managers, messengers, and stakeholders – as an input for effective management, and conversely to consider how to address lack of trust as a barrier to effective management.

Key takeaways

- **Conflict-centered management vs. objective-based management:** Wolf management should focus on management of conflict, with consideration of the social factors that accompany an impact-based management approach. Lessons from other states with wolves suggest population management is not robustly correlated with conflict minimization. Generally, the public has a high expectation that state wildlife agencies will address wildlife related challenges.
- **Avoiding misinterpretation of maximum vs. minimum population metrics:** It is important to use clear and consistent messaging to reinforce the purpose of minimum population counts/estimates, which are not intended as population objectives or maximums and have been misinterpreted in other contexts.
- **Zonal management:** Initial and long-term management should be impact-based. Zonal management of conflict could be a consideration for future management. Delineation of zones in the future could be informed by experience and data gathered through impact- (and conflict-) based management, understanding of ecological and social suitability (inclusive of wildlife and agricultural interests), and learnings from wolf dispersal and establishment on the ground.

- **Wolf population self-regulation:** Intrinsic self-regulation of wolves is unlikely at a statewide scale; wolves will likely be extrinsically regulated particularly by social carrying capacity. Wolf population self-regulation does not achieve the same goals as conflict management.
- **Positive impacts and wolf management:** Positive and negative impacts can occur due to wolf presence; positive impacts do not generally require hands-on management but can be communicated through education and outreach and can inform management activities and funding opportunities.
- **Non-lethal livestock conflict minimization:** Adoption of proactive and reactive non-lethal conflict risk reduction techniques by livestock producers in Colorado is important to the long-term success of the wolf restoration and management program. The effectiveness of these tools is context-specific and not well quantified.
- **Post-depredation management of conflict wolves:** While wolf depredations on livestock in other states are uncommon and do not represent a notable burden to the livestock industry as a whole, some wolves do cause significant problems for some ranchers and some areas experience repeated and frequent wolf depredations on livestock. Management of wolf-livestock conflicts following depredations should allow flexibility for managers; non-lethal and lethal management techniques should be applied adaptively and are context-specific. To be effective at reducing further depredation events, lethal and non-lethal responses for resolving conflict should be applied quickly and properly. Relocation of depredating wolves has little technical merit.
- **Lethal management of conflict wolves:** Lethal and non-lethal management are both critically important tools for conflict minimization; lethal management will likely attract greater social attention. In evaluating the management approach on a context-specific basis, consider the trade-offs among ability to target depredating wolves, conflict minimization efficacy, cost, reproductive and recruitment success, wolf population size and listing status, impacts to livestock producers, and social/stakeholder interests when considering lethal take options, including incremental and whole pack removal.
- **Considerations for ecological effects:** Ecological function is an important factor to consider but is difficult to quantify and may be less relevant as a metric at the state scale.
- **Impacts of wolves to ungulates, big game, and big game hunting:** Although statewide impacts to ungulate populations and hunting opportunities have not occurred in other states and are unlikely in Colorado, wolves can have local impacts to ungulate recruitment due to predation of young ungulates. Wolves prefer elk and will also prey on deer and other ungulates; moose may be targets of predation where they are abundant. Reduction in big game hunting opportunities and targeted wolf control have sometimes occurred locally in other states to address negative ecological or economic effects of reduced ungulate populations. Ungulate populations are impacted by a complexity of interacting factors.
- **Impacts of wolves to prey compromised by infectious disease:** Predators like the gray wolf may select for prey compromised by infectious diseases, which could prove useful in reducing infectious disease prevalence in ungulate populations, primarily when pathogens are directly

transmitted among hosts. The strength of a potential disease reduction depends on numerous factors, including specific disease etiology, the strength of selection for infectious individuals, and overall predation rates. It is unclear whether wolves will have a measurable effect on chronic wasting disease (CWD) in Colorado, where environmental contamination is likely to be a primary transmission route and where CWD is already well-established in mule deer, a species that wolves generally do not select for in the presence of elk.

- **Interactions with other wildlife species:** Wolves are important components of trophic networks where they are present on the landscape and their presence may have interactions with other large carnivores. The presence of wolves will not have an impact on populations of threatened and endangered species in Colorado, specifically lynx and Gunnison sage grouse.
- **Management of conflict with humans:** Attacks by wolves on humans are exceedingly rare; education and outreach for recreationists and other public lands users should include best practices and guidance, including how to differentiate wolves and coyotes. Flexibility to address rare instances of wolf habituation in areas dominated by humans is important.
- **Management of conflict with pets and hunting dogs:** Wolf attacks on pets are uncommon; education, outreach, and management should be used to proactively prevent conflict. It is important that public messaging emphasizes the risks assumed when domestic and hunting dogs are present in areas with wolves.
- **Wolf monitoring and expectations for stakeholders and public:** Monitoring and research should be based on restoration and management goals, use a variety of techniques, and be connected to other elements of wolf management, including conflict minimization. While robust monitoring is valuable at early stages of reintroduction, limitations to monitoring will increase with wolf population growth, requiring transition to a population estimate approach. It is important to consider effective messaging and coordination with stakeholders and the general public when communicating monitoring objectives and data; lead with trust and share data on an as-needed basis.
- **Social and/or economic dimensions of wolf management:** Social and economic dimensions are critical to understand, measure, and incorporate into decisions on wolf management. Perceptions of wolves and perspectives on management vary among people, are generally consistent within interest groups, and often reflect deeply held beliefs and values. There is high potential for social controversy and conflict, particularly as related to expectations and acceptance for use of non-lethal practices, lethal control, recreational harvest/regulated public hunting, and wolf population numbers. Some research suggests that economic benefits can be substantial and much larger than economic costs, however economic benefits and costs are not distributed equally across stakeholders and the public. Consider the breadth of existing social science research, economic indicators, and stakeholder and public feedback when making management decisions, and incorporate new social and economic research into future decisions. Education and outreach can also inform and be informed by social science. It is critical to have trusted, responsive managers on the ground and consistency of management.

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Wolf population management

Conflict-centered management vs. objective-based management

Summary of TWG Feedback: Wolf management should focus on management of conflict, with consideration of the social factors that accompany an impact-based management approach. Lessons from other states with wolves suggest population management is not robustly correlated with conflict minimization. Generally, the public has a high expectation that state wildlife agencies will address wildlife related challenges.

- Focus on conflict-centered management properly scaled for issues involving livestock, ungulates, etc.
 - Have a systematic and flexible plan to be able to support and respond proactively and reactively to minimize conflict.
 - Impact-based management alone will not necessarily satisfy the needs and interests of those that are concerned about wolf populations on the landscape.
 - Impact-based management may also not satisfy the interests and concerns of those that want wolves on the landscape.
- The link between wolf population management (i.e., developing population objectives and managing towards those objectives) and conflict reduction is not necessarily robust on a statewide basis.
 - There may not necessarily be more depredations with higher statewide wolf populations (at some level, there are more conflicts as the population increases but these do not necessarily have a linear relationship).
 - Wolf population size and frequency of depredations do not share a linear relationship at a Statewide scale in the northern Rocky Mountain states and other states. Conflict minimization (lethal and non-lethal) play a role in this pattern in other states.
 - Depredations are more common in places with higher wolf density and livestock density at the local scale.
- Effective management of livestock, big game and other conflicts at a local scale are distinct as management issues from population objectives and population management over larger scales. That is to say that local, impact-based management (managing to resolve conflicts) is different than statewide management for population objectives. Diverse stakeholders need to be involved at both scales, i.e., in defining approaches to local conflict management and determine population size management over larger scales.
- A population objective is not required for diverse stakeholder involvement in statewide population management. Consensus on whether a population objective is needed or what it might be has not been achieved among public advisory councils in other states, and similarly the TWG could not reach consensus on this. A variety of biological and social considerations affect this issue.
- *If* a population objective is considered in the future:
 - Any population management objective should be based in biological and social science, including an understanding of social carrying capacity determined over time.
 - If a wolf population objective is established, it is difficult to manage to that objective through conflict management alone.
 - If using regulated hunting for population management toward a population objective, efficacy of regulated hunting depends on when the objective is set (i.e., the population

at that time), what it is set at, and what other management and allowance for lethal take are in place. Insights from other states suggest that regulated hunting is likely more effective to maintain or achieve that objective when the wolf population is smaller.

- TWG members do not have agreement on whether a population objective should be established. Some members expressed concern in wildlife managers' ability to maintain adequate pace of response to conflict as wolf populations grow. Some members suggested that proactive management - setting and managing towards local or statewide population objectives - may help to mitigate potential management capacity issues. Other members do not support the need for statewide population objectives.

Avoiding misinterpretation of maximum vs. minimum population metrics

Summary of TWG feedback: It is important to use clear and consistent messaging to reinforce the purpose of minimum population counts/estimates, which are not intended as population objectives or maximums and have been misinterpreted in other contexts.

Note: Please see TWG's separate report on recommendations and rationale regarding minimum population thresholds and metrics for State downlisting and delisting.

- Minimum population counts for downlisting and delisting are not intended as and should not be interpreted as population objectives nor maximums.
 - Be clear and consistent in the messaging of this; reinforce the message constantly at the highest levels of leadership within the State.
- Trust in the agency and its managers on the ground, along with its responsiveness and engagement with the public, is important for the management of population size and other topics.
- Public and stakeholder focus on the minimum as a maximum is indicative of various interests or concerns about wolves on the landscape, for example, concerns about livestock conflict, ungulate impacts, ecological benefits, etc.

Zonal management

Summary of TWG Feedback: Initial and long-term management should be impact-based. Zonal management of conflict could be a consideration for future management. Delineation of zones in the future could be informed by experience and data gathered through impact- (and conflict) based management, understanding of ecological and social suitability (inclusive of wildlife and agricultural interests), and learnings from wolf dispersal and establishment on the ground.

- Zonal management is a consideration for how to address social and ecological dynamics and conflicts. Zonal management is the concept whereby different local areas are managed differently with respect to the tradeoff between wolf conservation versus local wolf conflicts while considering wolf population goals and trends at a larger scale. Conflicts refer to those with livestock and big game, or other, less likely, interactions with humans, pets, or other species. Management in some areas may be focused on wolf population conservation and growth while management in other areas may have higher wolf mortality rates to proactively minimize impacts on big game or livestock depredation, so long as overall wolf population size or growth are adequate.

- Zonal management does *not* refer to geographic recovery area; the TWG has proposed Statewide recovery thresholds for Colorado.
- Zonal management does *not* refer specifically to management based on population objective, but rather based upon ecological and social suitability and conflict.
- Above minimum population thresholds, zonal management can be used with management favoring different outcomes (e.g., wolves, agriculture) where social and ecological conditions support them.
 - Consider the Colorado State University (CSU) and US Department of Agriculture Animal and Plant Health Inspection Service- Wildlife Service (USDA-APHIS-WS) model for habitat suitability/conflict to inform zonal management: this includes social and ecological factors.
 - This model suggests the existence of ecological and social suitability in Colorado, with low conflict, to support zonal management.
 - Truthing the model with data collected from wolf monitoring in Colorado will help to validate it prior to establishing any zonal management in the state.
- A consideration for timing of implementation of zonal management is that where wolves are released is not necessarily where they will end up: this includes consideration that Proposition 114 requires release west of the Continental Divide but introduced wolves will almost certainly move east of the Divide and naturally migrating wolves are already present east of the Divide. Delineation of management zones is best informed with experience and data on wolf establishment and distribution on the ground.
- Delineation of wolf management units with lines on a map is complex, should be informed by Colorado-specific data and goals, and should embed flexibility over time based on management learning and experience. For example, in Montana, the decision to apply zonal management was made with 15 years of data on wolves on the landscape.
- Impact/conflict-based management can occur without zonal management; i.e., rather than drawing lines on maps, manage based on impacts in areas that emerge from the experiences on the ground. Impact/conflict-based management can also inform the development of zonal management over time, such that zones are delineated and managed according to the emergent patterns of impacts.

Wolf population self-regulation

Summary of TWG feedback: Intrinsic self-regulation of wolves is unlikely at a statewide scale; wolves will likely be extrinsically regulated particularly by social carrying capacity. Wolf population self-regulation does not achieve the same goals as conflict management.

- Wolves are territorial; intrinsic self-regulation occurs at a high population density: in combination with extrinsic regulation (see below) this can also be referred to as ecological carrying capacity.
- Self-regulation may be possible at a smaller scale but is unlikely to be seen at a statewide scale; population density necessary for statewide self-regulation is unlikely to be seen in Colorado.
- Wolves will adjust to food supply (extrinsic regulation) below the level at which intrinsic population control limits the population size or growth rate.
- Wolf population self-regulation is not a substitute for conflict management. Managers will have to address conflict management before a wolf population reaches a point where it is functioning at ecological carrying capacity, or the combination of extrinsic and intrinsic self-regulation.

Positive impacts and wolf management

Summary of TWG feedback: Positive and negative impacts can occur due to wolf presence; positive impacts do not generally require hands-on management but can be communicated through education and outreach and can inform management activities and funding opportunities.

- Positive and negative impacts can occur due to wolf presence on the landscape; these can include ecological, social and economic impacts as discussed in sections below.
- Positive impacts can be communicated and supported through education, information, and outreach. For example, managers could share distribution maps (general areas, not den locations or other sensitive data) to support wolf tourism (viewing, howling). Consider both the positive and negative impacts of increasing tourism.
- Positive impacts generally do not require hands-on-wolf management. However, where positive impacts exist, they could inform management; for example, if there are positive impacts in a park, consider managing for them by creating a buffer for management around that area.
- Some literature indicates that while the economic benefits of wolves can be many times higher than the costs of management to prevent and resolve conflicts, the distribution of benefits do not align with the distribution of costs. Positive impacts could inform funding and support for wolf management.

Management of livestock conflict

Non-lethal livestock conflict minimization

Summary of TWG feedback: Adoption of proactive and reactive non-lethal conflict risk reduction techniques by livestock producers in Colorado is important to the long-term success of the wolf restoration and management program. The effectiveness of these tools is context-specific and not well quantified.

- Non-lethal conflict reduction techniques include those implemented prior to and to prevent conflict as well as those implemented following depredation to prevent further conflict.
- To be most effective at minimizing and preventing depredation events, non-lethal conflict techniques should ideally be applied early and properly when wolves are in or anticipated in an area. To accomplish this, advanced preparation and engagement among the agency, partners, livestock producers, nonprofits, and others working on conflict minimization in Colorado is strongly advised prior to and continuing through reintroduction.
- Experiences with livestock producers in other states also suggests that incentivizing and allowing creativity in conflict risk reduction approaches and working with producers is an effective approach.
- Context-specific considerations for effectiveness and feasibility of use of conflict risk reduction techniques include livestock type, age, time of year, land size, other land uses, landscape conditions, and local geospatial features, among other considerations that may impact livestock operations and wolf predation behaviors.
- Quantifying the effectiveness of various non-lethal tools is difficult and research in this area is in development, suggesting effectiveness is highly context-specific and requires some trial.

- Suggestions for dissemination of non-lethal tools include building upon and/or leveraging relationships with members of the agricultural community, including through agency outreach (CPW, USDA APHIS-WS, and/or Colorado Department of Agriculture), community collaboratives, NGOs, stakeholder groups and livestock producer associations, rancher-to-rancher engagement and training programs, academic programs such as Colorado State University Extension, and conflict risk reduction cooperatives.
- Providing funding support, either directly or through cost-share programs, may help to foster adoption of techniques.

Post-depredation management of conflict wolves

Summary of TWG feedback: While wolf depredations on livestock in other states are uncommon and do not represent a notable burden to the livestock industry as a whole, some wolves do cause significant problems for some ranchers and some areas experience repeated and frequent wolf depredations on livestock. Management of wolf-livestock conflicts following depredations should allow flexibility for managers; non-lethal and lethal management techniques should be applied adaptively and are context-specific. To be effective at reducing further depredation events, lethal and non-lethal responses for resolving conflict should be applied quickly and properly. Relocation of depredating wolves has little technical merit.

- A guiding principle for management should be to allow wildlife managers flexibility, such as in defining a problem and/or conflict wolf and/or chronic depredation.
- Chronic depredation would consist of multiple depredations and could consider temporal and spatial factors (e.g., from other states: two depredations in a calendar year, three within ninety days, or four within a relative nine-month window from first depredation), as well as the phase of recovery and management. Simplicity should be a guiding factor in this definition. A potential definition for a conflict wolf would be a wolf that creates conflict, not exclusive to but including depredation.
- Management response may vary between one or multiple depredations, and depredation response may not always be driven solely by depredation frequency. For example, lethal removal might be an effective way to reduce future depredations after an initial depredation event if the wolf population is large enough, and implementation of non-lethal deterrents may be effective after multiple depredation events in a small pasture situation.
- It can be difficult to determine which individual wolf or pack is depredating, and an alternative could be to consider depredation by area, such as focusing on depredations affecting a producer and/or community rather than on the individual wolves and/or packs. Knowledge of areas where conflict is more likely to occur will increase over time, and adaptive responses can be tailored based on this knowledge. Areas with higher wolf density and livestock density tend to be those with higher conflict.
- Efficacy of non-lethal techniques vary on a case-by-case basis, including factors such as if a depredation has already occurred as well as spatial and temporal conditions for when and how the depredation occurred.
 - While efficacy of non-lethal methods may decrease over time or after an initial depredation, implementation of non-lethal methods and aversive conditioning post-depredation have had success to prevent further depredations and prevent use of lethal management actions.
 - A specific example of an effective non-lethal technique is the removal of bone piles and other attractants, ideally pre-depredation, or potentially post-depredation.

- Some landscape conditions, independent of individual predator or pack reputation or conflict minimization, may create conflict hotspots.
- The effectiveness of translocation of conflict wolves may vary. Relocation of conflict wolves has little technical merit and presents a social challenge in relocating a known depredator elsewhere.
 - Those wolves might attempt to return back to their original location and/or create problems for producers in other places.
 - Relocation takes significant time and resources.
 - If the purpose of relocation is to stop further depredations, it is important to consider whether this accomplishes that purpose.
 - This practice has only been previously used if managers do not have flexibility via regulation to use other conflict wolf management tools.

Lethal management of conflict wolves

Summary of TWG feedback: Lethal and non-lethal management are both critically important tools for conflict minimization; lethal management will likely attract greater social attention. In evaluating the management approach on a context-specific basis, consider the trade-offs among ability to target depredating wolves, conflict minimization efficacy, cost, reproductive and recruitment success, wolf population size and listing status, impacts to livestock producers, and social/stakeholder interests when considering lethal take options, including incremental and whole pack removal.

- Availability of both lethal and non-lethal management tools is important to support management flexibility.
- Lethal management of wolves will be accompanied by significant social attention in Colorado.
 - Some social science research suggests Coloradans are least likely, compared to other states in the region, to support lethal management and that non-lethal tools will need to be an integral part of management.
 - Wildlife damage management research has consistently shown the affected public supports lethal management and the unaffected public generally does not support lethal management regardless of species involved.
 - Proper emphasis and exercise of non-lethal techniques, quality of investigations, agency transparency and education and outreach about conflict management and conflict wolves should be among factors considered prior to justifying lethal techniques to respond to and prevent future depredations.
- Targeted lethal control may decrease future depredations. There are tradeoffs between incremental (individual) removal and whole pack removal:
 - There have been both successes and failures with incremental removal.
 - The more wolves that are removed, the higher the efficacy for reducing conflict and reducing likelihood of an additional depredation; however, there is a tradeoff in terms of wolf recruitment, and in some cases, social acceptability.
 - Incremental removal of individuals responsible for the depredation may be more socially acceptable. However, it is difficult to effectively target the individual depredators (due to time, knowledge, and monitoring constraints); consider targeted incremental removal in early phases when managers have the ability to target depredating wolves.
 - Wolf populations can sustain 25-30% annual mortality while maintaining a stable or increasing population. This is well above the level of mortality that would be expected

due to lethal take for management of depredating wolves: however, it does not address the specific ecological and social consequences of lethal removal when only a small number of wolves or packs are present (i.e., early in reintroduction).

- Data do not suggest that depredation will increase due to lethal removal of individual wolves from a pack.
- Lethal take of depredating wolves may increase effectiveness of non-lethal management techniques by removing individuals with bolder behavior and conditioning fear of humans in remaining pack members: however, the science is not robust on this topic.
- Lethal removal is problematic if the individual depredators are also the breeding individuals, which will affect recruitment. The probability of persistence and reproduction decreases as more individual wolves are removed from a pack.
 - If there is not reproduction, lack of pups can lead to pack dissolution.
 - The larger a pack, there will be more resilience to a mortality event and the higher likelihood that the pack will recruit pups the year following removal. However, larger packs are also more likely to depredate again.
 - Seasonality and whether the removed wolves are breeding individuals will also affect pack persistence and reproduction.
- Management options could consider the role of lethal control in areas of public land grazing vs. areas of mixed public and private lands. This was a consideration for phased management in one Northern Rockies state, where more liberal management was included in earlier phases for areas of mixed private and public land, whereas management was liberalized in later phases for public lands. However, differentiation raises challenges for consistency of management. Alternatively, options could consider land use patterns rather than land ownership. There are many areas where public and private lands are interspersed and not fenced; knowing precisely whose land an action occurred on can be problematic. However, it may be possible to consider management based on the general use patterns (agricultural, residential, recreational, wilderness, etc.).
- Public harvest (different than conflict management) has not directly led to a decrease in depredation in areas of harvest in other states, but there are indirect impacts for wolves being sensitized to and fearful of humans as a result of public harvest, which may in turn decrease wolf interactions with and depredations of livestock.

Management of interactions with ungulates and other wildlife species

Considerations for ecological effects

Summary of TWG feedback: Ecological function is an important factor to consider but is difficult to quantify and may be less relevant as a metric at the state scale.

- Positive ecological effects from having wolves on the landscape can occur, however they are difficult to quantify and document, require appropriate scale, and are also situation-specific. Landscape level ecological effects are both difficult to quantify and to achieve.
 - Ecological effectiveness is a vague concept and situation-specific; for example, positive effects of a full complement of large carnivores in Yellowstone may not apply in other areas.

- Ecological effectiveness and trophic cascades across a large area are not likely to occur until there is a saturated wolf population. However, management to address social carrying capacity and conflict in human-dominated landscapes will impact pack size and distribution and will likely limit achievement of ecological carrying capacity.

Impacts of wolves to ungulates, big game, and big game hunting

Summary of TWG feedback: Although statewide impacts to ungulate populations and hunting opportunities have not occurred in other states and are unlikely in Colorado, wolves can have local impacts to ungulate recruitment due to predation of young ungulates. Wolves prefer elk and will also prey on deer and other ungulates; moose may be targets of predation where they are abundant. Reduction in big game hunting opportunities and targeted wolf control have sometimes occurred locally in other states to address negative ecological or economic effects of reduced ungulate populations. Ungulate populations are impacted by a complexity of interacting factors.

Predators like the gray wolf may select for prey compromised by infectious diseases, which could prove useful in reducing infectious disease prevalence in ungulate populations, primarily when pathogens are directly transmitted among hosts. The strength of a potential disease reduction depends on numerous factors, including specific disease etiology, the strength of selection for infectious individuals, and overall predation rates. It is unclear whether wolves will have a measurable effect on chronic wasting disease (CWD) in Colorado, where environmental contamination is likely to be a primary transmission route and where CWD is already well-established in mule deer, a species that wolves generally do not select for in the presence of elk.

- At a statewide level, wolves are unlikely to have a major impact on overall big game populations or hunting opportunities in Colorado based on evidence from northern Rocky Mountain states.
- Ungulate populations are impacted by a complexity of interacting factors.
- Impacts of wolves to ungulates are a local rather than statewide issue; ungulate management in response to gray wolf impacts should also be localized.
- Wolf-prey selection demonstrates a strong preference for elk over deer, where elk are present.
- The impact of predation is focused on recruitment because wolves tend to eat young elk; they will prey on a variety of age classes of different ungulate species (including reproductive and non-reproductive age): however, their preference is for young and old elk. This impact occurs in combination with presence of other predators and ungulate habitat limitations. Wolf predation occurs throughout the year, with some seasonal variability and peak kill rates in late winter.
- In other states where wolves are present with other carnivores, reduction in big game hunting opportunities (particularly cow hunting or through changes in license type) has sometimes occurred to maintain ungulate population size. Declines in ungulate population size have occurred when reductions in recruitment due to predation have occurred in combination with cow hunting. Therefore, recent big game management in other states where wolves are present has focused on reducing or eliminating cow hunting opportunities to avoid population declines.
- In some states, under both federal and state management authority, wolf control may be considered if it was determined that wolves were a contributing factor to negative performance of big game populations.
 - Wolf impacts to ungulate populations are localized, typically occur in the presence of impacts from multiple large carnivores, and examples of impacts and subsequent management of wolf impacts to big game are rare; some areas such as NW Montana and the LoLo area of Idaho have been managed for wolf impacts to big game.

- Under federal management authority, it was only allowed for nonessential experimental populations in States that had Service-approved wolf management plans (i.e., ID, MT, WY), although when this might be considered changed slightly over time.
- Many state wolf management plans also consider wolf impacts to big game populations and when wolf control may be considered to improve the performance of big game populations. These considerations vary by state. In Montana, Idaho and Wyoming, there are regulated hunting seasons. Both Washington and Oregon have very similar language as to what is proposed for how wolves could be managed should there be demonstrated effects on local ungulate populations.
- In addition to considerations for infectious disease and CWD (discussed above), there are considerations for potential wolf effects on ungulate population health and noncommunicable disease. Gray wolves preferentially select for relatively weak prey, including old and diseased (i.e., noncommunicable) prey, which may reduce disease prevalence such as arthritis.
- Moose are generally not a significant portion of wolf diet; however, wolf predation of moose is variable and the impacts to the moose population are localized, dependent in part on the size of the moose population. Wolves are more likely to select moose where moose populations are higher. In Yellowstone, moose are rare and moose predation is low. In locations where moose populations are low, there is potential for relatively higher impacts from wolf predation, even if wolf predation of moose is low.
 - Moose are challenged by a variety of problems that overshadow wolf predation; these include living on the southern end of their range, including habitat, parasites and ticks, bear predation, and potential competition with elk on winter range; challenges are driven by climate and heat stress at the southern end of their range and this can be compounded by climate change. Moose populations in Colorado are doing well.

Interactions on other wildlife species, particularly other large predators and/or other threatened and endangered species

Summary of TWG feedback: Wolves are important components of trophic networks where they are present on the landscape and their presence may have interactions with other large carnivores. The presence of wolves will not have an impact on populations of threatened and endangered species in Colorado, specifically lynx and Gunnison sage grouse.

- Various species benefit from carcasses of prey killed by wolves.
- Abundance and distribution of carrion/carcasses in the winter may benefit wolverines.
- Wolves will kill individual coyotes; Yellowstone data show that coyote populations survive but may change their pack dynamics and behaviors.
- Wolves, lions, and bears may interact and cause some limited mortality for each other.
- Wolf kill rates may decrease in the presence of grizzly bears (not present in Colorado); grizzly bears are dominant on wolf kill carcasses in summer and wolves will stick with carcasses thus reducing kill rates.
- The effects of wolves on lion populations are variable. Northern Yellowstone research did not find a population effect of wolves on lions. Lions may move down in elevation in the absence of wolves. Mountain lion kill rates may increase in presence of wolves because wolves are dominant to lions on carcasses, and lions may increase their kill rates as a result.
- Wolves will eat beavers; in the Great Lakes states, beaver can represent half of wolf diets and 30% of biomass consumed: however, there is generally not a population effect on beavers. Wolf predation of beavers is potentially more opportunistic than bear predation of beavers.

- There is no reason to believe that there will be a significant impact of wolves on lynx or the Gunnison Sage-grouse and Greater Sage-grouse.

Management of conflict with humans and domestic pets

Summary of TWG feedback: Attacks by wolves on humans are exceedingly rare; education and outreach for recreationists and other public lands users should include best practices and guidance, including how to differentiate wolves and coyotes. Flexibility to address rare instances of wolf habituation in areas dominated by humans is important.

Wolf attacks on pets are uncommon; education, outreach, and management should be used to proactively prevent conflict. It is important that public messaging emphasizes the risks assumed when domestic and hunting dogs are present in areas with wolves.

- Strong public messaging should emphasize that dogs can be an attractant for wolves, and, although rare, wolves will kill dogs. Recreationists and hunters should all be aware of this risk when taking dogs into wolf country.
- Hunters that use hunting hounds should be aware of wolf presence where they are hunting and factor that into their decisions regarding whether to hunt with dogs in that area. Wolves do kill hunting hounds, particularly those that hunt far away from people.
- Livestock guardian dogs remain an important consideration for conflict minimization; livestock producers with livestock guardian dogs should also be aware of the risk of wolves to dogs. The use of larger livestock guardian dogs to protect against wolves can also have potential impacts for domestic pets and hunting dogs, due to conflicts between the livestock guardian dogs and pets/hunting dogs sharing the same landscape.
- Consideration of recreationists' experience and purpose on the landscape can help inform education.
- There can be issues with mistaken identity: dogs can be misidentified as wolves; recreationists that are shooting coyotes could mistakenly shoot wolves.
- Distinguish between tolerant and habituated wolves:
 - Tolerant wolves may walk through campsites or pass by people. Wolves that become more tolerant of people are more susceptible to poaching and hunting.
 - Wolves may occasionally become habituated. For example, in Yellowstone National Park, wolves may occasionally take human food or items from campsites.
 - Hazing is a key part of the toolkit for managing habituated wolves and is an effective tool used on a case-by-case basis.
 - Effectiveness of hazing is increased when it is implemented early, before wolves become more bold and habituated.
 - Hazing and aversive conditioning can also be challenging for a management agency because of the need to catch the animals consistently in the act of the behavior that you want to discourage.
 - Having hazing available to producers can support early intervention.
 - A phased approach to hazing and habituation could be considered based on population status.
 - There have been two instances in Yellowstone of lethal take for aggressive and habituated wolves.
- Management approaches:

- State and federal law allow take of wolves that are threatening human safety.
- Management of a wolf that kills a pet or hunting dog will depend on the context; it is important for state agencies to have flexibility.
- Flexibility to address other situations such as wolves denning in human-dominated areas with various tools and on a case-by-case basis is recommended. It is difficult to anticipate all scenarios for interactions with humans, recreationists, livestock, other wildlife, etc.
- Well-trained staff that are good at communicating and managing is important.

Wolf monitoring and expectations for stakeholders and public

Summary of TWG feedback: Monitoring and research should be based on restoration and management goals, use a variety of techniques, and be connected to other elements of wolf management, including conflict minimization. While robust monitoring is valuable at early stages of reintroduction, limitations to monitoring will increase with wolf population growth, requiring transition to a population estimate approach. It is important to consider effective messaging and coordination with stakeholders and the general public when communicating monitoring objectives and data; lead with trust and share data on an as-needed basis.

- There is value in collaring every wolf that is reintroduced for monitoring and data collection purposes and to learn from and improve upon for future releases; however, it is important to educate the public and set expectations that not every wolf in Colorado will be collared as the population grows. There is a risk that the public will incorrectly perceive that the agency is failing in its monitoring efforts over time as fewer wolves are collared and monitored.
- It is important to understand that collars tell managers where wolves have been but not where they are present; monitoring cannot necessarily prevent conflict, but it can increase education on wolf behaviors, patterns, and presence in an area. It can also help in educating people on what to look for with respect to livestock conflict minimization.
 - Some non-lethal tools (i.e., radio-activated guard (RAG) boxes) rely on radio collars; there may be interest in collaring for these purposes, aside from collaring for the state monitoring program. RAG boxes can be used to scare wolves away over a short distance. Ideally, they would be used to alert ranchers of wolf presence, particularly in areas of prior depredation.
 - Immediately following a depredation event can also be an effective time to capture and collar wolves.
 - Collar reliability and longevity varies, and GPS collars are less reliable than VHF collars. A combination of collars can support an effective monitoring program.¹
- Monitoring and research programs should be based on the wolf restoration and management goals and objectives.
 - Colorado's downlisting and delisting thresholds provide recovery goals to guide monitoring program design.
 - Population growth rate is an important indicator for recovery goals. It can be informed by abundance monitoring (e.g., minimum counts, population estimations, number of packs), survival monitoring (adult and pup), recruitment (including reproduction and survival, as well as immigration), and distribution (e.g., den locations).

¹ See the November 2021 TWG Restoration Logistics Report, Pages 17-18, for additional discussion of collars.

- Survival monitoring is an indicator of performance rather than population size. Survival is affected by conflict management, including lethal control.
- Monitoring and research program design, costs, and effectiveness are interrelated with the entirety of the wolf program, including conflict management.
 - It is essential for those conducting monitoring and those leading conflict management and depredation investigations to communicate and effectively coordinate with each other. Monitoring approaches and costs should evolve with the wolf population size, from minimum counts and intensive ground (i.e., camera) and aerial monitoring toward population estimates.
 - A wolf reintroduction and management plan should include a research effort to develop a population estimate model beginning in the early stages of reintroduction. Such a model will support a long-term monitoring program that does not rely on intensive capture and collaring as the population size grows.
- Monitoring and research are a year-round effort involving a variety of techniques to locate and collar wolves.²
 - While a lot of monitoring work can be accomplished from the air and with aerial captures, these techniques are more effective when there are already a lot of collars deployed.
 - A fixed wing pilot with experience locating and tracking uncollared wolves from the air can be an enormous asset in improving the success of helicopter capture efforts.
 - Foothold traps are an important tool for monitoring in other states. Injury rates for foothold traps are low. Use of traps for all wildlife management in Colorado is extremely limited per state Constitution; traps can be used for some conflict mitigation and research purposes.
 - Significant groundwork and scouting are also needed to locate wolves, particularly in early phases of restoration; groundwork increases absent the use of other techniques listed above.
- Adopt an approach to monitoring, information- and data-sharing that leads with trust.
 - Sharing data should be discretionary on an as-needed basis – for example, when working with producers to minimize and manage conflict, or with research partners – rather than a want-to-know basis.
 - Legal implications, including open records laws, should be considered prior to the decision to share data. The statutory and regulatory basis for not sharing data should be made clear to the public.
 - Information-sharing can be general in nature; it does not necessarily need to involve sharing of specific telemetry data or other more sensitive information.
 - Sharing information with the ranching community provides transparency and factual information, can build early trust, and can empower communities to understand the data.
 - This must be balanced against protecting wolves from illegal take; however, there have been positive experiences in other states in sharing monitoring data and locations.
 - Trust is reciprocal; there is risk in sharing information but agencies and ranchers must be able to trust each other.
 - Monitoring activities can also include the public and private property owners.

² See the November 2021 TWG Restoration Logistics Report, Pages 7-10, for additional discussion of capture methods and considerations.

Social and/or economic dimensions wolf management

Summary of TWG feedback: Social and economic dimensions are critical to understand, measure, and incorporate into decisions on wolf management. Perceptions of wolves and perspectives on management vary among people, are generally consistent within interest groups, and often reflect deeply held beliefs and values. There is high potential for social controversy and conflict, particularly as related to expectations and acceptance for use of non-lethal practices, lethal control, recreational harvest/regulated public hunting, and wolf population numbers. Some research suggests that economic benefits can be substantial and much larger than economic costs, however economic benefits and costs are not distributed equally across stakeholders and the public. Consider the breadth of existing social science research, economic indicators, and stakeholder and public feedback when making management decisions, and incorporate new social and economic research into future decisions. Education and outreach can also inform and be informed by social science. It is critical to have trusted, responsive managers on the ground and consistency of management.

- Social and economic dimensions of wolf management consider a variety of stakeholders, interests, and values, for example rural/agricultural and urban.
 - There is high potential for controversy and conflict among different perspectives with respect to wolf restoration and management. There are deeply held, conflicting cultural beliefs or values regarding wolves that are unlikely to change.
 - Social and economic dimensions affect all aspects of wolf management, including restoration, conflict management, compensation and whether and how to approach population management.
 - There is a broad spectrum of perspectives and research to consider specifically in relation to social dimensions of wolf management, social acceptance, and recreational harvest (or, regulated public hunting of wolves). Related to these issues are varying perspectives on ethics and fair chase where regulated public hunting is allowed. These topics will be controversial and contextual; demand, acceptance and/or opposition for harvest will vary by cultures and geographies. Whether allowance or disallowance of recreational harvest/regulated public hunting will change fundamental beliefs is unclear. In addition to being informed by social considerations, allowance or disallowance of regulated public hunting will also be informed by legal considerations including interpretation of authorities relative to the definition of gray wolves in CRS 33-2-105.8 as being a nongame species.
 - There is also high potential for social controversy regarding whether and/or how to set recovery criteria population goals, define self-sustaining populations, and manage populations.
 - Failure to adequately consider different viewpoints can lead to politically driven swings in management.
 - Wolf management and issues in other places, and especially in and around National Parks, affect the national dialogue and state management; management around National Parks involving more national interest groups and polarization can increase the amount of social conflict.
 - Trust in messengers is important; different messengers are effective for different audiences.

- Having responsive, trusted managers on the ground is important for navigating diverse cultures and contexts with respect to wolves.
- Existing and future social and economic science can inform management decisions.
 - Research should be balanced with experiential insights and learning from managers and partners on the ground.
 - Social, economic and biological/ecological research each have the potential to be interpreted to confirm and/or serve different perspectives and positions.
 - Stakeholder representation and leadership in development of the plans increases trust and acceptance; general survey data are not enough.
 - Social/economic indicators (positive and negative) combined with on-the-ground insights can inform future suitability assessments and zonal management by helping to understand patterns of conflict, economic benefits, etc. (see discussion above).
 - A TWG member suggested engaging social scientists and economists to help expand on insights synthesized in this report, including by summarizing public opinion surveys conducted since the early 1990s, research insights from the 2020 Colorado election results on Proposition 114, and other existing literature.
- Social indicators to help inform management could include:
 - Consider the CSU and USDA-APHIS-WS model for habitat suitability/conflict (includes ecological and social data (voting patterns)).
 - Consider ongoing CSU/CPW social science research in Colorado.
 - Behaviors and attitudes in response to wolf presence (for example, adoption of and attitudes toward non-lethal conflict minimization practices and/or compensation, or evidence of poaching or illegal take).
 - Perceptions and values. Consider examples of research from the Northern Rockies. For example, in Montana, social science research has been conducted in 2012 and 2017 and is scheduled to be repeated in 2022; it initially included surveys of big game license holders, wolf license holders, landowners and wolf advocates, and then became a general household survey. It included general wolf acceptance questions and questions on tolerance of specific management actions (reactive to what was done); managers noted that information collected from such surveys can be informative to management but does not necessarily help with the issue of building trust.
- Economic indicators to help inform management could include:
 - Impacts from any changes (if applicable) in ungulate harvest management correlating with wolf restoration, with consideration of pre- and post-restoration license sales as well as the relationship between hunting license sales and outfitting and ranching economics.
 - Positive economic consequences (for example, for the outdoor industry, reduced vehicle collisions, etc.).
 - Economic costs to producers of direct and indirect losses, non-lethal and lethal management, and funding availability for management.
 - Economic costs to agencies (management, compensation, education/outreach, additional staffing, resources, etc.).
 - If there is a net economic benefit, consider how, if possible, it can be quantified and directed toward where the costs are incurred.
 - Economic assessments, particularly those that demonstrate significant positive benefits of wolf restoration, could also be valuable to inform legislators/legislation and support general assembly funding for wolf management.

Appendix A: About the Technical Working Group

The purpose of the Technical Working Group (TWG) is to review objective, science-based information as well as provide its own knowledge and experience at the state/federal/tribal level to inform the development of the Colorado Wolf Restoration and Management Plan. The TWG is composed of members who bring experience in wolf reintroduction, wolf management, conflict minimization, depredation compensation, and other relevant topics. CPW is responsible for writing the Wolf Restoration and Management Plan. The Parks and Wildlife Commission (PWC) serves as the decision-making body responsible for approving the Wolf Restoration and Management Plan. The TWG serves in an advisory capacity to Colorado Parks and Wildlife, offering non-binding input into the development of plan content. The TWG is not a decision-making body and has no authority on wolf management policy, research, or operations. The TWG operates by consensus. For purposes of the TWG, consensus refers specifically to general agreement, or lack of objection, that an option or alternative has sufficient technical merit to be recommended for consideration by CPW. In the absence of consensus, dissenting views will be documented.

Technical Working Group Members:

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