Forest Service
U.S. Department of Agriculture

In Partnership with Western Colorado University

Indigenous Fish and Wildlife Management Strategy

Fossil Ridge Wilderness, Gunnison National Forest

"Like winds and sunsets, wild things were taken for granted until progress began to do away with them. Now we face the question whether a still higher 'standard of living' is worth its cost in things natural, wild, and free."

– Aldo Leopold

Indigenous Fish and Wildlife Management Strategy

Fossil Ridge Wilderness, Gunnison National Forest

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October 2020

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ON THE FRONT COVER
Top: Henry Mountain, the highest point in the wilderness at 13,254 feet, as seen from an expansive, subalpine grassland meadow along the Van Tuyl Trail (Tobias Nickel, July 4, 2020)
Middle left: Bighorn ram (CPW)
Middle right: Southern white-tailed ptarmigan in fall plumage (Shawn Conner, BIO-Logic, Inc.)
Bottom left: Colorado River cutthroat trout (Photo © Alyssa Anduiza, courtesy of Aspiring Wild)
Bottom right: Adult boreal toad (Brad Lambert, CNHP)

ON THE BACK COVER
The shores of Henry Lake in the heart of the Fossil Ridge Wilderness. Rising to over 13,000 feet, the granite peaks of the Fossil Ridge tower in the background (Tobias Nickel, June 16, 2020)

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Dedication

This publication is dedicated to all past, present, and future defenders of wilderness. Your efforts safeguard the Earth's wild treasures from our species' most destructive tendencies and demonstrate that humility and restraint are possible in an age of overconsumption and unfettered development.

I also dedicate it to all those who venture responsibly into the Fossil Ridge Wilderness – may you find the inspiration, solitude, and tranquility that you seek.

"When despair grows in me
and I wake in the night at the least sound
in fear of what my life and my children's lives may be,
I go and lie down where the wood drake
rests in his beauty on the water, and the great heron feeds.
I come into the peace of wild things
who do not tax their lives with forethought
of grief. I come into the presence of still water.
And I feel above me the day-blind stars
waiting for their light. For a time
I rest in the grace of the world, and am free."

– Wendell Berry, The Peace of Wild Things

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Executive Summary

This document provides an indigenous fish and wildlife management strategy for the Fossil Ridge Wilderness administered by the Gunnison Ranger District of the Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests. The purpose of this strategy is to inform and empower local land managers to make carefully-weighted fish and wildlife management decisions that respect and preserve wilderness character and ensure persistence and/or recovery of selected priority species faced with direct or indirect human pressures.

The opening chapters provide a synthesis of law and policy and biophysical and social sciences related to the management of fish and wildlife resources inside wilderness. The intent of these sections is to establish a common understanding among wilderness managers, fisheries and wildlife biologists, and other stakeholders on the concept of wilderness character and increase communication and transparency regarding the trade-offs of fish and wildlife management in wilderness.

Subsequent chapters outline species-specific wilderness management strategies. In coordination with Colorado Parks and Wildlife (CPW) and other stakeholders, the following priority species were identified for the Fossil Ridge Wilderness: Rocky Mountain bighorn sheep, Colorado River cutthroat trout, boreal toad, and southern white-tailed ptarmigan. For each priority species, this strategy establishes management objectives, identifies survey and monitoring needs, and makes management recommendations. Wilderness stewardship considerations of potential future management actions are also discussed. Lastly, monitoring questions are developed to evaluate the effectiveness of management actions and adapt subsequent work.

This strategy assists the Gunnison Ranger District in meeting its Wilderness Stewardship Performance (WSP) goals. WSP is a framework to track how well the Forest Service is fulfilling its primary responsibility under the Wilderness Act of 1964 – which is to preserve wilderness character. Under this framework, specified wilderness stewardship accomplishments improve performance scores for individual wilderness areas. This document puts the Gunnison Ranger District on a path toward stewardship excellence in the Fish and Wildlife Element of WSP. Acting on management recommendations identified in this strategy and subsequently monitoring their effectiveness will continue to improve the WSP score of the Fossil Ridge Wilderness.

Note that this strategy is not a decision document. The management actions discussed in this strategy are not intended to be prescriptive. Rather, this strategy identifies fish and wildlife management actions that would allow wilderness managers to respond to current threats and prepare for a range of possible future scenarios. Some management actions discussed herein may necessitate further analyses and decisions through application of the Minimum Requirements Decision Guide (MRDG) and/or National Environmental Policy Act (NEPA).

Finally, this strategy is a living document that should be revisited and revised (if needed) by an interdisciplinary team on an annual basis to reflect up-to-date information on fish and wildlife management priorities, newly identified threats to indigenous species, and emerging information needs. This is important to ensure that content reflects current priorities, changes in available data, and captures any desired modifications of the priority species list.

Acknowledgments

I want to thank Joseph Carlson from the U.S. Forest Service, who served as a supportive supervisor throughout the development of this report. As wilderness areas come under increasing threat from human pressures, agency managers like Joe, who are committed to wilderness stewardship, are needed more than ever to protect our remaining wild places. I also want to express my gratitude to my faculty advisor, Sally Thode. Sally provided invaluable support and mentorship when it was most needed, both as a friend and as a teacher. In addition, I want to acknowledge Amy Honan, who reviewed several draft versions of this report and provided excellent feedback and guidance.

My appreciation also goes to the Forest Service, Gunnison Ranger District and the Center for Public Lands at Western Colorado University for providing funding for this fellowship, allowing me to turn my passion for wilderness stewardship into a viable master's project. Maddie Rehn and Dr. Melanie Armstrong from the Center for Public Lands provided important logistical support. In addition, several faculty from Western Colorado University contributed their expertise to this report. Dr. Kevin Alexander provided feedback on the Colorado River cutthroat trout section and also shared his extensive knowledge of the Uncompahgre fritillary butterfly gained from years of monitoring the species in the San Juan Mountains. Dr. Derek Houston shared his genetic research and expertise on the taxonomy of cutthroat trout. Dr. Patrick Magee provided guidance on priority species selection and shared his impressive knowledge of local flora and fauna accumulated from years of being a dedicated naturalist, conservationist, and professor of wildlife biology in the Gunnison Basin.

Finally, this report would not have been possible without the cooperation of many federal and state agency staff, who, despite limited time and resources, generously offered their assistance and wealth of knowledge. In particular, I would like to acknowledge the following state wildlife biologists: Kevin Blecha provided critical input on bighorn sheep management; Daniel Brauch shared valuable feedback on the Colorado River cutthroat trout section; Daniel Cammack gave expert advice on boreal toad conservation; and Amy Seglund generously shared her knowledge about alpine species and backpacked into the Fossil Ridge Wilderness with me to survey for southern white-tailed ptarmigan. From the Bureau of Land Management, I would like to acknowledge Russell Japuntich for providing input on the management of Colorado River cutthroat trout. At the Forest Service, Matthew Vasquez shared his knowledge gained from years of experience as a biologist at the Gunnison Ranger District.

It is my sincere hope that these cooperative relationships between students and faculty from Western Colorado University and state and federal agency managers will be sustained and grow. This strategy is an educational tool and intended to facilitate open, transparent communication among stakeholders about stewardship of our shared wilderness resources. Application of this strategy provides numerous opportunities for joint stewardship and research projects in the future.

A hiker crossing Lamphier Creek in the Fossil Ridge Wilderness. (Sean Christensen, June 14, 2020)

Introduction

Purpose and Need for Action

The purpose of this project is to provide the U.S. Forest Service, Gunnison Ranger District with an indigenous fish and wildlife management strategy specific to the Fossil Ridge Wilderness. This strategy is intended to inform and empower local land managers to make carefully-weighted fish and wildlife management decisions that respect and preserve wilderness character and ensure persistence of selected priority species faced with direct or indirect human pressures.

This document assists the Forest Service in meeting its Wilderness Stewardship Performance (WSP) goals. WSP is a framework to track how well the Forest Service is fulfilling its primary responsibility under the Wilderness Act of 1964 – which is to preserve wilderness character. Under this framework, specific wilderness stewardship accomplishments improve performance scores for individual wilderness areas. An indigenous fish and wildlife management strategy is one of the required components under the Fish and Wildlife Element described in the *Wilderness Stewardship Performance Guidebook* (Forest Service, 2020; Appendix A).

In addition, this document supports implementation of several objectives and goals approved by interagency leadership in the *2020 Vision: Interagency stewardship priorities for America's National Wilderness Preservation System* (BLM et al., 2014). This strategy directly addresses priorities under the "Protect Wilderness Resources" rubric, which call on the wilderness stewardship community to:

- Identify, conserve, and restore native fish and wildlife species and habitats in wilderness
- Strengthen collaborative partnerships for managing fish and wildlife species in wilderness
- Complete a state-of-knowledge synthesis of law and policy and biophysical and social sciences related to the management of fish and wildlife in wilderness.

Beyond fulfilling these legal mandates, policy requirements, and interagency priorities, this indigenous fish and wildlife management strategy is needed to:

- Cooperatively develop management objectives to guide conservation efforts and sustain the diversity of fish and wildlife present in the Fossil Ridge Wilderness
- Facilitate coordination and communication between the Forest Service, CPW, and other stakeholders in the management of fish and wildlife resources inside wilderness
- Ensure that all fish and wildlife management actions affecting the Fossil Ridge Wilderness are evaluated to be the minimum necessary for the administration of the area
- Educate resource specialist and agency partners on the concept of wilderness character and clarify how fish and wildlife management actions influence wilderness character
- Ensure that wilderness management decisions are made in a transparent and defensible way
- Preserve institutional knowledge of the Fossil Ridge Wilderness and its native fauna
- Provide a case study to guide the development of indigenous fish and wildlife management strategies for other areas included in the National Wilderness Preservation System.

Scope

This strategy provides guidance for management of fish and wildlife populations and their habitats in the Fossil Ridge Wilderness. Because land managers are legally mandated to approach wilderness stewardship with utmost humility and restraint, this document does not provide a comprehensive assessment of fish and wildlife species present in the wilderness. Rather, this strategy identifies wilderness-specific priority indigenous fish and wildlife species for which there is a perceived management need. Non-priority species, including non-indigenous fish and wildlife species, are only considered in this strategy insofar as they affect the persistence and/or recovery of priority species.

For each priority species, this strategy establishes management objectives, identifies survey and monitoring needs, and makes management recommendations. Additionally, this strategy discusses the trade-offs of potential future management actions from fish and wildlife and wilderness management perspectives. Lastly, this strategy describes how the effectiveness of future management actions is to be evaluated and used to guide subsequent work.

This strategy is not intended to be a decision document (Forest Service, 2020). It informs local managers of the Fossil Ridge Wilderness under existing laws and policies only. This strategy is supplemental and complementary to existing statutes, regulations, policies, and forest plan components. Some management actions discussed herein may necessitate further analyses and decisions through application of the MRDG and/or NEPA processes.

Geographically, this strategy addresses fish and wildlife populations and their habitats in the Fossil Ridge Wilderness (Fig. 1, Fig. 2). However, wilderness managers are increasingly confronted with the reality that administrative boundaries are permeable to human influences (Landres et al., 1998). Moreover, administrative boundaries rarely align with ecological processes (e.g., migration corridors, gene flows, and disturbance regimes), leaving native biodiversity vulnerable to anthropogenic stressors and conflicting land uses outside wilderness boundaries. Recognizing that the Fossil Ridge Wilderness cannot be managed in isolation, land managers need to collaborate at larger scales and across jurisdictional and ownership boundaries to achieve conservation objectives (Fig. 3).

Square Top Mountain, the second highest peak in the Fossil Ridge Wilderness at 12,972 feet, sculpted by tectonic processes and the unstoppable forces of erosion (Tobias Nickel, September 21, 2020).

Brief Description of the Fossil Ridge Wilderness

The Colorado Wilderness Act of 1993 designated approximately 33,060 acres of the GMUG National Forests as the Fossil Ridge Wilderness (Forest Service, 2018b; Fig. 1). In addition, the Fossil Ridge Recreation Management Area (FRRMA), encompassing 43,900 acres of land adjacent to the wilderness, was also established (Fig. 3). Both the Fossil Ridge Wilderness and the surrounding recreation management area are administered by the Gunnison Ranger District.

The Fossil Ridge Wilderness is located approximately 15 miles northeast of the city of Gunnison in west-central Colorado (Fig. 3). The wilderness area contains three large, distinct topographic features, including two parallel north-south trending drainage basins and a high alpine ridge that forms the backbone of the wilderness (Fig. 1). In the eastern portion of the wilderness, the South Lottis Creek drainage was carved out by glacial activity, leaving a widely shaped valley framed by dramatic slopes. To the west, the Crystal Creek drainage exhibits more rugged topography, creating an area that is difficult to access and provides a haven for wildlife and adventurous visitors seeking almost guaranteed solitude. Separating these two drainage basins lies the prominent limestone ridgeline that is the namesake of this wilderness. The 'Fossil Ridge' contains fossilized remains of numerous prehistoric sea creatures and rises well above tree line, providing panoramic views of almost half of Colorado's fourteeners.

With an elevation spanning from 8,880 feet near the Summerville Trailhead to 13,254 feet at the summit of Henry Mountain, the Fossil Ridge Wilderness protects a range of ecosystems (Fig. 2). At lower elevations, lodgepole pine and aspen forests are commonly found, while mid-range latitudes support primarily spruce-fir forests. Interspersed between these forests, subalpine grassland meadows can be found. Meanwhile, meandering streams, riparian shrublands, wetlands, and high-elevation lakes provide crucial habitat for a diversity of wildlife species. Above tree line, talus fields and low-growing alpine vegetation cover the exposed slopes and wind-swept peaks of the Fossil Ridge.

To learn more about the Fossil Ridge Wilderness, please consult the *Fossil Ridge Wilderness Character Narrative and Monitoring Report* (Warnick, 2016).

The Fossil Ridge Wilderness as seen from the summit of Fairview Peak. (Tobias Nickel, June 28, 2020)

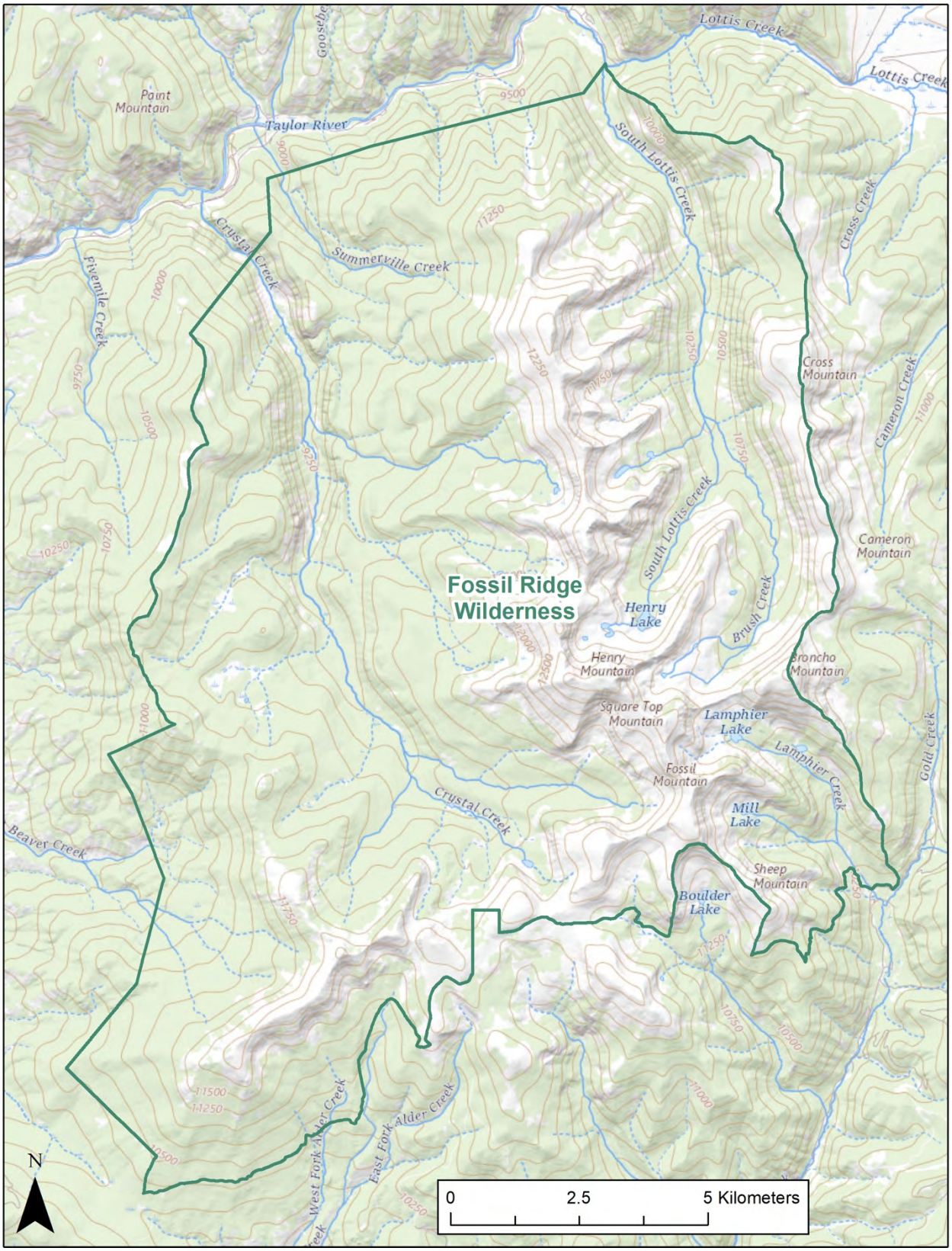


Figure 1. Topographic map of the Fossil Ridge Wilderness. (Map by Tobias Nickel, August 5, 2020)

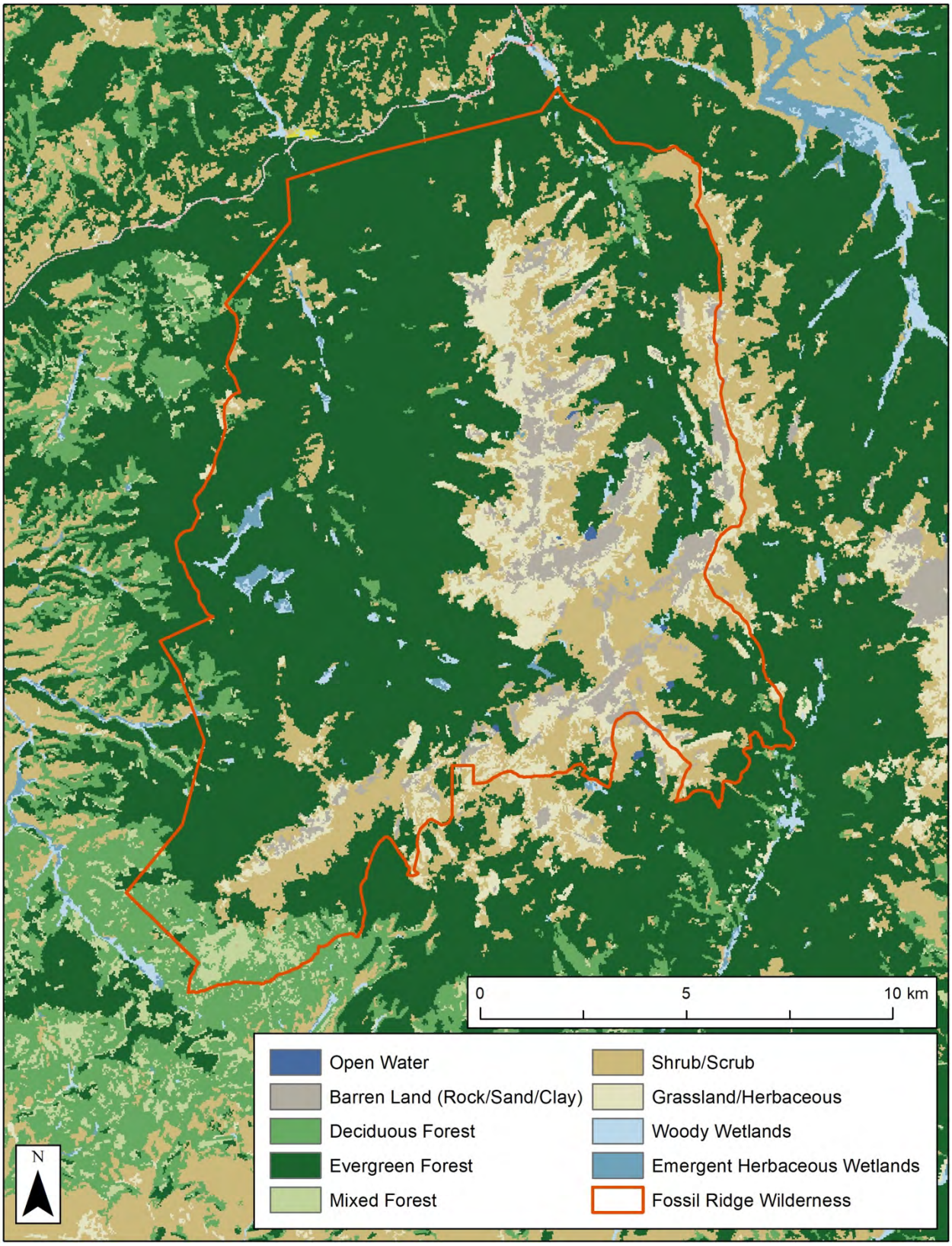


Figure 2. Land cover types of the Fossil Ridge Wilderness. (Map by Tobias Nickel, August 5, 2020)

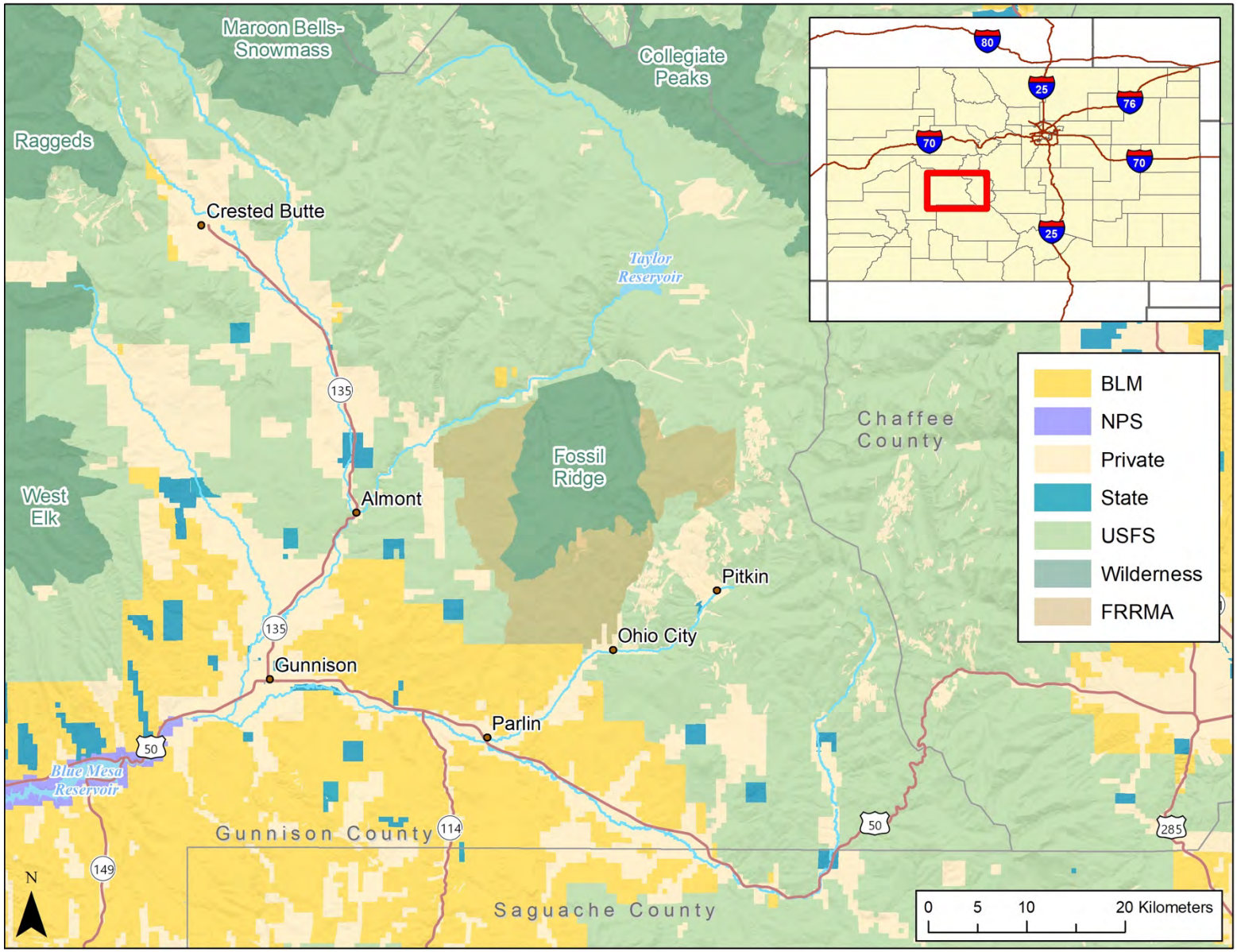


Figure 3. The landscape matrix of private, state, and federal lands of which the Fossil Ridge is a part. (Map by Tobias Nickel, August 5, 2020)

Overview of Wilderness Character

Defining Wilderness Character

The Wilderness Act of 1964 (16 U.S.C. § 1131-1136) was passed by a nearly unanimous vote in the United States Congress to protect natural lands from the seemingly endless threats of "expanding settlement and growing mechanization." The primary mandate of the Wilderness Act is given in Section 4(b) and states that "each agency administering any area designated as wilderness shall be responsible for *preserving the wilderness character of the area*" [emphasis added]. In order to establish a common understanding of this directive, wilderness character was formally defined by an interagency team representing the Forest Service, the U.S. Fish and Wildlife Service (USFWS), the National Park Service (NPS), and the Bureau of Land Management (BLM) as follows:

> "Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature. Taken together, these tangible and intangible values define wilderness character and distinguish wilderness from all other lands." (Landres et al., 2015)

Based on the statutory language of the Wilderness Act, Landres et al. (2015) further identify five qualities of wilderness character: untrammeled, natural, undeveloped, solitude or primitive and unconfined recreation, and other features of value. The five qualities apply nationally to all wilderness areas – regardless of their size, location, or administering federal agency – because they are rooted in the legal definition of wilderness. Together, these five qualities are used by the federal agencies to monitor how management actions, visitor use impacts, and external factors affect wilderness character over time (NPS 2014; Dratch et al., 2018; Landres et al., 2019; BLM, 2020).

The tranquil waters of Crystal Lake eliciting feelings of calm and peace. (Tobias Nickel, July 4, 2020)

Landres et al. (2015) discuss the five qualities of wilderness character in detail. Below are brief definitions of each quality that include the statutory language from Section 2(c) of the Wilderness Act (in italics) followed by a short explanation from Landres et al. (2015):

Untrammeled
Wilderness is "an area where the earth and its community of life are untrammeled by man"

- Wilderness ecological systems are essentially unhindered and free from the intentional actions of modern human control or manipulation when the untrammeled quality is preserved.

Natural
Wilderness "is protected and managed so as to preserve its natural conditions"

- Wilderness ecological systems are substantially free from the effects of modern civilization when the natural quality is preserved.

Undeveloped
Wilderness is "an area of undeveloped Federal land…without permanent improvements or human habitation"

- Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation when the undeveloped quality is preserved.

Solitude or Primitive and Unconfined Recreation
Wilderness "has outstanding opportunities for solitude or a primitive and unconfined type of recreation"

- Wilderness provides opportunities for visitors to find solitude and to challenge themselves with a primitive and unconfined type of recreation when the solitude or primitive and unconfined recreation quality is preserved.

Other Features of Value
Wilderness "may also contain ecological, geologic, or other features of scientific, educational, scenic, or historical value"

- Other tangible features of scientific, educational, scenic, or historical value in wilderness add to wilderness character when they are preserved.

In addition to these qualities of wilderness character, wilderness also has important intangible aspects that are difficult or impossible to quantify or monitor (Landres et al., 2015). These intangible aspects arise from the interactions humans have with the biophysical elements of wilderness. They can include the scenic beauty, spiritual value, and opportunities for self-discovery, self-reliance, and challenge that come from wilderness settings (Dawson and Hendee, 2009).

Wilderness character may change over time and may be improved or diminished by the actions (or inactions) of land managers (Landres et al., 2015). One of the greatest challenges of wilderness stewardship is that management actions taken to protect one quality of wilderness character can often degrade another quality (Landres, 2000; Cole, 2001; Cole and Yung, 2010). In addition, the cumulative result of seemingly small decisions and actions may cause a significant gain or loss of wilderness character over time (Landres et al., 2015). Because of this complexity, wilderness stewardship requires that agency staff make informed, appropriate, and defensible decisions and monitor the impacts of management actions (Landres et al., 2015).

Fish and Wildlife Management from the Perspective of Wilderness Character

Central to the development of a well thought out indigenous fish and wildlife management strategy for use in designated wilderness is recognition that wild places and wild species are intertwined in a reciprocal relationship (Forest Service, 2016c). Acknowledging this interdependence of wilderness and fish and wildlife, it is essential to also understand that actions taken to accomplish fish and wildlife management objectives in wilderness can come at a cost to wilderness character.

Of the five qualities of wilderness character, it is most commonly the natural quality of wilderness that is degraded when direct or indirect human pressures cause the decline or loss of indigenous fish or wildlife from any portion of their historic range within wilderness (Landres et al., 2015). However, by intervening, even with the best and most justifiable of intentions, managers detract, at a minimum, from the untrammeled quality of wilderness (Landres et al., 2015). The need to balance the natural and untrammeled qualities is explored in more depth in the next section. Depending on the specific management action, other qualities of wilderness character may also be degraded as a result of fish and wildlife management. For example, installation of artificial instream barriers or use of motorized equipment degrade the undeveloped quality, while noise involved with use of aircraft and encounters with survey crews can temporarily impact opportunities for solitude (Landres et al., 2015).

To be clear, the potential for conflict between qualities of wilderness character does not predicate a completely hands-off approach is always the right answer to wilderness stewardship. To the contrary, management actions are sometimes necessary in wilderness to ensure the persistence or recovery of fish and wildlife populations faced with direct or indirect human pressures (Forest Service, 2016c). Sound decision-making in this arena depends on the ability of managers to carefully-weigh the costs and benefits of ecological intervention and balance the competing qualities of wilderness character.

Looking southeast from Fossil Mountain toward Mill Lake below. (Tobias Nickel, September 20, 2020)

Balancing the Natural and Untrammeled Qualities of Wilderness Character

The central legislative mandate of the Wilderness Act is to preserve wilderness character, which includes both untrammeled and natural qualities. When the Wilderness Act was passed, the words "untrammeled" and "natural" were likely intended to be complementary because untrammeled areas were considered natural and vice versa. Today, however, these two qualities are increasingly in opposition to each other and have given rise to divergent philosophical views of what wilderness is and what it should be (Landres et al., 2000; Marris, 2011; Minteer and Pyne, 2015; Kaye, 2018).

Since passage of the Wilderness Act of 1964, the word "untrammeled" and its meaning for wilderness stewardship have been discussed at length. Landres et al. (2015) define a trammeling action as "an action that intentionally manipulates 'the earth and its community of life.'" Two concepts are crucial for understanding what is and is not a trammeling action: restraint and intention. Roderick Frazier Nash (2004) captures these concepts when he writes, "restraint is the core of the new valuation of wilderness as a moral resource. When we protect wilderness, we deliberately withhold our power to change the landscape." Trammeling actions occur when opportunities for restraint are ignored or bypassed. Actions that deliberately interfere with, manage, or control any aspect of ecological systems are instances of trammeling. Further information on trammeling actions are contained in Appendix B.

A related but independent theme running through the Wilderness Act is that wilderness should be free from the effects of "increasing population, accompanied by expanding settlement and growing mechanization" and that the "earth and its community of life… is protected and managed so as to preserve its natural condition" (Section 2(a) and 2(c), respectively). Landres et al. (2015) interpret the natural quality of wilderness character to encompass "all naturally occurring biological and physical elements of the wilderness," including plants, animals, soil, air, and water, as well as naturally occurring disturbance processes such as fire, flooding, and outbreaks of insects. The natural quality is preserved when ecological systems are substantially free from the effects of modern civilization.

While the untrammeled and natural qualities are often thought of as the same, they differ in ways that are consequential for wilderness stewardship. Separating actions from effects, Landres et al. (2015) shed light on the critical difference between these two qualities:

> "The Untrammeled Quality monitors *actions* that intentionally manipulate or control ecological systems, whereas the Natural Quality monitors *effects* from actions taken inside wilderness or from external forces on these systems, regardless of whether they are intentional or not."

Due to these differing emphases, the untrammeled and natural qualities are often linked in an inverse way (Landres et al., 2015). Even with the best of intentions, actions taken to improve the natural quality (e.g. spraying herbicide to eradicate invasive plants, igniting prescribed burns to restore fire regimes, or reintroducing an extirpated species) are deliberate manipulations that degrade the untrammeled quality of wilderness character (Landres et al., 2015).

As a result, land managers charged with the mandate of preserving wilderness character are increasingly confronted with a stewardship dilemma (Landres, 2000; Cole, 2001; Cole and Young, 2010; Lieberman, 2017; Lieberman et. al., 2018; Landres et al., 2020). As human domination of

ecological systems and processes is increasing both in extent and magnitude, new pressures to trammel and calls for active ecosystem management to sustain sensitive native species are arising. Under these circumstances, wilderness mangers will increasingly be faced with difficult decisions of whether, when, where, and how to intervene in ecosystem processes (Lieberman, 2017; Lieberman et. al., 2018; Landres et al., 2020).

However, attempts to restore and maintain a resemblance of past conditions may be a Sisyphean undertaking due in large part to factors associated with a changing climate. In the face of shifting environmental conditions, the question arises whether it is desirable or even feasible to sustain historical ecological conditions, especially when that means expending ever greater amounts of energy and using heavy-handed human control to resist change. In "The Untrammeled Wild and Wilderness Character in the Anthropocene," Roger Kaye (2018) writes: "Wilderness areas will continue to become less and less natural. Attempting to maintain their natural conditions or components will require increasing levels of intervention, manipulation, and ecological restoration." Hence, in the attempt to protect natural conditions, wilderness managers may be sacrificing one of the principal reasons why wilderness areas were protected to begin with: as places where non-human nature is self-willed, autonomous, and not subjugated to human designs and purposes (Woods, 2017; Kaye, 2018). As succinctly stated by Howard Zahniser (1992), "We must remember always that the essential quality of the wilderness is its wildness."

By contrast, if wilderness managers choose not to intervene, important ecological values, such as native biodiversity, ecosystem function, and ecosystem services, could be lost irreversibly. Scientific evidence is mounting that human activity is bringing about the sixth mass extinction, as ecosystems are experiencing a dramatic loss of biodiversity (e.g., Kolbert, 2015; Díaz et al., 2019). Current extinction rates are estimated to be 300, 400, or even 2,700 times higher than the background extinction rate (respectively, Groom, 2006; May et al., 1995; Hunter and Gibbs, 2007; all cited in Woods, 2017). Researchers predict that this rate will rise considerably in the future in the absence of large-scale conservation efforts and frequent ecological interventions (De Vos et al., 2014). Under these circumstances, passive protection alone and letting evolution "roll the dice" (Lucas, 1973) in response to human pressures may have undesirable, even devastating, outcomes.

Regardless of the philosophical debate over wilderness stewardship priorities in the Anthropocene, legislation and policies mandate that managers exercise restraint when authorizing actions that interfere with or control wilderness ecological systems. In an editorial titled "Guardians not Gardeners," Howard Zahniser (1963) notes that the inspiration for wilderness stewardship "is to use skill, judgment, and ecological sensitivity for the protection of some areas within which natural forces may operate without man's management and manipulation."

As pressures to intervene in ecological processes increase, the author wishes all wilderness managers the "ecological sensitivity" to carefully weigh the benefits and drawbacks of authorizing any new trammeling actions. If the untrammeled quality is diminished, benefits to other aspects of wilderness character should clearly outweigh costs of trammeling. It is the author's sincere hope that this document provides managers with a tool to approach wilderness stewardship with humility, respect and a deeper understanding, ultimately helping them to preserve wilderness character as a whole.

Top: Crystal Lake mirroring the clouds above; bottom: Henry Mountain. (Tobias Nickel, July 4, 2020)

Wilderness-Wildlife Interrelationships

Fish and Wildlife as a Measure of Wilderness Character

Fish and wildlife are critically important to the entire ecosystem by providing food and habitat to other animals, digesting plant material and thereby making nutrients available in the soil for plants to use, scavenging carcasses of dead animals, and contributing to a wilderness ecosystem in a multitude of other ways (Hendee and Mattson, 2009). Alterations in the occurrence or abundance of animals can result in cascading changes within the animal community as well as associated plant communities (e.g., Pace et al., 1999; Knight et al., 2005; Beschta and Ripple, 2009). Moreover, for many people, simply knowing that particular animals are present is important to the meaning of wilderness (Nash, 1970). If key wildlife species are lost, the intensity of the sense of wilderness may be diminished. Undoubtedly, indigenous biota of a given wilderness collectively constitute fundamental ecological and cultural components of that place's wilderness character.

Furthermore, the distribution, abundance, diversity, and behavior of fish and wildlife species reflect ecological conditions and their changes over time serve as indicators of wilderness character (Hendee and Mattson, 2009; Landres et al., 2015). Importantly, the presence of particular kinds of indigenous fish and wildlife can suggest the relative absence of human influence. For example, wide-ranging species, such as migratory ungulates and large carnivores, can serve as indicators of wilderness conditions, because the survival of these wilderness-dependent species is fundamentally linked to and a measure of the natural, undeveloped, and solitude qualities of wilderness character (Hendee and Mattson, 2009). Conversely, the presence of non-indigenous fish and wildlife species can pose a significant threat to ecological systems and, therefore, is inversely related to wilderness character (Vitousek et al., 1996; Cox, 1999; Cronk and Fuller, 2001; Baskin, 2002; Tempel et al., 2004).

Recognizing the importance of fish and wildlife as a measure of wilderness character, *Keeping it Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System* (Landres et al., 2015) identifies animals as one of four indicators to best represent trends in the natural quality. Consistent with *Keeping it Wild* 2, the Forest Service also prescribes monitoring of fish and wildlife resources as part of its agency-specific *Wilderness Character Monitoring Technical Guide* (Landres et al., 2019). Additionally, the Forest Service's Wilderness Stewardship Performance (WSP) framework identifies fish and wildlife as an important element contributing to wilderness stewardship excellence (Forest Service, 2020).

In order to maintain ecosystems and uphold the tenants of the Wilderness Act, it is crucial that wilderness managers document fish and wildlife management goals, assess and monitor the status of sensitive species, and, if necessary, implement management actions to ensure species conservation. The preservation of wilderness character itself depends on the conservation and thoughtful management of fish and wildlife.

A Wilderness Role in Fish and Wildlife Conservation

Protected areas are essential to most regional, national, and global efforts to conserve biodiversity and sustain natural ecological processes (United Nations Environment Programme et al., 2018). Reinforcing the importance of protected areas, a global analysis showed that biodiversity is substantially higher inside than outside protected areas and that this positive effect is mostly attributable to differences in land uses (Gray et al., 2016).

Studies have further shown that Earth's remaining wilderness areas act as buffers against species loss and play a critical role in mitigating the unfolding global biodiversity crisis. For example, Butchart et al. (2012) found that, worldwide, species with greater protected area coverage experienced smaller increases in extinction risk in recent decades. Similarly, Di Marco et al. (2019) demonstrate that extinction risk for species occurring within wilderness areas is globally, on average, less than half that of species whose ranges do not overlap with wilderness.

Given the relative integrity of ecosystems found within the National Wilderness Preservation System, these designated wilderness areas provide important refuges for species in the United States that are declining in landscapes dominated by humans. For example, wilderness areas enhance survival of species with specialized habitat needs and those that are vulnerable to human contact (Hendee and Mattson, 2009). A meta-analysis also found that climate change impacts on ecological communities are more severe in fragmented landscapes, thus making the refuge function of large, undeveloped wilderness areas even more important in the twenty-first century (Mantyka-pringle et al., 2011).

While many species with an affinity for wilderness conditions can survive in less intact ecosystems, they live and behave most naturally in wilderness (Hendee and Mattson, 2009). Wilderness areas maintain natural evolutionary selection and related behaviors, because wilderness protects habitats that have been least modified from conditions under which their biotic communities evolved (Hendee and Mattson, 2009). As such, wilderness areas comprise valuable reservoirs of genetic information and act as reference areas for efforts to re-wild degraded landscapes (Watson et al., 2018).

Views from Gunsight Pass of the glacier-carved South Lottis drainage. (Tobias Nickel, June 15, 2020)

Managing Fish and Wildlife in Designated Wilderness

Laws, Policies, and Forest Planning

Several laws, regulations, and policies relate directly to the management of fish and wildlife resources inside wilderness.

Relevant Laws

While many laws affect the administration of wilderness, the Wilderness Act (1964) and the Endangered Species Act (1973) most directly bear on the management of fish and wildlife resources inside wilderness. The Wilderness Act mandates that managers preserve wilderness character and allow natural processes to unfold freely. At the same time, to aid in recovery of threatened and endangered species, the Endangered Species Act may direct managers to intervene in natural processes, manipulate habitat conditions, or place installations inside wilderness, thus degrading some of the qualities of wilderness character (Landres et al., 2015). Examples include the taking of California Condor (*Gymnogyps californianus*) eggs for hatching and raising in captivity, installing artificial water sources in the desert for Sonoran pronghorn (*Antilocapra americana sonoriensis*), or implementing prescribed fire to support an endangered plant (Arthur Carhart National Wilderness Training Center, 2020). In these situations where the Wilderness and Endangered Species Acts come into apparent conflict, managers must uphold mandates from both laws and search for a balance between preserving wilderness character and ensuring the recovery of federally listed species.

Relevant Policies

Forest Service Manual (FSM) Chapter 2320 - Wilderness Management outlines agency policy pursuant to the Wilderness Act. Section 2323.3 directly addresses the management of fish and wildlife resources in wilderness and establishes the following objectives:

1. Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist.
2. Consistent with objective 1, protect wildlife and fish indigenous to the area from human caused conditions that could lead to Federal listing as threatened or endangered.
3. Provide protection for known populations and aid recovery in areas of previous habitation, of federally listed threatened or endangered species and their habitats.

Section 2323.3 further recognizes that states have concurrent jurisdiction and responsibilities for the protection and management of fish and wildlife populations in wilderness. Forest Service policy calls for close collaboration between state and federal agencies following established agreements. In addition, Section 2323.3 provides policy guidance for numerous fish and wildlife-related actions inside wilderness, including species reintroductions, habitat surveys and population inventories, predator control, fish stockings, spawn taking, chemical treatment of waters, manipulation of habitat, fish and wildlife research, visitor management to protect fish and wildlife resources, among others.

Besides FSM Chapter 2320, other chapters that are not wilderness-specific but are directly relevant to this strategy include Chapter 2020 - Ecological Restoration and Resilience and chapters listed under the 2600 Series - Wildlife, Fish, and Sensitive Plant Habitat Management.

Forest Planning

The National Forest Management Act (1976), as amended, mandates the preparation of forest plans to establish a vision and overall management direction for each national forest. A forest plan identifies desired conditions, goals, objectives, standards that guide subsequent projects and management practices. While forest plans are strategic in nature and do not prescribe implementation of any specific action, all projects and activities authorized by the Forest Service must be consistent with applicable forest plan components.

The existing forest plan for the GMUG was published in 1983 and most recently amended in 2009. In 2007, the GMUG put a multi-year forest plan revision effort on hold until the Colorado Roadless Areas were defined and a final planning rule was established for the Forest Service. In June of 2017, the GMUG (re)initiated forest plan revision under the 2012 Forest Planning Rule. The 2012 Rule prescribes a three-phase process to forest planning that includes assessment, plan development, and monitoring. Resource-specific assessments for the GMUG plan were completed in 2017. A Working Draft Plan was made available for public comment in spring of 2019. A forthcoming draft Environmental Impact Statement (EIS) is anticipated before the end of 2020. Completion of the final EIS and approval of the Forest Plan is currently scheduled for late 2021.

In development of this strategy, the amended 1983 Forest Plan, the 2007 Proposed Forest Plan, and the 2019 Working Draft Forest Plan for the GMUG were consulted (Forest Service, 1991, 2007, and 2019). In addition, relevant assessment reports (Forest Service, 2018a-g) developed during phase one of ongoing forest plan revision were consulted and are cited throughout this document. Lastly, the rapid stakeholder assessment report (Ricco and Schultz, 2016) and public participation strategy (Forest Service, 2017) developed in preparation for GMUG forest plan revision were consulted to inform stakeholder engagement for collaboratively developing this strategy (Appendix C).

This strategy is intended to support the Gunnison Ranger District in conserving native biodiversity and stewarding the Fossil Ridge Wilderness toward stewardship excellence. In doing so, this strategy is intended to be consistent with GMUG forest planning and is supplemental and complementary to existing statutes, regulations, policies, and forest plan components. As stated previously, this strategy is not a decision document and does not compel any specific actions. The guidance and management recommendations provided in this document should be interpreted and implemented in a manner consistent with and conforming to existing legal and policy requirements.

Concurrent Jurisdiction between State and Federal Agencies

There is a rich and complex body of law and judicial interpretation concerning the debate over state versus federal authority for managing fish and wildlife in wilderness areas. Going back to the legal tradition of wildlife ownership in feudal Europe, it was long argued that states own the wildlife within their borders. In the case of *Geer v. Connecticut* (1896), the Supreme Court embraced this doctrine of state wildlife ownership, writing a state's "right to preserve game flows from the undoubted existence in the State of a police power."

However, in *Hughes v. Oklahoma* (1979), the Supreme Court reversed this previous decision, calling state ownership of wildlife a "19th century legal fiction." Furthermore, in the landmark decision in *Kleppe v. New Mexico* (1976), the Supreme Court unanimously ruled that the Tenth Amendment does not apply to the management of wildlife on federal lands. The court wrote that the "'complete power' that Congress has over public lands necessarily includes the power to regulate and protect the wildlife living there." The Supreme Court also stated that Congress may enact legislation governing federal lands (e.g., the Wilderness Act of 1964) pursuant to the property clause and "when Congress so acts, federal legislation necessarily overrides conflicting state laws under the supremacy clause."

In other words, the federal government retains the authority to manage fish and wildlife on federal land, which includes areas part of the National Wilderness Preservation System. This does not mean state agencies cannot manage fish and wildlife in wilderness. It means that states have authority to manage fish and wildlife in wilderness as long as state actions do not conflict with the legal mandates established in the Wilderness Act of 1964.

Importantly, any management action proposed by the state which takes place on federal land and may degrade wilderness character requires federal approval, unless explicitly exempted through formal agreements or special provisions in wilderness legislation. For example, if the state proposes an action employing a use prohibited by Section 4(c) of the Wilderness Act, the federal agency must conduct a minimum requirements analysis to determine if the proposed action is the minimum necessary for the administration of the area and make a decision accordingly.

In this context, it is also important to clarify the meaning of Section 4(d)(8) of the 1964 Wilderness Act, which states: "Nothing in this Act shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish in the national forests." This Section neither diminishes nor enlarges state authority and does not change the relative responsibilities for fish and wildlife management on federal lands. In general, the states have authority and responsibility to manage fish and wildlife on federal lands unless their plans or actions conflict with federal law, regulation, or policy.

To learn more about managing fish and wildlife in wilderness, please consider taking the free, self-paced online course Managing Special Provisions in Wilderness: Wildlife. In addition, the management of federally threatened and endangered species differs substantially from non-listed species and is covered in Natural Resource Management in Wilderness: Threatened & Endangered Species. Both courses are developed by the Arthur Carhart National Wilderness Training Center and offered in partnership with the Eppley Institute for Parks and Public Lands.

Cooperation between State and Federal Agencies: Memoranda of Understanding

The goal for fish and wildlife management in wilderness is close cooperation and coordination between the state and federal agencies. If wilderness character and fish and wildlife are to flourish for future generations, both federal wilderness managers and state wildlife biologists must communicate and collaborate to identify and manage toward a shared vision. This will significantly reduce conflict and diminish the need for the federal agencies to preempt the states.

Rather than disentangling the jurisdictional debate over state versus federal authority, federal and state agencies have entered into memoranda of understanding (MOUs) to establish frameworks for cooperation, clarify responsibilities, and identify mutual interests and benefits. Frustration between state wildlife and federal wilderness managers over different management goals in wilderness, lack of standardization in implementing wilderness policies, and differences in interpretation of the Wilderness Act all led to an agreement between the Forest Service, the BLM, and the Association of Fish and Wildlife Agencies (AFWA) representing the states.

Most recently revised in 2006, this "Policies and Guidelines for Fish and Wildlife Management in National Forest and Bureau of Land Management Wilderness" (AFWA, 2006) establishes that both state and the federal agencies share responsibility for management of fish and wildlife in wilderness. The document also states that "The FS and BLM are required to preserve wilderness character as directed by the Wilderness Act, while supporting the States' fish and wildlife objectives, to the extent such objectives are consistent with the Act."

To implement the national AFWA Policies and Guidelines at the state level, the Forest Service, Rocky Mountain Region entered into a MOU with the Colorado Department of Natural Resources, Division of Parks and Wildlife (Forest Service and CPW, 2015). This agreement directs state and federal managers "to identify opportunities and jointly pursue projects that meet mutually beneficial fish, wildlife, and wilderness management objectives." The document also stresses the "conservation of natural processes to the greatest extent possible" and "the principle of doing only the minimum necessary to conserve or enhance fish and wildlife resources, while protecting wilderness character." Importantly, the 2015 MOU specifies which state management actions require a federal decision and which ones do not.

The MOU entered into by the Forest Service, Rocky Mountain Region and CPW was effective through December 31, 2017. While this MOU needs to be renewed at the regional level, collaboration between CPW and the Forest Service, Gunnison Ranger District must continue regardless and should rely as much as possible on the expired MOU as well as the AFWA (2006) guidelines and policies.

Minimum Requirements Analysis

Under the Wilderness Act of 1964, any management action taken in wilderness must be determined to be the minimum necessary for the administration of the area as wilderness. The purpose of a minimum requirements analysis (MRA) is to ensure that management actions implemented meet this determination. An MRA is required by law whenever land managers are considering a use prohibited by Section 4(c) of the Wilderness Act and defined in the glossary. An MRA may also be required for management actions that do not employ one of the prohibited uses but still have the potential to affect wilderness character (Arthur Carhart National Wilderness Training Center, 2016). If an issue has been explicitly addressed in wilderness legislation, agency policy, or MOUs, then formal application of an MRA may not be required each time a specified management action is implemented in previously agreed-upon areas (e.g., see the discussion on aerial fish stockings on pp. 82-83).

MRAs are accomplished by Forest Service personnel using the Minimum Requirements Decision Guide (MRDG). An MRDG is a process to identify, analyze, and recommend wilderness management actions (or recommend against taking action). The MRDG process is designed to help wilderness managers make informed, appropriate, and defensible decisions that comply with the fundamental tenets of the Wilderness Act. Importantly, an MRDG should be used as an analytical tool, not as a justification for a predetermined decision or simply as a form for rubber-stamp approval (Arthur Carhart National Wilderness Training Center, 2016).

If management actions described in this document are to be implemented, then the first step is to complete an MRDG on a project-by-project basis. While fish and wildlife management actions are often taken to protect or enhance the natural quality, they commonly also have the following adverse effects on other qualities of wilderness character (Forest Service, 2016c):

- Degrading the untrammeled quality (any active intervention in ecological processes)
- Degrading the undeveloped quality (e.g., when aircraft, motorized equipment, mechanical transport, and/or installations are used)
- Degrading outstanding opportunities for solitude (e.g., presence of agency personnel and noise involved with use of aircraft or motorized equipment)

To the extent feasible, any management action must minimize negatively impacting these qualities of wilderness character. Prior to implementation, any management proposal must be vetted as being the minimum necessary for administration of the area as wilderness. None of the following discussions of specific management actions should be interpreted as circumventing or supplanting these important processes and considerations. Managers must always compare the effects of a proposed action in wilderness to the effects of doing nothing at all, the latter of which will sometimes be the preferable alternative for most effectively safeguarding wilderness character.

For additional resources and to learn more about the minimum requirements concept, please consult the ‘minimum requirements’ section on Wilderness Connect for Practitioners.

A Framework for Evaluating Proposals for Ecological Intervention in Wilderness

Landres et al. (2020) astutely observe, "the combination of climate change with other landscape stressors is driving ecological restoration to be one of the single most important, challenging, and potentially litigious wilderness stewardship issues." Making matters worse, "decisions allowing or denying restoration in wilderness are currently made on a case-by-case basis in the context of scientific uncertainty, ambiguous law and policy, and competing values" (Landres et al., 2020). In response, Landres et al. (2020) present a framework based on a structured set of scientific, legal, and ethical questions to guide the evaluation of proposals for ecological intervention in wilderness (Table 1). This framework is a tool designed to increase communication and transparency among scientists, managers, and stakeholders regarding the trade-offs of ecological restoration. As of 2020, this framework is being pilot tested in 16 wilderness areas (Landres et al., 2020). While the Fossil Ridge Wilderness was not selected for pilot testing, this framework is highly relevant to the development and application of this strategy. Local managers may want to consult this framework in the future to make informed and transparent wilderness decisions grounded in science, law, and ethics. Note that application of this framework would be supplementary and complementary to the MRDG process.

Table 1. A framework to evaluate proposals for ecological intervention in wilderness. (Landres et al., 2020)

Category	*Questions*
Scientific questions: what is the situation?	What is the historic background for the ecological degradation, and was it caused by past human actions or legacy land use impacts?
	What is the current ecological degradation, and is it within the range of historic variation for this system?
	Are current human actions preventing natural ecological recovery?
	Is the cause of ecological degradation local, regional, or global (such as climate change)?
	What are the cascading ecological effects of the degradation, and how quickly are these impacts likely to occur?
	What are the anticipated short- and long-term ecological outcomes of not restoring or intervening?
	What is the intended ecological outcome of the restoration or intervention: to restore to historic conditions, maintain current conditions, facilitate adaptation to new conditions, or other goal?
	What types of restoration or intervention activities are being proposed, and what is the spatial and temporal scale of these activities?
	Are the proposed actions based on previous site-specific experience and techniques?
	Are monitoring and evaluation of results included as part of the proposed restoration or intervention?
Legal questions: what can we do?	Do the proposed actions degrade wilderness character in violation of Section 4(b) of the Wilderness Act?
	Do the proposed actions involve activities prohibited or regulated by Section 4(c) of the Wilderness Act?
	Do the proposed actions seek to restore or protect existing biodiversity or ecosystems, or seek to facilitate transition to a new ecosystem state?
	Do the proposed actions satisfy specific provisions of wilderness legislation?
	Do the proposed actions directly or indirectly advance a commercial service?
	Are the proposed actions required to satisfy provisions of other legislation, such as the Endangered Species Act?
	Do the proposed actions fulfill or comply with requirements of judicial rulings that apply to the management area?
	Has the appropriate decision-making jurisdiction and authority within the agency been determined?
	Is formal consultation and permitting with another agency or with tribes/indigenous groups required?
	Does other agency direction such as policies, management plans, or special orders (including Executive Orders) influence the decision on the proposed restoration or intervention actions?
Ethical questions: what should we do?	Why do the proposed actions need to occur in this particular wilderness and why do these actions need to occur now?
	Has the managerial responsibility to preserve the untrammeled quality of wilderness been seriously considered?
	What are the potential short- and long-term effects of the proposed actions on wilderness character?
	Would the proposed restoration or intervention require repeated actions over time to be effective?
	What are the cumulative effects of the restoration or intervention actions on wilderness character, in combination with the effects of administrative, scientific, commercial, and visitor use?
	Are indigenous cultural values and traditional ecological knowledge relevant to the proposed restoration or intervention?
	Who are the likely stakeholders, and has the anticipated range of views on the proposed restoration or intervention been seriously considered?
	What are the trade-offs in the effects of the restoration or intervention on the qualities of wilderness character, including rare or valued aspects of wilderness character, and trade-offs between natural and cultural resources?

Rocky Mountain Columbine. (Tobias Nickel, July 4, 2020)

Indian Paintbrush growing on the shores of Boulder Lake. (Tobias Nickel, July 10, 2020)

Priority Species for the Fossil Ridge Wilderness

Defining Priority Species

The Fish and Wildlife Element of WSP directs local units to identify species indigenous to a given wilderness for which there is a perceived management need currently or in the foreseeable future (Forest Service, 2020). For purposes of this strategy, indigenous species are "those wildlife and fish species that historically occurred within a wilderness area without human assistance" (Forest Service, 2020). Priority species may be listed as threatened or endangered under the Endangered Species Act or may for some other reason be singled out as a management priority by federal agencies, state agencies, or non-governmental organizations (Forest Service, 2016c). The only requirement is that they fit the definition of indigenous provided above. The desired outcomes of scoring guidance for the Fish and Wildlife Element of WSP are to 1) improve the status of priority species whose persistence in a wilderness is threatened and/or (2) successfully reintroduce priority species to previously occupied range within a wilderness (Forest Service, 2020).

Process Used for Identifying Priority Species

The *Wilderness Stewardship Performance Guidebook* (Forest Service, 2020) does not prescribe any particular process for selecting priority species. To be locally relevant and useful, species selection should reflect the priorities, environmental conditions, and management objectives specific to each wilderness area and national forest. Similarly, the supporting resource, *Guidance for Developing an Indigenous Fish and Wildlife Management Strategy* (Forest Service, 2016c), encourages managers to "adapt processes, formats, and content to meet local needs." The guidance document is "not intended to constrain creative thinking nor be prescriptive in how units administering wilderness go about strategy development." Rather, the document refers to itself as "food for thought to put managers on a productive, but supremely flexible track" (Forest Service, 2016c).

To date, very few national forests have developed wilderness-specific indigenous fish and wildlife management strategies. One notable exception is the Gila National Forest, which hosted a pilot workshop in 2016 and developed such a strategy for the Gila and Aldo Leopold Wildernesses (Forest Service, 2016a) alongside the above-mentioned guidance document (Forest Service, 2016c). The guidance document and Gila National Forest case study formed an important foundation and source of inspiration for the development of this strategy.

The following framework was used to identify priority species and develop this indigenous fish and wildlife management strategy for the Fossil Ridge Wilderness. All actions were carried out by the Wilderness Fellow unless otherwise specified.

1. Gather information—Background information was gathered to understand the wilderness, including its history, native biota, ecosystems, and anthropogenic threats. This information was gathered by reviewing scientific literature, visiting the wilderness, reading relevant documents (e.g., enabling legislation, forest planning documents, species recovery plans, MOUs, state wildlife action plan, climate change vulnerability assessment), and consulting state and national databases including: Colorado Natural Heritage Program (CNHP), Colorado Hunting Atlas, CPW Species Activity Mapping, NatureServe National Species

Dataset, USFS Natural Resource Information System (NRIS), USFWS Environmental Conservation Online System (ECOS), USFWS Information for Planning and Consultation (IPaC), Avian Data Center, among others.

2. Conduct interviews—Subject-matter experts across disciplines and from different stakeholder groups were consulted to identify species of particular interest to local managers and partners. A stakeholder analysis (Appendix C) was carried out to identify partner agencies and organizations and other interested parties. Due to the unfolding COVID-19 events, most interviews were conducted via phone, email, or videoconference. A list of general questions that guided many of these interviews is available in Appendix D.
3. Create priority species list—Priority species were identified based on information gathered and interviews conducted. A justification for each selection was provided. The list of priority species was submitted to and approved by the district biologist and wilderness manager.
4. Identify management objectives—Desirable outcomes and management goals for each priority species were cooperatively developed through consultation of the scientific literature, planning documents, and follow-up conversations with staff from the Forest Service, CPW, and other stakeholders.
5. Develop management recommendations—Potential management actions, information needs, and best practices to achieve management objectives for each priority species were identified and developed. These actions were viewed favorably by subject matter experts, grounded in the best-available science, and consistent with agency policy and forest planning guidance.
6. Analyze trade-offs of potential management actions—The impacts of potential management actions were evaluated from both fish and wildlife and wilderness management perspectives. Important wilderness stewardship considerations were identified to guide management of each priority species. It was discussed how management actions taken to conserve fish and wildlife populations and improve habitat might influence wilderness character and how adverse effects could be minimized.
7. Integrate monitoring and adaptive management—Monitoring questions were developed to evaluate the effectiveness of fish and wildlife management actions. Given the need to minimize trammeling actions inside wilderness, it was also discussed how monitoring results might guide subsequent work and inform management decisions.
8. Peer review—Subject-matter experts critically evaluated the document for its scientific merit, provided constructive comments, and recommended revisions.
9. Incorporate comments—Changes, edits, and feedback from agency staff and peer reviewers were incorporated into the final draft.
10. Approval of final strategy—The document was reviewed, finalized, and approved by relevant staff, including the Forest Supervisor.

List of Priority Species and Rationales for Selection

Four priority species were selected for the Fossil Ridge Wilderness: Rocky Mountain bighorn sheep, Colorado River cutthroat trout, boreal toad, and southern white-tailed ptarmigan. A justification for each selection is provided below. Please note that the omission of any particular species from this priority species list should not be interpreted as meaning that species is not important. The omission of a species simply means that actively managing that species inside the Fossil Ridge Wilderness is not a priority at this time. Species that were closely considered but ultimately not selected for inclusion in this strategy are briefly discussed on pp. 95-103. As climate change progresses and other anthropogenic stressors increase, some of the species not selected may become increasingly vulnerable and warrant focused management attention. Species can be added or removed at the discretion of future interdisciplinary teams as conditions or priorities change.

Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*)

Justification for selection:

- With the introduction of domestic livestock and their diseases, Rocky Mountain bighorn sheep populations declined sharply in the late 1800s and have never fully recovered. Bighorn sheep populations continue to be impacted by bacterial pneumonia and remain the focus of intensive monitoring and management actions throughout the state.
- CPW wildlife biologists are monitoring and managing the Fossil Ridge (S70) bighorn sheep herd and other nearby herds and will continue to do so in the future.
- Rocky Mountain bighorn sheep are considered a Tier 2 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015). They are also identified as a Sensitive Species by the Forest Service, Rocky Mountain Region (Forest Service, 2018g).
- Bighorn sheep are likely the most iconic of Colorado's wildlife species. Bighorn sheep are the Colorado state mammal and are also the symbol of CPW. Bighorn sheep are among the most sought after watchable wildlife species in the state and also provide hunting recreation opportunities for hundreds of hunters annually.

Southern White-tailed Ptarmigan (*Lagopus leucura altipetens*)

Justification for selection:

- Alpine areas constitute a large portion of the Fossil Ridge Wilderness, and alpine-obligate species are an integral component of its wilderness character. Alpine ecosystems and associated species are considered highly vulnerable to climate change (Neely et al., 2011). As climate change progresses, populations of alpine species may become increasingly isolated and vulnerable to extirpation (Beever et al., 2010). Southern white-tailed ptarmigan complete their life cycle almost entirely above treeline and are well-suited as an indicator of the health of alpine ecosystems (Braun et al., 1993; Jackson et al., 2015). Monitoring of this subspecies should be a management priority to assess climate change impacts on alpine ecosystems and inform future conservation actions (Hoffman, 2006; CPW, 2015; Seglund et al., 2018b).
- Southern white-tailed ptarmigan are considered a Tier 1 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015). They are also identified as a Sensitive Species by the Forest Service, Rocky Mountain Region (2018g). In addition, the subspecies was petitioned to be listed as threatened under the Endangered Species Act (Greenwald, 2010).

Colorado River cutthroat trout (*Oncorhynchus clarkii pleuritcus*)

Justification for selection:

- CPW has been stocking several high-elevation lakes in the Fossil Ridge Wilderness with salmonids since at least 1952 and will continue those activities in the foreseeable future. Since 2001, CPW has been exclusively stocking blue lineage Colorado River cutthroat trout (CPW, 2020d). Fish stocking in wilderness is a potentially controversial practice that can affect several qualities of wilderness character (Landres et al., 2001). At this time, aerial fish stocking is arguably the single most intrusive ecological intervention taking place inside the Fossil Ridge Wilderness and necessitates coordination and collaboration between state and federal agencies to minimize adverse impacts on the wilderness resource.
- Green lineage Colorado River cutthroat trout was formerly assumed to represent the federally threatened greenback cutthroat trout (Behnke, 1992, 2002). As a result, green lineage was given interim protection under the Endangered Species Act. In consideration of additional genetic research (Metcalf et al. 2007, 2012; USFWS, 2014b; Bestgen et al., 2019), the USFWS decided to retract interim protection in April of 2020. Nevertheless, Colorado River cutthroat trout (blue and green lineages) is listed as a Tier 1 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015). Both lineages are also considered Sensitive Species by the Forest Service, Rocky Mountain Region (Forest Service, 2018g).
- As tools have become available to be able to differentiate between lineages of cutthroat trout, our understanding of cutthroat trout taxonomy has greatly increased with distinct lineages identified representing most major river basins. Decisions have yet to made about whether genetically distinct lineages will be managed as genetic variability within the Colorado River cutthroat trout subspecies or whether new subspecies will be named. As genetic research continues, our understanding of cutthroat trout taxonomy keeps evolving, with potential regulatory status and conservation implications in the future. A status assessment for green lineage Colorado River cutthroat trout has not yet been conducted, and a petition to list this lineage under the Endangered Species Act remains a possibility.
- The Gunnison Basin Climate Change Vulnerability Assessment (Neely et al., 2011) found Colorado River cutthroat trout to be highly vulnerable to the effects of climate change. Predictive stream temperature models (Isaak et al., 2017) further suggest that all but the highest elevation streams on the GMUG National Forests may potentially become too warm for Colorado River cutthroat trout. In such a scenario, the high-elevation streams of the Fossil Ridge Wilderness could serve as important cold-water refugia for native cutthroat trout (Roberts et al., 2013). As climate change progresses and stream temperatures increase, there may be potential for species conservation gains to be made through establishing a conservation population of Colorado River cutthroat trout inside the Fossil Ridge Wilderness.

Boreal toad (*Anaxyrus boreas boreas*)

Justification for selection:

- Boreal toads, like many amphibian species, have experienced population declines as a result of chytrid fungus (Corn et al., 1989; Loeffler, 2001). The subspecies was considered but removed as a candidate for listing under the Endangered Species Act (USFWS, 2017a). This decision was largely influenced by the fact that the Eastern population of the boreal toad has exhibited a moderate or high resiliency to the chytrid fungus, and, therefore, has a low risk for extinction (Murphy et al., 2009; USFWS, 2017a). However, the Southern Rocky Mountain population of the boreal toad has been more susceptible to the chytrid fungus and has experienced significant population declines, warranting focused management attention (Corn et al., 1989; Murphy et al., 2009; USFWS, 2017a).
- Boreal toad is listed as a Tier 1 Species of Greatest Conservation Need in the state of Colorado (CPW, 2015). Boreal toad is also identified as a Sensitive Species by the Forest Service, Rocky Mountain Region (Forest Service, 2018g).
- There are large gaps in current knowledge regarding the abundance and distribution of boreal toad and potentially suitable habitat inside the Fossil Ridge Wilderness.
- Research suggests that high-elevation areas, such as the Fossil Ridge Wilderness, may provide important refugia from disease for boreal toads and should be prioritized for conservation initiatives like reintroductions (Mosher et al., 2018a).
- There is potential to restore metapopulation dynamics among formerly occupied sites by adding new existing populations that would have a good chance for long-term persistence.
- CPW has been restoring boreal toad in areas adjacent to the wilderness and has plans to continue those activities in the near future. There is interest from CPW to be engaged with conservation actions for this species inside the Fossil Ridge Wilderness.
- There is potential for species conservation gains to be made through reintroductions to previously occupied habitat without the need for prohibited uses in wilderness.

Boulder Lake from the saddle between Sheep and Fossil Mountains (Tobias Nickel, Sept. 21, 2020).

Wilderness Management Strategy – Rocky Mountain Bighorn Sheep

Introduction

Based on early accounts by trappers and explorers, Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) were common in Colorado prior to European settlement in the mid-1800s (Moser, 1962). Bighorn numbers declined rapidly in the late 1800s, likely a result of overharvest, habitat loss or degradation, and the introduction of domestic livestock and their diseases (Beecham et al., 2007; George et al, 2009). As early as 1885, concerns about declining bighorn populations resulted in the Colorado legislature placing a moratorium on bighorn hunting, which remained in effect for over 60 years (Barrows and Holmes, 1990). By the early 1900s, bighorn sheep in Colorado existed only in isolated, remnant populations (Warren, 1910).

In contrast to deer and elk, bighorn sheep populations declined sharply during the early settlement years and have never really recovered. Major disease-related die-offs have plagued bighorn sheep populations for over a century and have played a significant role in declines of bighorn sheep throughout western North America (Warren, 1910; Grinnell, 1928; Shillinger, 1937; Buechner, 1960; Post, 1962; Goodson, 1982; Miller, 2001; George et al., 2008). The earliest reports of disease-related die-offs of bighorn sheep followed the advent of domestic sheep (*Ovis aries*) grazing in bighorn habitat (Warren, 1910; Grinnell, 1928; Shillinger, 1937). While the causes of early die-offs are difficult to verify retrospectively, contact with domestic livestock that led to the introduction of novel pathogens seems to be the most logical and widely accepted explanation (Beecham et al., 2007; George et al., 2009).

More than a century later, the susceptibility of bighorn sheep to diseases originally introduced by domestic livestock is still considered the primary factor limiting Rocky Mountain bighorn sheep populations in Colorado (Miller, 2001; Beecham et al., 2007; George et al., 2009). In particular, pasteurellosis, a respiratory disease caused by bacteria in the *Pasteurellaceae* family, has been identified as the ultimate cause of most disease-related die-offs of bighorns in Colorado (Miller, 2001), with other bacteria, viruses, lungworm, and environmental stressors being possible contributing factors in some cases (Beecham et al., 2007; George et al., 2009).

In addition to initial die-offs affecting all age classes, pasteurellosis epidemics in bighorn sheep can cause long-term reductions in lamb survival and recruitment resulting in stagnant or declining populations over many years after the herd is infected (Woodard et al. 1972; Foreyt, 1990; Coggins and Mathews 1992; Miller, 2001). Once introduced, pathogenic bacterial strains can persist in survivors of the initial epidemic and continue cycling in affected populations (Miller, 2001). Moreover, infected bighorns may serve as a source of infection for other herds through natural movements and translocations (George et al., 2009). Attempts to treat bighorn with various drugs have largely been unsuccessful with no significant differences observed in treated versus untreated individuals and herds (Foreyt, 1993; Cassirer et al., 2001; Sirochman et al., 2012).

Other threats to the long-term viability of bighorn sheep populations in Colorado include the lack of connectivity and loss of genetic diversity due to habitat fragmentation, increased human disturbance, competition with domestic livestock and other wild ungulates, predation on small, isolated herds,

encroachments of shrubs and forests into open grasslands and bighorn foraging habitat, and increasing human development of winter ranges (Beecham et al., 2007; George et al., 2009). While the relative importance of these threats to the persistence of bighorn sheep varies from area to area, the risk of disease outbreaks resulting from contact with domestic sheep – and perhaps goats (*Capra aegagrus hircus*) and cattle (*Bos Taurus*) – is widely believed to be the single greatest threat facing bighorns across their range in Colorado and elsewhere (Beecham et al., 2007; George et al., 2009).

To halt and reverse the decline of bighorn sheep populations in Colorado, the species has become one of the most intensely managed in the state (George et al., 2009). Translocations of bighorn sheep in Colorado began in 1944 (Moser, 1962). Translocation projects, most of which took place in the 1970s and 1980s, have been implemented to reintroduce bighorn sheep to historic range, augment existing populations, enhance genetic diversity, or to supply stock for other states that are restoring bighorns (George et al., 2009). From 1944-2007, there were at least 147 releases of bighorn sheep in Colorado resulting in the translocation of 2,424 animals (George et al., 2009). Herds established through translocation account for 54% of total herds in Colorado (George et al., 2009). In 2007, most translocated herds (78%) had less than 100 individuals (George et al., 2009), which is considered to be the minimum viable bighorn sheep population size to ensure long-term persistence (Berger, 1990; Smith et al., 19991; Douglas and Leslie, 1999; Singer et al., 2001).

Today, bighorn sheep are managed again to provide quality hunting opportunities while maintaining healthy and self-sustaining bighorn sheep herds. After more than six decades of closed sheep hunting seasons, the first official hunting season for Rocky Mountain bighorn sheep in Colorado began in 1953 (Moser, 1962). The rationale for lifting the moratorium on bighorn hunting at the time was to disperse bighorns with the management goal of reducing disease transmission (George et al., 2009).

The number of bighorn sheep in Colorado has generally been increasing since translocation began in the 1940s (George et al., 2009). CPW began making annual, post-hunt estimates of bighorn sheep populations in 1986. From 2004 to 2019, estimated total statewide Rocky Mountain bighorn population ranged from 6,810 to 7,365 (CPW, 2020b). The estimated 2019 statewide Rocky Mountain population was 6,850 in 81 herds (CPW, 2020b). While recurring respiratory disease epizootics remain obstacles to recovering bighorn sheep populations in the state, Colorado is estimated to have one of the largest Rocky Mountain bighorn sheep populations in the United States (Beecham et al., 2007).

Bighorn ram (CPW).

Current Status in the Fossil Ridge Wilderness

Two bighorn sheep Game Management Units overlap the Fossil Ridge Wilderness (CPW, 2020a). The bighorn sheep herds associated with these units are: S26 Taylor River and S70 Fossil Ridge. Both herds were historically managed as a single unit (S26). Based on seasonal habitat use and migration patterns, CPW recognized that these two herds were independent of one another and divided them into separate management units beginning in 2006 (Beecham et al., 2007).

Based on CPW (2020c) Species Activity Mapping, only the Fossil Ridge herd's occupied range substantially overlaps with the wilderness area, while the Taylor River herd spends most, if not all, of its time north of the wilderness. In summer, the Fossil Ridge herd concentrates in the alpine areas surrounding Henry Mountain inside the wilderness (Fig. 4). During winter, the herd generally migrates south to lower elevation areas, including outside wilderness and in close proximity to rangeland and human developments. Unless otherwise noted, this strategy will focus on management of the Fossil Ridge (S70) bighorn sheep population, although several management recommendations may be applicable and relevant more broadly.

The Fossil Ridge herd was initiated in the winter of 1992 with translocation of 20 bighorns from the Trickle Mountain (S10) source population (Beecham et al., 2007). By 2006, the Fossil Ridge herd had grown to an estimated 60 animals (George et al., 2009). During the severe winter of 2007-08, the herd experienced a die-off affecting all age-classes following exposure to a pathogen likely carried by syntopic cattle (Wolfe et al., 2010). As a likely consequence of limited winter range, the Fossil Ridge herd had migrated onto private land, where a local rancher observed intimate interactions between bighorns and cattle (Wolfe et al., 2010). Between December 2007 and February 2008, CPW staff found 21 moribund or dead bighorn sheep on the Fossil Ridge herd's winter range. Field and laboratory investigations suggested that pneumonia in affected bighorns may have been caused by a pathogenic *Pasteurellaceae* strain of cattle origin, with infections perhaps exacerbated by other respiratory pathogens and sever weather conditions (Wolfe et al., 2010).

Following the all-age die-off event in the winter of 2007-08, ten surviving bighorns were captured, equipped with radio collars or marked with ear tags, and administered treatments for bacteria, viruses, and parasites (Wolfe et al., 2010). CPW surveys indicate that recovery of the Fossil Ridge herd has been slow, which is common for herds that have experienced all-age die-offs, as pasteurellosis epidemics in bighorn sheep can cause long-term reductions in lamb survival and recruitment (Woodard et al. 1972; Foreyt, 1990; Coggins and Mathews 1992; Miller, 2001).

Between 2009 and 2019, population estimates for the Fossil Ridge herd increased from 15 to 30 animals, remaining below the estimated 60 bighorns present prior to the disease outbreak (CPW, 2020b). Several authorities consider 100 individuals the minimum viable bighorn sheep population size to ensure long-term persistence (Berger, 1990; Smith et al., 19991; Douglas and Leslie, 1999; Singer et al. 2001). As a result, the Fossil Ridge herd remains vulnerable to stochastic events such as introduction of a novel pathogenic strain, large-scale and high-intensity wildfire, or episodes of intense predation.

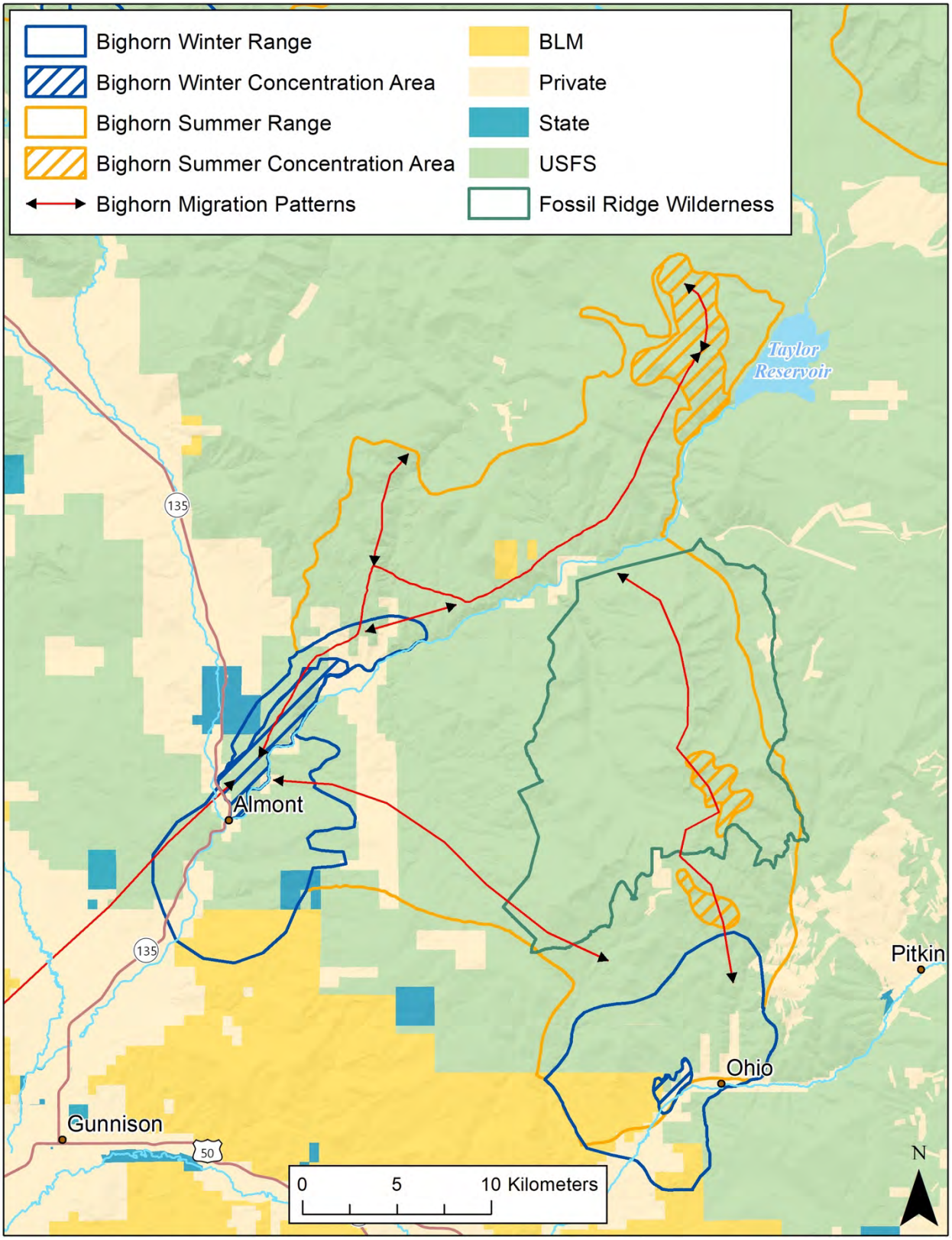


Figure 4. Summer and winter ranges and migration patterns of the Fossil Ridge (S70) and Taylor River (Map by Tobias Nickel, August 5, 2020)

Management Objectives

1. Recover the Fossil Ridge bighorn herd to a viable population size (>100 individuals)
2. Monitor population abundance, trends, and health of the Fossil Ridge bighorn herd
3. Collaborate across jurisdictional and ownership boundaries to minimize risks for disease transmission between bighorn sheep and domestic livestock
4. Monitor and record observations of bighorn sheep-mountain goat interactions
5. Monitor visitor use and study recreational impacts on bighorn sheep performance
6. Evaluate metapopulation potential and increase connectivity between herds residing in close proximity while also considering the potential for increased disease transmission
7. Maintain high quality hunting opportunities
8. To the extent possible, allow fire to play its natural role in the ecosystem to improve bighorn sheep habitat conditions
9. Coordinate and cooperate with CPW to:
    a. Identify and manage toward a shared vision of bighorn conservation in the Fossil Ridge Wilderness
    b. Jointly pursue research projects and share data to improve stewardship of fish and wildlife resources in wilderness
    c. Support CPW's fish and wildlife objectives, to the extent such objectives are consistent with the Wilderness Act
    d. Minimize impacts to wilderness character
10. Achieve the above objectives with minimal adverse impacts to wilderness character
    a. To the extent possible, allow natural processes to unfold without human intervention
    b. Integrate principles of adaptive management and monitor the effectiveness of actions implemented to guide subsequent work and minimize trammeling
    c. Utilize the MRDG as an analytical tool to evaluate all administrative proposals that could potentially affect wilderness character

Bighorn sheep. (CPW)

Management Recommendations

Inventory and population estimation

Reliable data on bighorn sheep herd composition, recruitment, and population numbers are needed to develop and evaluate population management goals and make informed management decisions (George et al., 2009). Currently, the Fossil Ridge bighorn herd is surveyed approximately every three to five years via aircraft (Kevin Blecha, CPW, Wildlife Biologist, personal communication). The Fossil Ridge Wilderness contains occupied habitat of both bighorn sheep and mountain goat (*Oreamnos americanus*) herds (CPW, 2020a). Therefore, surveys for both species are combined in this area. Because mountain goats are easier to spot in the summer, this is usually the time of year when these surveys take place (Kevin Blecha, CPW, Wildlife Biologist, personal communication). Population modeling is used to project annual population numbers and trends and to provide a basis for harvest recommendations and other management actions.

Separate bighorn sheep from domestic livestock

Given the susceptibility of bighorns to diseases transmitted by livestock, one of the most important aspects of bighorn conservation is to avoid interspecies contact. In a review of disease transmission between domestic sheep/goats and bighorn sheep, Schommer and Woolever (2008) conclude that the available information supports creating spatial and/or temporal separation between domestic sheep/goats and bighorn sheep as a prudent management strategy to protect bighorn populations.

The Forest Service, BLM, CPW, Colorado Department of Agriculture, and the Colorado Woolgrowers Association entered into an MOU "to provide general guidance for cooperation in reducing contact between domestic and bighorn sheep in order to minimize potential interspecies disease transmission and to ensure healthy bighorn sheep populations while sustaining an economically viable domestic sheep industry in Colorado" (Forest Service et al., 2014). Several other guidance documents describe best management practices to minimize the risk of disease transmission between domestic and wild sheep including:

- BLM (2016) Manual 1730, *Management of Domestic Sheep and Goats to Sustain Wild Sheep*
- *Adaptive Wild Sheep Disease Management Venture (DMV) Strategy* developed by the Wild Sheep Working Group of the Western Association of Fish and Wildlife Agencies (2017)
- The Council for Agricultural Science and Technology (CAST) (2008) commentary on *Pasteurellosis Transmission Risks between Domestic and Wild Sheep*.

In the past, these management recommendations have exclusively focused on interactions between bighorn sheep and domestic sheep and goats. However, the findings from Wolfe et al. (2010) support the notion that domestic cattle can also harbor *Pasteurellaceae* strains that are pathogenic in bighorn sheep. The case of likely pathogen exchange between the Fossil Ridge bighorn herd and syntopic cattle in the winter of 2007-08 suggests that intimate interactions between bighorn sheep and cattle should also be discouraged as a precautionary measure (Wolfe et al., 2010).

Under Section 4(d)(4)(2) of the Wilderness Act, grazing continues to be permitted in wilderness areas, where it was an established practice prior to designation. The Fossil Ridge Wilderness overlaps with two cattle grazing allotments, and there are additional cattle allotments in the

surrounding area (Fig. 5). However, little grazing activity actually occurs inside the wilderness. There is essentially no grazing in wilderness from the Gold Creek Allotment, and the majority of animal unit months (AUMs) counted from the Taylor Park Allotment are the result of walk-throughs between pastures (Warnick, 2016). There are no sheep allotments near the Fossil Ridge Wilderness.

The greatest risk for the Fossil Ridge bighorn herd to come into close contact with domestic livestock is on their winter range, which largely lies outside the wilderness (CPW, 2020a). The seasonal migratory patterns of large ungulates are a testament to the fact that wilderness areas cannot be managed in isolation (Landres et al., 1998). Land managers need to collaborate at larger scales and across jurisdictional and ownership boundaries to achieve bighorn sheep management objectives. The disease outbreak that followed the Fossil Ridge herd mixing with cattle on private land in the winter of 2007-08 underscores this need.

As part of GMUG Forest Plan Revision, agency staff are developing a risk-of-contact assessment that will inform management of domestic sheep and bighorns to minimize the potential for disease transmission. Once available, findings from the risk assessment should be implemented at the District level, incorporated into grazing permit stipulations, and communicated to permit holders. The Forest Service should work cooperatively with the BLM, CPW, private landowners, and grazing permittees to minimize the potential for bighorn sheep to interact with livestock whenever practicable.

Monitor bighorn sheep-mountain goat interactions

Interspecies competition with other wild ungulates, particularly mountain goats, may affect bighorn population performance (George et al., 2009). The historical status of mountain goats in Colorado is controversial, and several authorities consider mountain goats to be an introduced species (e.g., Wunder, 2000; Festa-Bianchet and Cote, 2008). Mountain goats are native to the Pacific Northwest and the Northern Rocky Mountains and were transplanted to Colorado starting in 1948 with the intent of developing a population that would support controlled hunting (Hibbs, 1966).

Since their successful introduction to Colorado, mountain goats have thrived and expanded their range, which has led to concerns that mountain goats may compete with bighorn sheep (George et al., 2009). Bighorn sheep and mountain goats have similar habitat requirements and dietary overlap, although this can vary by location and season (Adams et al., 1982; Varley and Varley, 1996). The spatial mechanisms of ecological separation between mountain goats and bighorn sheep seen in northern ranges appear to be less pronounced in Colorado (Adams et al., 1982). Based on observations of interspecies interactions, mountain goats are often the more aggressive and dominant species and appear to be capable of displacing bighorns (Reed, 1984 and 2001; Gross, 2001). In addition, Wolff et al. (2016) documented a case of likely disease transmission between sympatric mountain goats and bighorn sheep in the East Humboldt Range and Ruby Mountains in Nevada.

In the Fossil Ridge Wilderness, CPW (2020) Species Activity Mapping shows that ranges of the bighorn and mountain goat herds overlap for at least part of the year (Fig. 6). Given the potential competition-disease interactions between the two species, it will be important to monitor temporal and spatial habitat selection differences, opportunistically record competitive behavior, and manage for sustainable populations of both species.

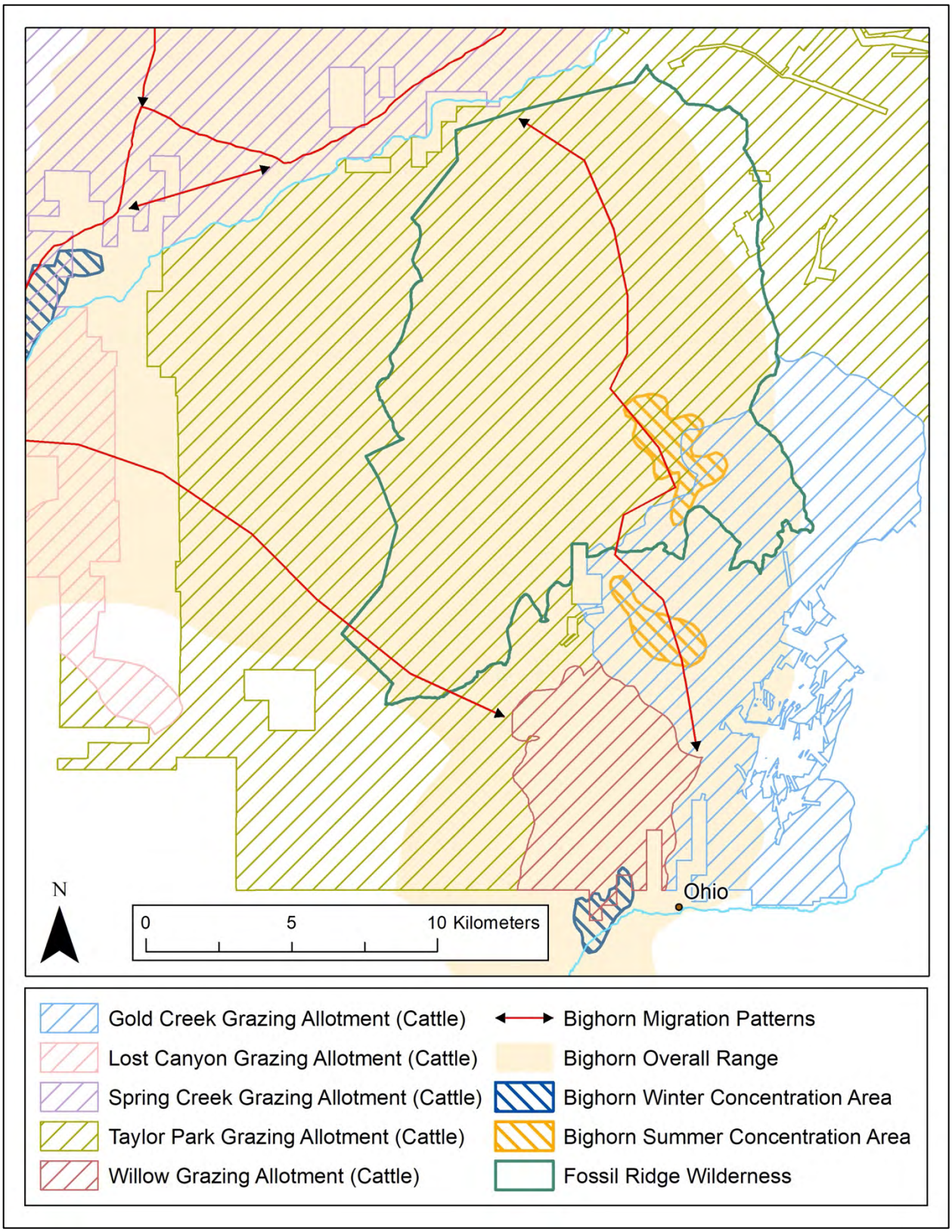


Figure 5. Grazing allotments overlapping the range of the Fossil Ridge bighorn herd. (Map by Tobias Nickel, August 5, 2020)

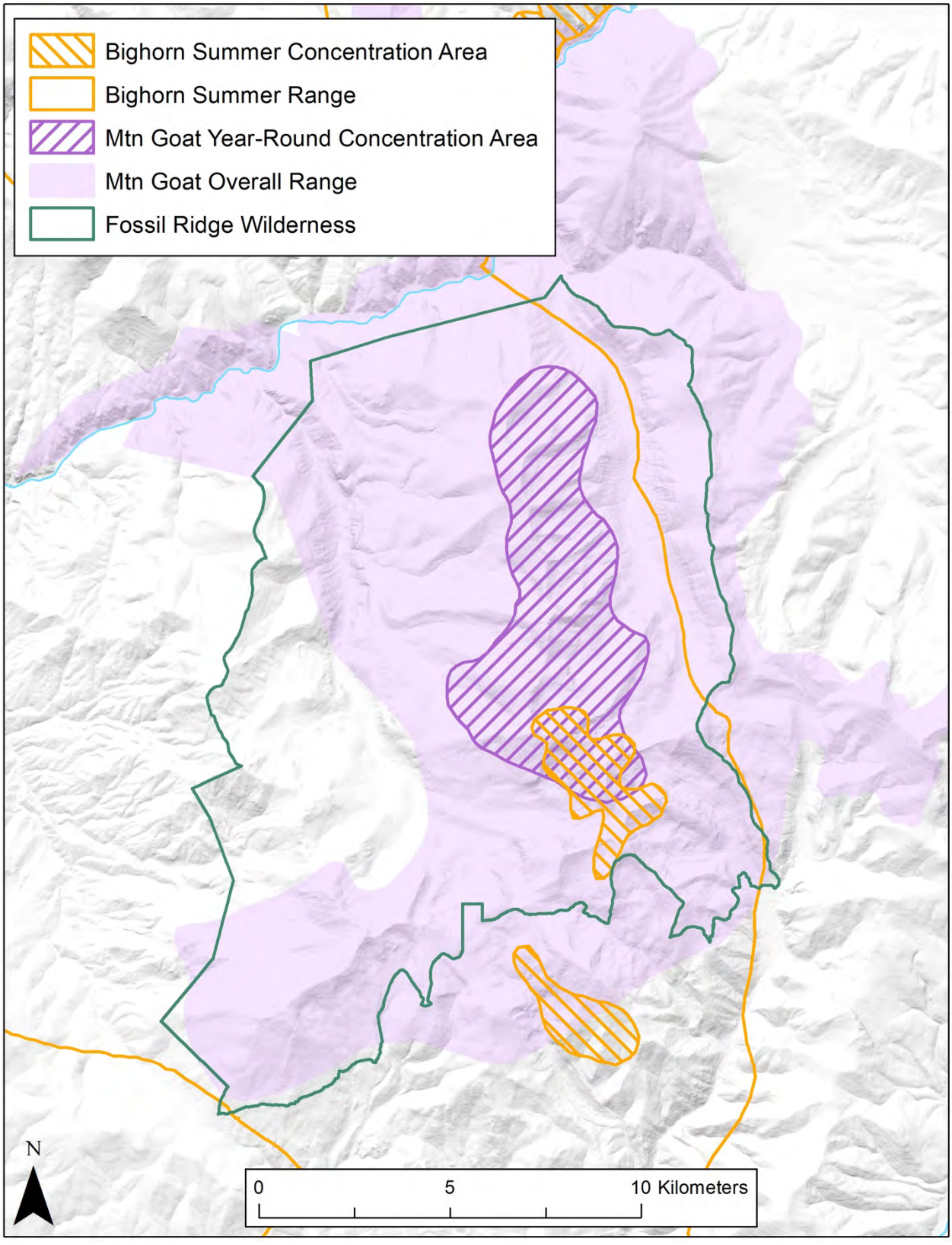


Figure 6. Overlapping ranges of mountain goat and bighorn sheep in the Fossil Ridge Wilderness. (Map by Tobias Nickel, August 5, 2020)

Monitor visitor use and study recreational impacts on bighorn populations

Rapid increase in human populations and outdoor recreation interests in the state of Colorado presents a need for land managers to monitor the possible impacts of recreation on wildlife populations. Bighorns may be adversely affected by exposure to human presence, as has been reported for a variety of other wildlife species. For example, human disturbance of elk (*Cervus elaphus*) during the calving period has been documented to reduce reproductive success (Phillips and Alldredge, 2000; Shively et al., 2005). While not much is currently known about recreational impacts on bighorn sheep, Wiedmann and Bleich (2014) documented lower recruitment and ewes abandoning lambing habitat after being subjected to intensive recreational use associated with new trail development in the Little Missouri National Grassland, North Dakota. It has also been postulated that human-induced stress responses may increase susceptibility to diseases in individual bighorns and thus could contribute to the onset of epidemics (Spraker et al., 1984; Kraabel and Miller, 1997).

The Fossil Ridge Wilderness is considered a low-use wilderness area (Atkinson, 2017), although this could change in the future given recreation use trends regionally (Forest Service, 2018d). Primary activities taking place in this wilderness include hiking and backpacking, fishing, and, to a lesser degree, hunting and horseback riding. Mountain bikes and motor vehicles are prohibited inside the wilderness, but motorized recreation is popular in the adjacent Fossil Ridge Recreation Management Area. While impacts from motorized recreation are a management concern, it is important to note that hikers have been documented to induce more severe behavioral responses in desert bighorn sheep (*O. c. nelsoni*) than either mountain bikes or vehicles (Papouchis et al., 2001).

Visitor use data collection (Atkinson, 2017) in the Fossil Ridge Wilderness between July and September of 2017 found that the Lamphier Lake area had the highest mean human encounters per hour (1.83), followed by the Mill Lake area (1.56) and the Henry Lake area (0.92). Atkinson (2017) also recorded campsites and dog encounters. No monitoring was done in the Crystal Creek drainage basin, which is the most remote and difficult-to-access area of the wilderness. To evaluate trends in "outstanding opportunities for solitude" (Wilderness Act, Section 2(c)), visitor use data collection will occur every five years as part of wilderness character monitoring (Warnick, 2016).

Solitude is not only integral to a wilderness experience and sought after by hikers. Protecting and managing wilderness to offer "outstanding opportunities for solitude" may also directly enhance the survival and performance of species vulnerable to human contact. Conservation biologists are increasingly concerned about and documenting the impacts of growing recreation use on wildlife populations (Larson et al., 2016). Further research is needed to understand the effects of recreation on wildlife populations, including Rocky Mountain bighorn sheep. The Forest Service and CPW should pursue opportunities for collaborative research to protect the "environment of solitude" for wildlife and human visitors alike (The Wilderness Society, 1935).

Habitat management

Bighorn sheep prefer open habitat with good visibility in proximity to escape terrain to avoid predators (Beecham et al., 2007). Advanced vegetative succession in the absence of fire has adversely affected some bighorn sheep populations as maturing forests and shrublands encroach into open grasslands and bighorn foraging habitat (Wakelyn, 1987). Conversely, an ongoing spruce beetle

(*Dendroctonus rufipennis*) outbreak has led to extensive mortality of Engelmann spruce (*Picea engelmannii*) trees across a broad landscape of the Southern Rocky Mountains, including the Fossil Ridge Wilderness (Forest Service, 2016b). The spruce-fir forest vegetation type provides a common interface with the alpine tundra and montane grassland habitats that most bighorn sheep herds occupy. The dense forest cover in this interface, once considered a potential barrier to bighorn sheep movements, now supports very little canopy. What these open forest conditions mean to bighorn sheep habitat selection is not well understood at this time (Forest Service, 2018f).

Using prescribed fire or allowing naturally-ignited fires to exist on the landscape may improve bighorn sheep habitat (Peek et al., 1979; Beechem et al., 2007; George et al., 2009). However, increased live and dead fuel loading and arrangements of close-standing vegetation increase the risk for large-scale, high-intensity wildfires (Anderson, 1982) that may adversely affect watershed and soil processes and wildlife habitat (Neary et al., 2005). Furthermore, unsuppressed wildfires can easily escape to non-wilderness areas and pose threats to existing infrastructure and public safety. As a result, fires in wilderness areas are often suppressed, and this suppression allowed explicitly by the Wilderness Act Section 4(d)(1). While fire management can affect wilderness character and fish and wildlife populations in profound ways, this topic extends beyond the scope of this strategy and is already being addressed in other forest planning documents.

Harvest management

From 2009 until 2017, the Taylor River (S26) and Fossil Ridge (S70) herds were managed as unhunted populations (CPW, 2020b). Starting in 2018, both herds were managed again as hunted populations. Due to depressed population numbers of the Fossil Ridge herd, only a single ram license was issued, and no ewe harvest was allowed in the year 2020 (CPW, 2020b). CPW will continue to determine the annual number of ram and ewe licenses based on an integrated approach to population and hunting management.

The Fossil Ridge Trail, which runs alongside the southern boundary of the wilderness, falls within the Fossil Ridge Recreation Management Area and is open to dirt bikes. (Tobias Nickel, July 11, 2020)

Top: View of Lamphier Lake from Gunsight Pass; bottom: westward views from Square Top Mountain of the Fossil Ridge and Crystal Creek drainage. (Tobias Nickel, July 5, 2020)

Adaptive Management and Contingency Planning

Contingent on population abundance, trends, and health, Forest Service and CPW staff may determine that additional actions are warranted to manage the Fossil Ridge bighorn herd. However, the options outlined below may be considered intrusive and contrary to the spirit of the Wilderness Act. Therefore, these management decisions must not be taken lightly and would require close coordination between state and federal personnel. The MRDG process and the framework proposed by Landres et al. (2020) should be used to carefully weigh the costs and benefits of ecological intervention and ensure that actions taken are the minimum necessary for the administration of the area as wilderness.

Captures and Translocations

Captures and translocations of bighorn sheep are used as management tools to augment existing populations, recover herds after all-age die-offs, restore populations in historical ranges, enhance genetic diversity, and gather scientific knowledge (George et al., 2009). Small population size and limited winter range preclude the Fossil Ridge herd from becoming a source population. On the contrary, the Fossil Ridge herd would likely benefit from augmentation to ensure long-term population viability and increase genetic diversity.

In the event that the Fossil Ridge herd is considered for augmentation, supplemental translocation proposals should be carefully evaluated because of the inherent risk of introducing novel pathogens into the recipient herd. Pathogenic strains can sometimes persist in survivors of an initial epidemic, and thus infected bighorns may serve as a source of infection for other herds through translocations (George et al., 2009). Disease screenings would be necessary to identify herds with similar exposure to pathogens to lessen the likelihood of disease outbreaks in the recipient or translocated bighorns. Translocation stock should be taken from habitats that are nearby and similar to the proposed release site (George et al., 2009). Impacts to social structure and population dynamics of source herds should be considered prior to removals (George et al., 2009).

Translocations should not be undertaken for the sole purpose of increasing genetic diversity. While some studies suggest that inbreeding and decreased levels of heterozygosity influence lamb survival rates and horn growth in bighorn sheep (Stewart and Butts, 1982; Sausman, 1984; Fitzsimmons et al., 1995), negative effects of low genetic diversity have not been conclusively demonstrated as a principal cause of decline in any bighorn sheep population (George et al., 2009). By contrast, the inherent risk of disease transmission associated with supplemental translocations of bighorn sheep is well documented and far outweighs the potential effects of diminished genetic diversity.

Predator control

Common predators of bighorn sheep include mountain lion (*Puma concolor*), coyote (*Canis latrans*), golden eagle (*Aquila chrysaetos*), black bear (*Ursus americanus*), red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*) (Moser, 1962). For most Rocky Mountain bighorn sheep populations in Colorado, there is little evidence that predation is limiting bighorn sheep numbers (George et al., 2009). However, remnant populations or newly transplanted bighorns seem to be particularly vulnerable to predation, resulting in transplant failures and contributing to local extirpations in a few cases (Beecham et al., 2007). Specialization of some mountain lions in preying on bighorn sheep has also been reported and

numerous losses can be attributable to a single lion (Ross et al., 1997; Logan and Sweanor, 2001; Festa-Bianchet et al., 2006). As a result, selective removal of mountain lions has been recommended in some cases (Ross et al., 1997; Mooring et al., 2004).

While predation control is sometimes suggested as the solution for reviving declining ungulate populations, there rarely is enough information available to support such management prescriptions (George et al., 2009). Predation is only one of many factors influencing bighorn population dynamics. Healthy bighorn populations in quality habitat are unlikely to incur additive mortality from predation (George et al., 2009). Therefore, increased levels of predation may be the byproduct of underlying issues, such as degraded habitat conditions or disease. Bighorns occupying marginal habitats or subjected to pathogens may be experiencing poor health, thus predisposing them to predation (George et al., 2009). In these instances, selective predation on unhealthy individuals may aid – not hinder – bighorn populations recovering from epidemics (George et al, 2009).

In the Fossil Ridge Wilderness, limited winter range and disease likely remain the overriding population regulators of the Fossil Ridge bighorn herd. Selective removal of predators in this area should be considered as a last resort and only after managers have carefully evaluated cause-specific mortality factors in bighorns.

Enhance population resilience and genetic exchange by promoting functional metapopulations

It is very likely that most bighorn populations in Colorado historically existed as part of large metapopulations (George et al., 2009). Within these metapopulations, bighorns would have interacted over large areas and maintained high genetic diversity. With population bottlenecks resulting from disease die-offs, overharvest, and increased human impacts on the landscape, many metapopulations have fragmented into comparatively isolated herds with much more restricted movements.

There are two schools of thought on increasing connectivity of bighorn herds (George et al., 2009). One posits that increased connectivity benefits gene flow and population resilience. An opposing view is that connectivity increases the potential for spreading infectious diseases, and this risk may negate any potential benefits derived from increased connectivity. Therefore, the goal of promoting metapopulations and facilitating gene flow must be tempered with the need to minimize the risk of disease introduction and spread (George et al., 2009).

There are several bighorn sheep herds residing within close proximity to the Fossil Ridge herd (Fig. 7), and it is thought that these herds once formed a larger metapopulation (Beecham et al., 2007). While habitat loss, road construction, and human development likely interfere with historic metapopulation functionality (Beecham et al., 2007), a few inter-population exchange events between the Fossil Ridge and surrounding herds have been documented (Kevin Blecha, CPW, Wildlife Biologist, personal communication). Moreover, there is a high probability that a large portion of these exchange events are undetected. With increasing emphasis on migration corridor protection (e.g., construction of highway over- and underpasses), natural movements and metapopulation dynamics of bighorn sheep in this area warrant additional research. As part of landscape-level conservation planning, opportunities to improve metapopulation connectivity between the Fossil Ridge and surrounding bighorn herds should be explored.

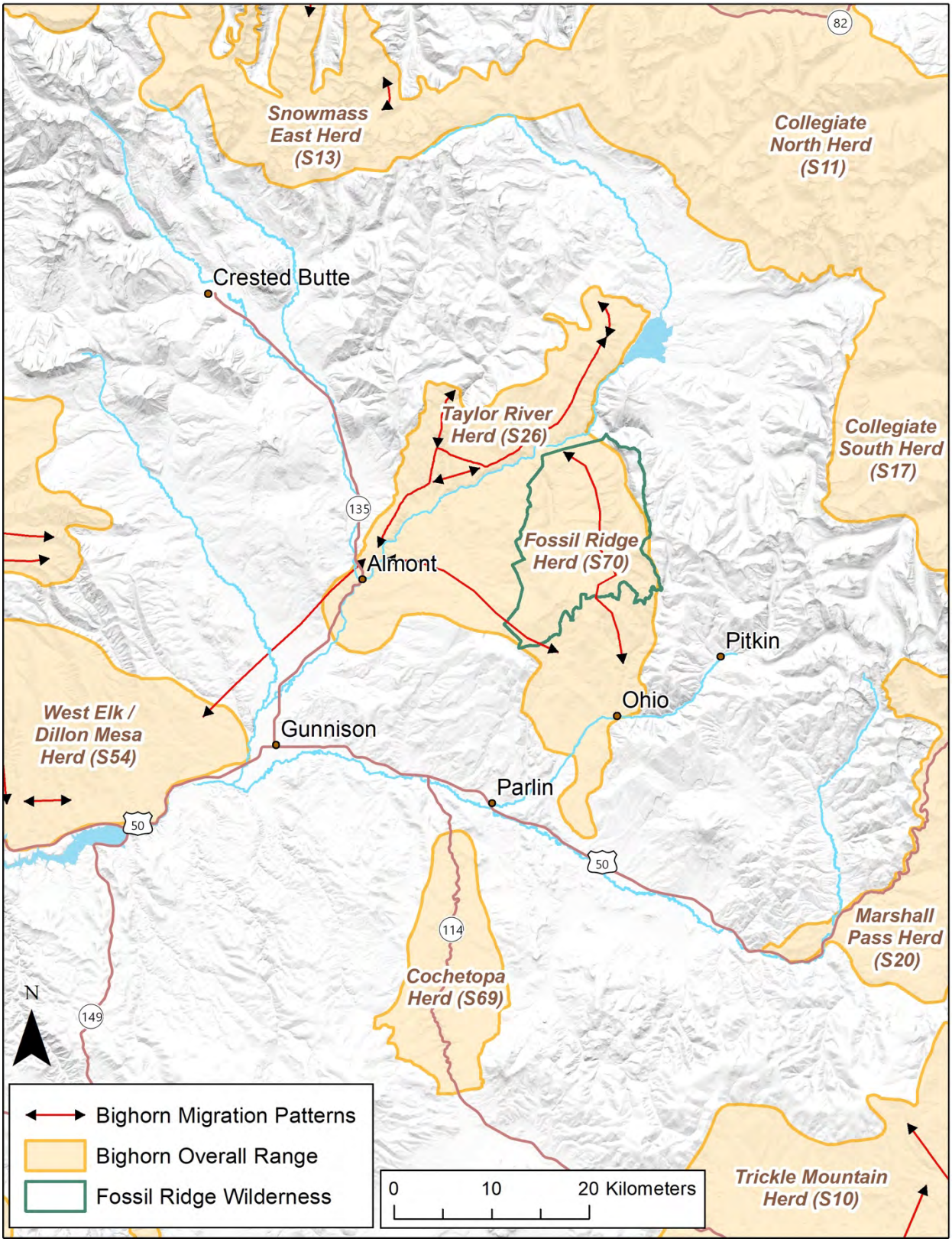


Figure 7. Bighorn sheep herds residing in close proximity to the Fossil Ridge herd. (Map by Tobias Nickel, August 5, 2020)

Wilderness Stewardship Considerations

Management actions within versus outside of wilderness

The first step in the MRDG process is to determine if action can be taken outside of wilderness to adequately achieve management objectives. The occupied range of the Fossil Ridge bighorn herd extends beyond wilderness boundaries (Fig. 4). During winter, the herd is assumed to migrate south to lower elevation areas that lie outside the Fossil Ridge Wilderness (CPW, 2019). As a result, there are foreseeable management opportunities that could result in conservation gains for this herd without requiring intervention inside wilderness. In fact, past actions (e.g., capturing and collaring) to manage this herd have exclusively taken place on lands outside wilderness (Kevin Blecha, CPW, Wildlife Biologist, personal communication). In the future, actions to manage the Fossil Ridge bighorn herd should continue to be implemented outside wilderness whenever practicable.

Preserving the natural quality of wilderness character

Bighorn sheep are an integral component of this area's wilderness character. If this iconic species became extirpated, the natural quality of the Fossil Ridge Wilderness would be diminished.

Impacts to the untrammeled quality of wilderness character

Many of the management recommendations discussed thus far constitute rationally planned human intervention in the biophysical environment, thus degrading the untrammeled quality. In spite of the good intentions and agency mandates to reverse the human-caused decline of bighorn sheep, deliberate actions of human control are contrary to the symbolic meanings of humility and restraint embedded in the Wilderness Act. Captures, translocations, drug treatments, and collaring represent missed opportunities to restrain our species' urge to control natural processes. Therefore, these actions potentially undermine wilderness as a place that is free from human intent, design, and utility. Further information on trammeling actions is contained in Appendix B.

Research in Wilderness

Section 4(b) of the Wilderness Act of 1964 states, "wilderness areas shall be devoted to the public purposes of recreational, scenic, *scientific*, educational, conservation, and historical use" [emphasis added]. Forest Service policy affirms this mandate of the Wilderness Act and directs managers "to provide appropriate opportunity for scientific studies that are dependent on a wilderness environment" and "encourage research in wilderness that preserves the wilderness character of the area" (FSM Section 2324.4). In addition, FSM Section 2323.37 specifically addresses conducting fish and wildlife research in wilderness, stating that this type of research is an "appropriate activity in wilderness." Forest service policy recognizes that scientific sampling of wildlife populations is essential to inform management and permits the capturing and inconspicuous marking of animals.

However, FSM Section 2323.37 also emphasizes that research must be conducted "in such a way as to minimize any adverse impacts on the wilderness resource or its users." FSM Section 2324.4 further directs managers to review research proposals "to ensure that research areas outside wilderness could not provide similar research opportunities" and "that research methods are compatible with wilderness values." Projects that would jeopardize wilderness values should be directed to areas outside wilderness.

Research methods that temporarily infringe on the wilderness character may be used, provided the information sought is essential for wilderness management and alternative methods or locations are not available. Installations, such as wildlife cameras and other scientific equipment essential for wildlife research, may be approved on a case-by-case basis utilizing the MRDG process. Where permitted, scientific installations should be subtle, temporary, and placed in such a way as to blend in with the surrounding environment. Researchers will be required to remove scientific installations after the completion of their studies.

What constitutes appropriate research inside wilderness has been a source of conflict between managers and scientists. Every year, agency managers receive hundreds of proposals to conduct scientific studies within wilderness (Landres et al., 2010). The cumulative impact that these research projects have on wilderness character can be significant (Landres et al., 2010). Demands for research and monitoring in wilderness are likely only going to increase in the future as scientists are seeking to understand the effects of global climate change and other anthropogenic stressors.

While wilderness areas offer the rare opportunity to study broad, landscape-level ecosystem processes with only minimal human alteration, the standard for approving scientific activities is, and should be, set higher inside wilderness than in other areas because of the overriding legislative mandate to "preserve wilderness character."

Inconsistency in evaluating proposals for scientific activities in wilderness, combined with a lack of communication between managers and scientists, has led to increasing frustration, conflict, and lack of defensibility when approving and denying proposals. In response, Landres et al. (2010) developed a consistent and comprehensive framework for evaluating proposals for scientific activities in wilderness. When evaluating studies to address research needs discussed in this document, the framework provided by Landres et al. (2010) should be utilized to improve communication and transparency among managers and scientists, thereby reducing conflict and impacts to wilderness character, increasing the relevance of science to improving wilderness stewardship, and bringing the benefits of wilderness science to society.

Aircraft use

Per the AFWA (2006) Policies and Guidelines, aerial counts and observations of wildlife are allowed to continue over wilderness. The now-expired MOU between the Forest Service, Rocky Mountain Region and CPW (2015), also specifies that aerial wildlife surveys do not require federal agency approval. While this activity does not require federal authorization, the sights and sounds of aircraft still threaten visitor opportunities for solitude and can temporarily shatter feelings of remoteness and wildness (Tarrant et al., 1995; McKenna et al., 2016). Low-altitude aircraft overflights can also affect wildlife stress levels, movement, and habitat utilization (NPS, 1994).

Effectiveness Monitoring

Given the importance of adaptive management to minimize trammeling actions in wilderness, the following monitoring questions will be considered when evaluating the effectiveness of actions to manage Rocky Mountain bighorn sheep in the wilderness. Where possible, these questions will be considered in the context of the ongoing wilderness character monitoring strategy for the Fossil Ridge Wilderness (Warnick, 2016).

- What are trends in abundance, survival, and recruitment in the Fossil Ridge bighorn herd?
- What are trends in contact between the Fossil Ridge bighorn herd and domestic livestock, both inside and outside of wilderness? Are best management practices to separate bighorns from domestic sheep being expanded to cattle? Are these best management practices communicated to grazing permit holders? Is the Forest Service working cooperatively with the BLM and private landowners to minimize potential for bighorn sheep to come into contact with domestic livestock whenever practicable?
- What are trends in the bighorn sheep population relative to the mountain goat population inside the Fossil Ridge Wilderness? Are interspecies interactions, display of competitive behavior, and range shifts being observed and recorded?
- What are visitor use trends in the Fossil Ridge Wilderness? Are human-induced disturbances on bighorn sheep being studied and considered?
- What are trends in bighorn sheep habitat quality inside wilderness? How are changes in fire regime, vegetative succession, and tree mortality affecting bighorn habitat?
- What are trends in connectivity and gene flow between the Fossil Ridge herd and surrounding bighorn herds?
- What are the impacts of trammeling actions taken to manage the Fossil Ridge bighorn herd? Given the objective of minimizing interventions in wilderness, have trammeling actions achieved the desired conservation outcomes?
- To what degree have prohibited uses (motorized equipment, aircraft, installations, etc.) been used to accomplish bighorn sheep management? Are these uses increasing?
- What efforts have been made to focus management of the Fossil Ridge bighorn herd on their range outside wilderness to the maximum extent possible?
- What are trends in coordination between state and federal agencies on bighorn sheep management activities in the wilderness? Are bighorn population estimates and observations being shared? Are wilderness managers communicating with CPW staff to minimize impacts to wilderness character? Are opportunities for collaborative research being pursued?

Top: view from Gunsight Pass of upper and lower Lamphier Lakes; bottom: Boulder Lake with Sheep Mountain in the background (Tobias Nickel, June 15 and July 10, 2020).

Wilderness Management Strategy – Southern White-tailed Ptarmigan

Introduction

The white-tailed ptarmigan (*Lagopus leucura*) is endemic to alpine regions of western North America (Hoffman, 2006). Colorado supports the largest population of white-tailed ptarmigan and the greatest expanse of suitable habitat in the contiguous United States (Hoffman, 2006). There are currently five recognized subspecies of white-tailed ptarmigan (USFWS, 2012). The southern white-tailed ptarmigan (*L. l. altipetens*) is the subspecies found in the Rocky Mountains of Colorado, with peripheral populations in northern New Mexico and possibly southern Wyoming (Langin et al., 2018). Southern white-tailed ptarmigan from Colorado have also been successfully introduced into suitable habitats outside their native range, including the Sierra Nevada in California (Braun et al., 2011) and the Uinta Mountains in Utah (Braun et al., 1978).

Southern white-tailed ptarmigan spend their entire lifecycles at or above treeline and are well adapted to survive in cold, alpine environments (Hoffman, 2006). Their color-changing plumage effectively camouflages them against white snow in winter and alpine vegetation and rocks in summer (Braun et al., 1993). During the winter, southern white-tailed ptarmigan occupy the lowest elevations in their respective ranges, feeding on willows (*Salix spp*.) and roosting in areas with soft snow at treeline (Hoffman and Braun, 1977; Braun et al., 1993; Hoffman, 2006). For breeding and nesting habitat, the birds migrate to higher elevations that are snow-free by late spring and where stands of willow and wind-sheared, stunted trees (krummholz) are still present (Hoffman, 2006). During summer and brood-rearing season, the birds move onto high ridges, benches, and mountain tops characterized by rock fields and low-growing vegetation, before severe snowstorms push them to lower elevations again in fall and winter (Hoffman, 2006).

The alpine ecosystems upon which southern white-tailed ptarmigan depend are considered highly vulnerable to climate change (Neely et al., 2011). As summarized by Hoffman (2006), the main consequences of climate change to southern white-tailed ptarmigan are the loss and fragmentation of habitat through (1) changes in the quality and quantity of snow cover, (2) changes in the distribution and composition of plant communities, and (3) upward movement of treeline. As forests expand upslope, alpine areas will become smaller and less continuous, and populations of southern white-tailed ptarmigan may become increasingly isolated and more vulnerable to extirpation.

Another concern is the potential effect of climate change on monsoonal patterns in the alpine of Colorado, where afternoon thunderstorms have historically been very common in July and August (Seglund et al., 2018b). In addition to moderating summer temperatures, afternoon thunderstorms are also important for maintaining verdant vegetation that would desiccate and become less productive without the almost daily moisture. If the summer thunderstorm regime is altered, the southern white-tailed ptarmigan may be negatively impacted due to changes in forage, reduction in mesic sites, loss of persistent snow fields, and increased temperatures (Seglund et al., 2018b).

While southern white-tailed ptarmigan are physiologically well-adapted to coping with cold temperatures, they are ill-adapted to dealing with high temperatures (Johnson, 1968; Hoffman, 2006). In their long-term study of southern white-tailed ptarmigan in Rocky Mountain National Park, Wang

et al. (2002) documented a population-level response in southern white-tailed ptarmigans to climate change, including depressed population growth rates and skewed hatch dates. Wang et al. (2002) postulate that predicted temperature increases may accelerate the decline of southern white-tailed ptarmigan in Rocky Mountain National Park and increase the probability of local extinction.

Besides climate change, other threats to southern white-tailed ptarmigan include grazing, mining, hunting, and recreation (Hoffman, 2006; USFWS, 2012; Seglund et al., 2018b). Improperly managed livestock grazing can come at significant ecological costs (Fleischner, 1994), and these impacts are amplified in alpine ecosystems, which are slow to recover and where resources are scarce (Thilenius, 1975). While cattle are not a major influence in the alpine, concentrated sheep grazing can degrade habitat and reduce forage for southern white-tailed ptarmigan (Hoffman, 2006; Seglund et al., 2018b). It has also been hypothesized that grazing by wild ungulates, especially elk (*Cervus elaphus*) and moose (*Acles alces*), may negatively impact southern white-tailed ptarmigan habitat in some areas (Hoffman, 2006; Zeigenfuss, 2006).

In addition to livestock grazing, mining has been an important industry within the range of the southern white-tailed ptarmigan (Hoffman, 2006). The impacts from historic mining include not only soil and vegetation disturbance, but heavy metals leeching from abandoned mine sites that have not been properly reclaimed (Salomons, 1995). In southwestern Colorado, southern white-tailed ptarmigan exhibited calcium deficiencies, skewed sex ratios, and other physiological and population-level effects after feeding on willows contaminated with cadmium, a metal mined (and thereby mobilized) in Colorado's high country (Larison et al., 2000). With over 23,000 abandoned mines across the state (Colorado Department of Public Health and Environment, 2020), the full extent to which acid mine drainage may affect southern white-tailed ptarmigan populations is uncertain.

Southern white-tailed ptarmigan are legally hunted in Colorado, but the threat of overharvest is limited to a few, easily accessible alpine areas (Hoffman, 2006). The impact of hunting on the statewide population is considered to be negligible at this time (Seglund et al., 2018b). However, increasing recreational activities other than hunting in alpine areas of Colorado may be a major cause of disturbances to southern white-tailed ptarmigan (Hoffman, 2006; CPW, 2015; Seglund et al., 2018b). Visitor use impacts include trash, trampling of sensitive alpine plants, noise pollution, and unattended dogs harassing the birds (Hoffman, 2006; Seglund et al., 2018b). In addition, heavily used trails and roads can become deeply incised, altering the hydrological regime and drying out wetlands, meadows, fens, and willow communities downslope (Seglund et al., 2018). The growing popularity of winter recreation may also increasingly disturb southern white-tailed ptarmigan when their reserves are already low due to environmental stressors (Hoffman, 2006; Seglund et al., 2018b). In particular, snowmobiling can lead to snow compaction and loss of willows, thus reducing winter forage and suitable snow for roosting (Hoffman, 2006; Seglund et al., 2018b).

Due to concerns over climate change and cumulative impacts from these other anthropogenic stressors, the southern white-tailed ptarmigan was petitioned to be listed as threatened under the Endangered Species Act (Greenwald, 2010). In a 90-day petition finding, the USFWS (2012) decided to initiate a status review of this subspecies. A species status assessment report is anticipated for late 2020 and will inform the decision on whether to list the southern white-tailed ptarmigan under the

Endangered Species Act. Independent of the forthcoming federal status decision, the southern white-tailed ptarmigan is a conservation priority, as it is considered a Tier 1 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015) and a Sensitive Species by the Forest Service, Rocky Mountain Region (2018g).

For more detailed information on the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain the species' viability, please refer to *White-tailed Ptarmigan: A Technical Conservation Assessment* (Hoffman, 2006), *Southern White-tailed Ptarmigan Population Assessment and Conservation Considerations in Colorado* (Seglund et al., 2018b), and the anticipated USFWS' species status assessment report.

Top: A southern white-tailed ptarmigan in winter plumage roosting in snow (Matt Strauser, CPW); bottom: A female southern white-tailed ptarmigan in summer nuptial plumage (Shawn Conner, BIO-Logic, Inc.).

Current Status in the Fossil Ridge Wilderness

The Fossil Ridge Wilderness protects intact samples of alpine ecosystems upon which the southern white-tailed ptarmigan depends. A statewide predicted range model identified 8,847 acres (27%) of the Fossil Ridge Wilderness as potentially suitable habitat for southern white-tailed ptarmigan (CPW, 2020c; Fig. 8). While the distribution and population status of southern white-tailed ptarmigan in this wilderness are currently unknown, the subspecies was confirmed inside the Fossil Ridge Wilderness during occupancy surveys conducted on September 20 and 21, 2020.

The surveys were carried out by Amy Seglund (CPW, Species Conservation Coordinator), Sarah Albright (CPW, Wildlife Technician), and Tobias Nickel (Forest Service, Wilderness Fellow). The surveyors walked the Mill Lake basin and surrounding ridges, focusing on rocky and grassy slopes and patches of willow. Following Braun et al. (1973), territorial male and chick distress calls were played using FOXPRO digital game units to increase detection rates. On September 20, southern white-tailed ptarmigan droppings were found in a rock chute (UTM E360489, N4280940; 3,686m). The following morning, several individuals were heard responding to playbacks on a rocky hillside with intermixed grassy patches and a cliff upslope. A male subsequently took flight from the cliff and landed nearby in a patch of wind-trimmed, low-growing Engelmann spruce (*Picea engelmannii*) (photo below). The male displayed behavior associated with territorial defense (flight and screams) and was recorded at UTM E360596, N4280896 and an elevation of 3,607m.

No additional individuals were confirmed during the survey, although it is worth noting that detection of southern white-tailed ptarmigan is less likely in September, when eliciting a response with playbacks becomes difficult (Seglund et al., 2018b). In addition to the single male identified during the survey, Dr. Patrick Magee (Professor of Wildlife Biology, Western Colorado University) reported seeing a southern white-tailed ptarmigan on the southeastern flank of Henry Mountain rising up from the saddle between Henry and Square Top Mountains on July 25, 2020 (photo p. 59).

A male white-tailed ptarmigan in summer plumage camouflaged against the rocks near a stand of low-growing Engelmann spruce in the Mill Lake basin. (Tobias Nickel, September 21, 2020)

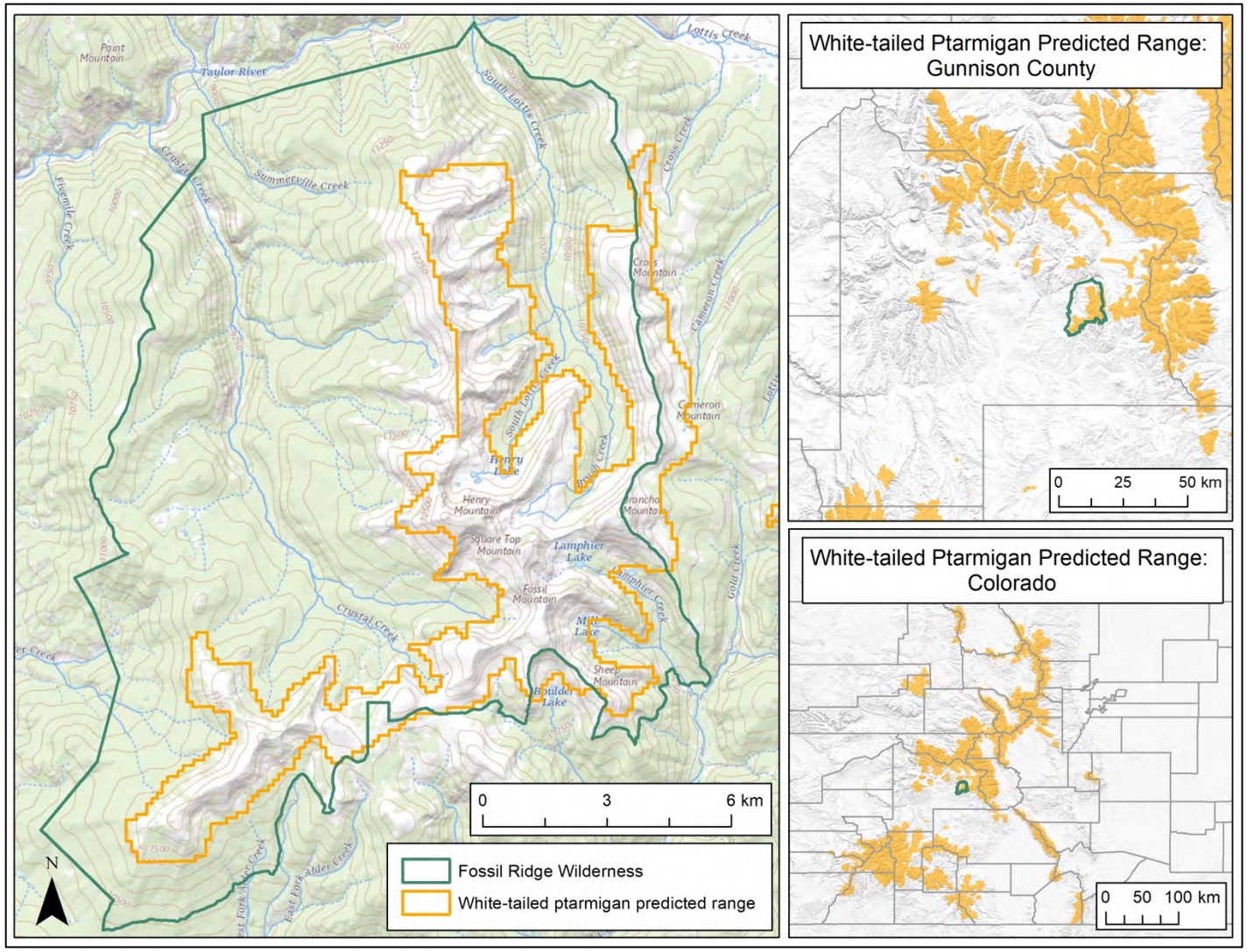


Figure 8. Southern white-tailed ptarmigan predicted range (Map by Tobias Nickel, September 17, 2020).

Note: The predicted range of southern white-tailed ptarmigan was mapped by CPW (2020) based on the following criteria: areas higher than 10,800 feet in elevation and Colorado GAP vegetation types mixed tundra, meadow tundra, prostrate shrub tundra, bare ground tundra, exposed rock, shrub dominated wetland/riparian, and graminoid/forb dominated wetland.

In conjunction with the occupancy surveys, a preliminary evaluation of potential habitat for southern white-tailed ptarmigan revealed a mosaic of rock fields and low-growing vegetation, including microsites for brood-rearing in Mill Lake basin and suitable summer and fall habitats on nearby ridges and mountain tops (Amy Seglund, CPW, Species Conservation Coordinator, personal communication; photos pp. 56-59). However, wintering habitat, characterized by presence of willow, may be a limiting factor for southern white-tailed ptarmigan in this wilderness. Large patches of willow are rare in the high-elevation basins of the Fossil Ridge, with Brush Creek basin being potentially the only exception (photos p. 57).

The southern white-tailed ptarmigan population of the Fossil Ridge Wilderness may be small due to limited winter habitat and, therefore, dependent on regional migration. Indeed, recruitment of immigrants (demographic rescue) is a major contributing factor to southern white-tailed ptarmigan population stability and maintenance (Giesen and Braun, 1993; Martin et al., 2000; Wilson and Martin, 2011). From alpine areas inside the wilderness, the closest habitat is located on Fairview Peak (Fig. 8; photo below). The shortest distance between potential habitats is 2.5 km (CPW, 2020c), although the average distance is likely closer to 5-10 km. Fairview Peak, in turn, is connected to large tracts of southern white-tailed ptarmigan habitat in the Sawatch Range (CPW, 2020c).

While southern white-tailed ptarmigan occupy small home ranges, females in particular are known to disperse from breeding sites to relatively distant wintering areas and return the following spring (Hoffman and Braun, 1975; Hoffman, 2006; Seglund et al., 2018b). Tracking radio-collared southern white-tailed ptarmigan, Seglund et al. (2018b) found the mean distance moved between summer and winter habitats to be 6.4 km for females and 1.3 km for males. The maximum distance recorded for a female to move within a season was 53.0 km in winter and 46.5 km in summer after a failed breeding attempt (Seglund et al., 2018b). Based on these data, exchange events between populations of southern white-tailed ptarmigan on Fairview Peak, in the Sawatch Range, and in the Fossil Ridge Wilderness are likely occurring and may be a critical feature to maintaining resilient populations.

The Fossil Ridge Wilderness exhibits few immediate, localized threats to southern white-tailed ptarmigan. Their habitat in this area is reasonably secure against future developments due to its statutory designation as wilderness. Under Section 4(d)(4)(2) of the Wilderness Act, grazing continues to be permitted in wilderness areas, where it was an established practice prior to designation. The Fossil Ridge Wilderness overlaps two cattle grazing allotments (Fig. 5), but cattle are grazed sparingly, if at all, above treeline (Warnick, 2016). Cattle have also not been reported to be broadly detrimental to alpine habitats used by southern white-tailed ptarmigan (Thilenius, 1975; Hoffman, 2006). While domestic sheep grazing can alter the alpine vegetation community and adversely impact southern white-tailed ptarmigan populations (Hoffman, 2006; Seglund et al., 2018b), no sheep allotments exist in the Fossil Ridge Wilderness. Wild ungulate browsing on willow at or above treeline is also unlikely to be a major influence due to the extensive amount of forage available at lower elevations (Kevin Blecha, CPW, Wildlife Biologist, personal communication).

No active mining occurs inside the Fossil Ridge Wilderness. Colorado abandoned mine land inventory data shows two historic mines straddling the boundary of the Fossil Ridge Wilderness (Colorado Geological Survey, 2020). One mine lies in the northwestern corner of the wilderness just

south of Cross Mountain. The other mine is located along the upper reach of East Fork Alder Creek along the southern boundary of the wilderness near the junction of the Summerville and Fossil Ridge trails. Surveying for southern white-tailed ptarmigan, staff also sighted a potential prospecting pit on the saddle between Sheep and Fossil Mountains. Early miners may have dug and prospected at additional sites that have not yet been inventoried. The ecological impacts from these abandoned mine sites in the Fossil Ridge Wilderness have not been assessed.

Recreation-induced disturbances in the alpine of the Fossil Ride Wilderness are currently thought to be minimal. Due to remote location and difficult access, hunting likely has little, if any, effect on southern white-tailed ptarmigan in this area. The Fossil Ridge Wilderness contains no "fourteeners," which tend to attract large numbers of hikers (Kedrowski, 2006). Except for a social trail that leads from Lamphier Lake to Henry Mountain via Square Top Mountain, visitor use is mostly confined to the trails and lakes in the forested portions of the wilderness (Tobias Nickel, personal observations). Off-road vehicles (including snowmobiles) are prohibited inside the wilderness, although motorized recreation is popular in the adjacent Fossil Ridge Recreation Management Area. Winter recreation is considered nearly nonexistent in the interior of the Fossil Ridge Wilderness, and it is unlikely that southern white-tailed ptarmigan would be disturbed in their wintering habitats.

In conclusion, there appear to be no significant *in situ* anthropogenic threats to southern white-tailed ptarmigan operating inside the Fossil Ridge Wilderness. As climate change impacts intensify, the Fossil Ridge Wilderness could serve as a potential refuge for southern white-tailed ptarmigan and other alpine species.

View of Mill Lake with Fairview Peak in the background (Tobias Nickel, September 21, 2020).

Top: Brush Creek basin as seen from the saddle between Henry and Square Top Mountains (Tobias Nickel, Sept. 21, 2020). Bottom: View from Gunsight Pass toward upper Brush Creek basin and Henry Mountain (Tobias Nickel, June 15, 2020). Note the abundance of willow in this basin.

Top: View from Fossil Mountain of Lamphier Lake basin; bottom: Expansive northward vistas enjoyed from the summit of Henry Mountain. In the foreground, the dark blue waters of Henry Lake feed into South Lottis Creek, while the craggy peaks of the Sawatch Range rise above 14,000 feet on the horizon. (Tobias Nickel, September 21, 2020).

Looking southeast from Henry Mountain toward nearby Square Top Mountain and the Sawatch Range in the far distance. This ridgeline appears to be excellent late summer and fall habitat (Amy Seglund, CPW, Species Conservation Coordinator, personal communication). Dr. Patrick Magee (Professor of Wildlife Biology, Western Colorado University) also reported seeing a southern white-tailed ptarmigan on July 25, 2020 in the immediate vicinity of where this photo was taken. (Tobias Nickel, June 15, 2020)

Management Objectives

1. Inventory and monitor populations of white-tailed ptarmigan
2. Evaluate and maintain habitat for white-tailed ptarmigan
3. Identify, assess, and mitigate localized threats to white-tailed ptarmigan and their habitats
4. Coordinate and cooperate with CPW to:
    a. Identify and manage toward a shared vision of white-tailed ptarmigan conservation
    b. Jointly pursue research and stewardship projects to conserve white-tailed ptarmigan
    c. Support CPW's fish and wildlife objectives, to the extent such objectives are consistent with the Wilderness Act
5. Achieve the above objectives with minimal adverse impacts to wilderness character
    a. To the extent possible, allow natural processes to unfold without human intervention
    b. Integrate principles of adaptive management and monitor the effectiveness of actions implemented to guide subsequent work and minimize trammeling
    c. Utilize the MRDG as an analytical tool to evaluate administrative proposals that could potentially affect wilderness character

Management Recommendations

Inventory and monitor current populations

Surveying for southern white-tailed ptarmigan is warranted to be able to assess long-term climate change effects on this subspecies and alpine ecosystems (Hoffman, 2006; CPW, 2015; Seglund et al., 2018b). These birds essentially complete their entire life cycle at or above treeline. As one of the few year-round residents of the alpine in Colorado, the southern white-tailed ptarmigan is well-suited as an indicator of the health of alpine ecosystems (Braun et al., 1993; Jackson et al., 2015).

Alpine ecosystems and species are considered highly vulnerable to climate change (Neely et al., 2011). As climate change progresses, the ranges of many species are expected to shift poleward and/or to higher elevations (Walther et al., 2002; Holsinger et al., 2019). However, alpine species may already occur at the edge of their respective ranges and upslope range shift may not be feasible. As ranges contract and connectivity is lost, populations of alpine-obligate species may become increasingly isolated and more vulnerable to extirpation (Beever et al., 2010). Therefore, baseline data collection and subsequent monitoring of these species should be a management priority to evaluate demographic changes and inform conservation actions.

To address these data needs, CPW is developing a long-term alpine monitoring program that will include periodic assessments of southern white-tailed ptarmigan and associated habitat conditions (Seglund et al., 2018b). While the Fossil Ridge Wilderness may not be selected as a study site for the statewide monitoring program, occupancy surveys for southern white-tailed ptarmigan should be carried out as part of wilderness stewardship to preserve the natural quality of this wilderness.

The current distribution and population status of southern white-tailed ptarmigan in the Fossil Ridge Wilderness is not well understood. Accurately estimating southern white-tailed ptarmigan densities over broad geographic areas is challenging (Hoffman, 2006). Presently, the most reliable and practical technique for censusing southern white-tailed ptarmigan involves playback of recorded calls (Braun et al., 1973). The primary drawback of this technique is that it can only be applied to relatively small areas and requires intensive effort by many individuals. However, mere occupancy surveys using this technique can be effectively completed at a larger scale (Seglund, 2011). Survey sites need to be carefully selected based on management priorities, information needs, and best available understanding of southern white-tailed ptarmigan habitat use patterns.

Until recently, no occupancy surveys for southern white-tailed ptarmigan had been conducted in the Fossil Ridge Wilderness. As described above, CPW and Forest Service staff confirmed a single southern white-tailed ptarmigan in the Mill Lake basin in September of 2020. Based on topographic maps, photographs, and available GIS data, several other areas with potentially suitable habitat were identified, including Brush Creek, Lamphier Creek, and Henry Lake basins (Amy Seglund, CPW, Species Conservation Coordinator, personal communication; photos pp. 57-58). Brush Creek basin, in particular, should be prioritized for future inventory, as this area contains abundant willow carr and mesic habitats, persistent snowfields, and extensive talus slopes of varying steepness.

CPW researchers intend to survey Brush Creek basin in 2021 (Amy Seglund, CPW, Species Conservation Coordinator, personal communication). If possible, occupancy surveys should be

conducted during the brood-rearing season (mid-July to late August), when southern white-tailed ptarmigan are most likely to respond to playbacks (Seglund et al., 2018b). When appropriate, surveys should be accomplished in collaboration with Forest Service biologists, students from Western Colorado University, and/or partner organizations (e.g., Rocky Mountain Biological Laboratory). Multi-species surveys for alpine species other than southern white-tailed ptarmigan (e.g., brown-capped rosy finch, American pika) should be conducted when practical. In addition, Forest Service field staff working in the alpine should be cross-trained to be able to visually identify southern white-tailed ptarmigan and their habitat features and be prepared to opportunistically record sightings in the Fossil Ridge Wilderness. Observations from volunteers, recreationists, Western Colorado University students and faculty, and other interested parties should also be documented and taken into consideration for conservation planning.

Evaluate habitat suitability

Habitat conditions for southern white-tailed ptarmigan should be assessed in conjunction with occupancy surveys. Key habitat features include willow-dominated plant communities, krummholz vegetation, moist alpine meadows, rock fields, and late-lying snowfields (Hoffman, 2006). For detailed descriptions of habitat requirements, please consult the technical conservation assessment (Hoffman, 2006) and the forthcoming USFWS' species status assessment report.

Wintering habitat may be the limiting factor for southern white-tailed ptarmigan in this wilderness due to low abundance of willow in many of the high-elevation basins. Willows are a critical resource for southern white-tailed ptarmigan from late fall through spring, when alternative food sources are scarce (May and Braun, 1972). Therefore, willow-dominated plant communities should be recorded and prioritized for future surveys and conservation planning. In the course of other field work, CPW and Forest Service staff should also visually evaluate and document evidence of heavy ungulate browsing in these communities. Monitoring and maintaining the health of willow carr ecosystems is critical to the long-term persistence of southern white-tailed ptarmigan in this wilderness.

Minimize livestock grazing in alpine environments

Experts generally agree that extreme caution should be exercised in permitting grazing in the alpine, as these ecosystems are fragile and slow to recover (Thilenius, 1975; Hoffman, 2006; Seglund et al., 2018b). Domestic sheep grazing is of particular concern in alpine environments and can adversely impact southern white-tailed ptarmigan, especially during drought conditions (Hoffman, 2006; Seglund et al., 2018b). To conserve alpine ecosystems and the species that depend on them, the Forest Service should continue to not permit sheep grazing inside the Fossil Ridge Wilderness.

Record abandoned mine sites

Heavy metals readily mobilized at abandoned mining sites can pose a potential health threat to southern white-tailed ptarmigan (Larison et al., 2020). Colorado abandoned mine land inventory data shows two historic mines straddling the boundary of the Fossil Ridge Wilderness (Colorado Geological Survey, 2020). Another prospecting pit was also sighted during a survey for southern white-tailed ptarmigan. Additional historic mining sites potentially exist withing the Fossil Ridge Wilderness, disturbing alpine soils and vegetation and leaving scars visible to this day. In the course of other field work, agency staff should document these sites by taking photographs and collecting

GPS points whenever possible. Unfortunately, alpine ecosystems have virtually no chance of recovering from the effects of mining, and mine reclamation in alpine environments remains challenging due to severe climate and limited soil resources (Hoffman, 2006). Assessing ecological impacts from historic mining activity and proposing reclamation of mined lands extends beyond the scope of this document. However, when appropriate, the Forest Service should pursue, encourage, and support mine reclamation efforts as well as research into the impacts of mining on southern white-tailed ptarmigan and other species.

Monitor visitor use impacts in the alpine

Rapid increase in human populations and outdoor recreation interests in the state of Colorado presents a need for land managers to monitor the possible impacts of recreation on wildlife populations. The Fossil Ridge Wilderness is considered a low-use wilderness area (Atkinson, 2017), although this could change in the future given regional trends in recreation (Forest Service, 2018d). To evaluate trends in "outstanding opportunities for solitude" (Wilderness Act, Section 2c), visitor use data collection is planned every five years as part of wilderness character monitoring for the Fossil Ridge Wilderness (Warnick, 2016). Baseline data was collected between July and September of 2017 and included campsite inventories and human and dog encounter data for the Mill, Henry, and Lamphier Lake areas (Atkinson, 2017).

Visitor use of the alpine areas occupied by southern white-tailed ptarmigan is currently not monitored in the Fossil Ridge Wilderness. However, travel in the alpine is likely a small fraction of overall recreational activity in this wilderness. One notable exception is a social trail that leads from Lamphier Lake to Henry Mountain via Square Top Mountain. However, even within this social trail corridor, visitor use pales in comparison to most summit trails in Colorado (Tobias Nickel, personal observations). As recreation in the alpine of Colorado continues to increase, Forest Service field personnel should continue to document visitor use impacts, such as social trails, trash, and loss of sensitive alpine vegetation.

Maintain trails to preserve the natural flow of water across the landscape

Poor design and lack of maintenance of trails can impact suitability of winter and breeding habitats for southern white-tailed ptarmigan (Seglund et al., 2018b). Without proper maintenance and drainage, trails can become deeply incised. Incised trails capture and trap water from rain and snowmelt runoff which leads to altered flow patterns, accelerated erosion, and dewatering and drying out of meadows, wetlands, fens, and willow carrs that may occur downslope (Seglund et al., 2018b).

Overall, the trails of the Fossil Ridge Wilderness are in good condition and not subject to heavy use (Tobias Nickel, personal observations). Moreover, few trails traverse through or above potential habitat for southern white-tailed ptarmigan. Nevertheless, wilderness managers should remain vigilant and address trail issues in a timely manner to avoid excessive damage to natural resources.

Public Outreach and Education

Enlisting the help of the public to address the threats that human activities pose to alpine ecosystems and associated wildlife is essential. As recreation in the alpine of Colorado continues to increase, it is imperative that visitors recreate responsibly and practice minimum-impact techniques. Public

outreach materials should be posted at trailheads and information centers to educate visitors on alpine ecology and Leave No Trace principles. In particular, requirements for pet owners to keep dogs close and under voice command should be enforced to prevent harassment of southern white-tailed ptarmigan adults and chicks (Seglund et al., 2018b). Garbage may also attract predators to southern white-tailed ptarmigan habitat, and a "pack it in, pack it out" mentality should be communicated (Seglund et al., 2018b). When appropriate, rangers, volunteers, and recreationists should utilize the Authority of the Resource technique to educate others about Leave No Trace principles in a positive way that can influence behavior (Wallace, 1990). As succinctly stated by former chief of the Forest Service, Max Peterson: "Wilderness management is 80-90 percent education and information and 10 percent regulation" (quoted in Marion and Reid, 2001).

Evaluate genetic exchange and metapopulation connectivity

Metapopulation functionality may be of critical importance to maintaining a viable population of southern white-tailed ptarmigan inside the Fossil Ridge Wilderness (Giesen and Braun, 1993; Martin et al., 2000; Wilson and Martin, 2011). Genetic relationships of southern white-tailed ptarmigan in Colorado are sufficiently well-characterized to understand levels of connectivity among populations (Langin et al., 2018; Seglund et al., 2018b). However, no genetic samples from southern white-tailed ptarmigan residing inside the Fossil Ridge Wilderness have been analyzed. During field surveys, dropped feathers from southern white-tailed ptarmigan should be collected and submitted for genetic analysis to assess levels of connectivity and gene flow between the Fossil Ridge population and other regional populations. As climate change progresses, alpine areas may become smaller and less continuous, and populations of southern white-tailed ptarmigan may become increasingly isolated (Hoffman, 2006). Under these circumstances, it will be important to detect changes in the genetic makeup that may indicate inbreeding or genetic drift in southern white-tailed ptarmigan populations.

A flock of white-tailed ptarmigan in their wintering habitat (Denny Bohon, USFS).

Adaptive Management and Contingency Planning

Contingent on survey findings, evolving climate change impacts, growing recreation use, and regulatory status decisions, Forest Service and CPW staff may determine that current efforts to conserve southern white-tailed ptarmigan in the Fossil Ridge Wilderness are insufficient. However, land managers' ability to influence this subspecies is limited, and human intervention is not necessary in the alpine other than to insure that natural processes are not disrupted (Hoffman, 2006).

While wilderness designation already affords the highest level of protection to southern white-tailed ptarmigan habitat, the Fossil Ridge Wilderness is not immune to intensifying climate change impacts and growing recreation uses. Aside from the above-mentioned actions, managers may consider implementing stricter visitor use regulations and population augmentation to ensure the persistence of southern white-tailed ptarmigan inside the Fossil Ridge Wilderness.

However, these tools may be considered intrusive and contrary to the spirit of the Wilderness Act. Therefore, these conservation decisions must not be taken lightly and would require close coordination between state and federal personnel. The MRDG process and the framework proposed by Landres et al. (2020) should be used to carefully weigh the costs and benefits of intervention and ensure that actions taken are the minimum necessary for the administration of the area as wilderness.

Visitor use regulations

Rapidly increasing recreation use in the alpine of Colorado may necessitate that managers diverge from the earlier-cited maxim that wilderness management is 90 percent education and 10 percent regulation. Alpine habitats are fragile and, therefore, land managers may need to consider limiting recreation activities to make sure these areas are not being overused and damaged (Hoffman, 2006; Seglund et al., 2018b). To minimize disturbance of southern white-tailed ptarmigan and damage to their habitats, managers have several visitor use management tools at their disposal. These tools include restriction of recreation uses that are incompatible with maintaining healthy alpine ecosystems, seasonal closures of areas that provide critical habitat, backcountry permit systems, and stricter enforcement of existing regulations, among others.

Wilderness designation of the Fossil Ridge already prohibits motorized recreation. Visitor use levels in the alpine of this wilderness area also appear to be relatively low at this time. As managers continue to monitor visitor use and associated impacts, they may need to consider regulatory approaches to conserve southern white-tailed ptarmigan in the Fossil Ridge Wilderness. However, implementation of additional regulations should be a last resort after other options, such as public outreach and educational programs, to address visitor use impacts have been exhausted.

Population augmentation

Translocation of southern white-tailed ptarmigan appears to have been successful in the Pecos Wilderness in New Mexico (New Mexico Department of Game and Fish, 2016), the Uinta Mountains in Utah (Braun et al., 1978), Pike's Peak in Colorado (Hoffman and Giesen, 1983), and the Sierra Nevada in California (Braun et al., 2011). As climate change progresses and other anthropogenic impacts intensify, translocations of southern white-tailed ptarmigan to isolated alpine habitats in Colorado may be necessary to maintain locally viable populations (Seglund et al., 2018b). If

augmentation is being considered, decision processes and contingencies should be clearly spelled out and established protocols should be followed (Braun et al., 2011). At the present time, however, the Fossil Ridge population is thought to be sufficiently connected to regional populations in the Sawatch Range and elsewhere. Therefore, it is extremely unlikely that translocations of southern white-tailed ptarmigan would take place in this wilderness in the foreseeable future.

Wilderness Stewardship Considerations

Management actions within versus outside of wilderness

The first step in the MRDG process is to determine if action can be taken outside of wilderness to adequately achieve management objectives. For many wildlife species, historic, current, and desired future distributions provide management opportunities that could result in conservation gains without requiring intervention in wilderness. However, such opportunities are comparatively limited for southern white-tailed ptarmigan. Unlike many lower-elevation ecosystems, alpine areas are relatively well represented in the National Wilderness Preservation System (Joppa and Pfaff, 2009; Aycrigg et al., 2013). A predicted range model for southern white-tailed ptarmigan encompassed 7,584 km^2 or 2.8% of the state of Colorado, with 55% of the predicted range designated as Forest Service wilderness (Seglund et al., 2018b). Additional southern white-tailed ptarmigan habitat is designated as NPS and BLM wilderness and wilderness study areas, further limiting management options outside of wilderness. As a result, management of southern white-tailed ptarmigan inside wilderness may be necessary to achieve conservation gains and ensure the persistence of this priority species.

Preserving the natural quality of wilderness character

Alpine areas represent a significant portion (~25%) of the Fossil Ridge Wilderness. Therefore, alpine-obligate species, such as southern white-tailed ptarmigan, are an integral component of this area's wilderness character. If this iconic bird became locally extinct, the natural quality of the Fossil Ridge Wilderness would be permanently diminished. To preserve southern white-tailed ptarmigan, its habitats, and associated species, agency staff must work together to limit disturbances in the alpine and manage toward a shared vision for southern white-tailed ptarmigan conservation.

Impacts to the untrammeled quality of wilderness character

While actions taken to conserve southern white-tailed ptarmigan would benefit the natural quality, some actions may also constitute a deliberate human intervention in the biophysical environment, thus affecting the untrammeled quality of wilderness character. In particular, actions such as banding birds, equipping them with radio-collars, collecting blood samples, and capture and translocation may be considered trammeling actions. These actions may require approval through the MRDG process and trade-offs should be considered, evaluated, and communicated prior to implementation. Further information on trammeling actions are contained in Appendix B.

Unconfined recreation

Wilderness provides outstanding opportunities for unconfined recreation in an environment that is relatively free from the encumbrances of modern society (Wilderness Act, Section 2c). Unconfined recreation refers to types of recreation in which visitors experience a high degree of freedom over their own actions and decisions without having to conform to society's norms or rules (Landres et al.,

2019). Management restrictions on visitor behavior, such as area closures or use limits, are likely to degrade opportunities for unconfined recreation. As managers consider adopting new regulations to protect resources in wilderness, the relative degree of imposition or inconvenience of visitor management restrictions should be considered.

Traditional tools and skills

The wilderness program of the Forest Service, Gunnison Ranger District has a track record of valuing the maintenance of traditional skills. A component of this strategy is to continue seeking opportunities to build on this success by completing fish and wildlife conservation achievements with the use of traditional tools and skills. Actions to study and manage white-tailed ptarmigan would be accomplished on foot and are unlikely to involve any prohibited uses. In particular, surveying for southern white-tailed ptarmigan requires staff to practice traditional skills of route-finding and off-trail travel in remote alpine settings. Trail maintenance work to preserve southern white-tailed ptarmigan habitat would also be accomplished using traditional tools.

Effectiveness Monitoring

Given the importance of adaptive management to minimize trammeling actions in wilderness, the following monitoring questions will be considered when evaluating the effectiveness of conservation actions to conserve southern white-tailed ptarmigan in the wilderness. Where possible, these questions will be considered in the context of the ongoing wilderness character monitoring strategy for the Fossil Ridge Wilderness (Warnick, 2016).

- What are trends in occupancy of southern white-tailed ptarmigan at selected sites in the Fossil Ridge Wilderness? What are trends in demographic parameters (abundance, survival, recruitment, and sex ratios) of southern white-tailed ptarmigan populations in the wilderness?
- What proportion of basins and surrounding ridgelines have been surveyed for southern white-tailed ptarmigan presence and evaluated for habitat suitability?
- What are trends in southern white-tailed ptarmigan habitat suitability? How are changes in vegetative succession, ungulate browsing, livestock grazing, recreation, and climate change affecting habitat suitability? Have any additional historic mining sites been documented?
- What are visitor use trends in the Fossil Ridge Wilderness? To what extent are human-induced disturbances from recreation impacting southern white-tailed ptarmigan? Are opportunities to educate visitors about alpine ecology and Leave No Trace being pursued?
- What are trends in trail conditions? Are trail maintenance issues addressed in a timely manner to avoid the dewatering and drying out of meadows, wetlands, and willow carrs?
- What are trends in connectivity and gene flow between southern white-tailed ptarmigan in the Fossil Ridge Wilderness and nearby populations?
- How much sampling effort was invested (e.g., staff hours spent, number of sites surveyed) to evaluate current distribution, demographic parameters, genetic status, and habitat suitability for southern white-tailed ptarmigan inside the Fossil Ridge Wilderness?
- What are trends in coordination between state and federal agencies and other parties with an interest in southern white-tailed ptarmigan conservation? Are opportunities for collaborative research and stewardship being pursued?

Wilderness Management Strategy – Colorado River Cutthroat Trout

Introduction

The Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*) presently occurs in Colorado, Utah, and Wyoming and has been extirpated from Arizona and New Mexico (Hirsch et al., 2013). In addition to greenback cutthroat trout (*O. c. stomias*), Rio Grande cutthroat trout (*O. c. virginalis*), and the presumed to be extinct yellowfin cutthroat trout (*O. c. macdonaldi*), Colorado River cutthroat trout is one of four subspecies of trout native to Colorado, and likely the only subspecies native to Colorado's Western Slope (Behnke, 1992, 2002; Metcalf et al., 2012).

Recent genetic investigations have increased our understanding of the relatedness of populations of Colorado River cutthroat trout and its close relatives. (Metcalf et al., 2007, 2012; USFWS, 2014a; Bestgen et al., 2019). As tools have become available to differentiate between lineages of cutthroat trout, our understanding of cutthroat trout taxonomy has greatly increased with distinct lineages identified representing most major river basins where warmer water does not allow exchange between groups of cutthroat trout. Metcalf et al. (2012) identified two extant, distinct lineages that comprise Colorado River cutthroat trout: the blue lineage, thought to be native to the Upper and Lower Green and Yampa and White River basins; and the green lineage, assumed to be native to the Colorado Headwaters, Upper Colorado-Dolores, and Gunnison basins (Metcalf et al., 2012; Fig. 9). In addition, a team of biologists recently discovered relict populations of a third lineage of Colorado River cutthroat trout native to the San Juan River basins (CPW, 2018).

In the past, morphological analysis (Behnke, 1992, 2002) indicated that the green lineage represented the federally threatened greenback cutthroat trout, which is assumed to be native to drainages east of the Continental Divide. The greenback cutthroat trout was declared extinct by 1937, but several relict populations were thought to be discovered in the 1950s (USFWS, 1998a; Young, 2009). However, widespread stocking of salmonids – which occurred prior to the genetic research (Metcalf et al., 2012) that helped clarify the historic ranges of different cutthroat trout lineages in Colorado – has led to introgressive hybridization in greenback cutthroat trout populations (Houston et al., 2012). As a result, all populations of greenback cutthroat trout, except for a single population in Bear Creek of the Arkansas River Basin, are now considered to be Colorado River cutthroat trout (Metcalf et al. 2007, 2012; USFWS, 2014b; Bestgen et al., 2019).

Because the green lineage Colorado River cutthroat trout was formerly assumed to represent the greenback cutthroat trout, this lineage was given interim protection under the Endangered Species Act. However, subsequent genetic research revealed that the green lineage is genetically distinct from greenback cutthroat trout (Metcalf et al. 2007, 2012; USFWS, 2014b; Bestgen et al., 2019). As a result, the USFWS decided to retract interim protection in April of 2020.

Ongoing research efforts are underway to help clarify the taxonomy of the Colorado River cutthroat trout (e.g., Trotter et al., 2018). Decisions have yet to made about whether genetically distinct lineages will be managed as genetic variability within the Colorado River cutthroat trout subspecies or whether new subspecies will be named. As genetic research continues, our understanding of cutthroat trout taxonomy keeps evolving, with potential regulatory status and conservation

implications in the future. A status assessment for green lineage Colorado River cutthroat trout has not yet been conducted, and a petition to list this lineage under the Endangered Species Act remains a possibility.

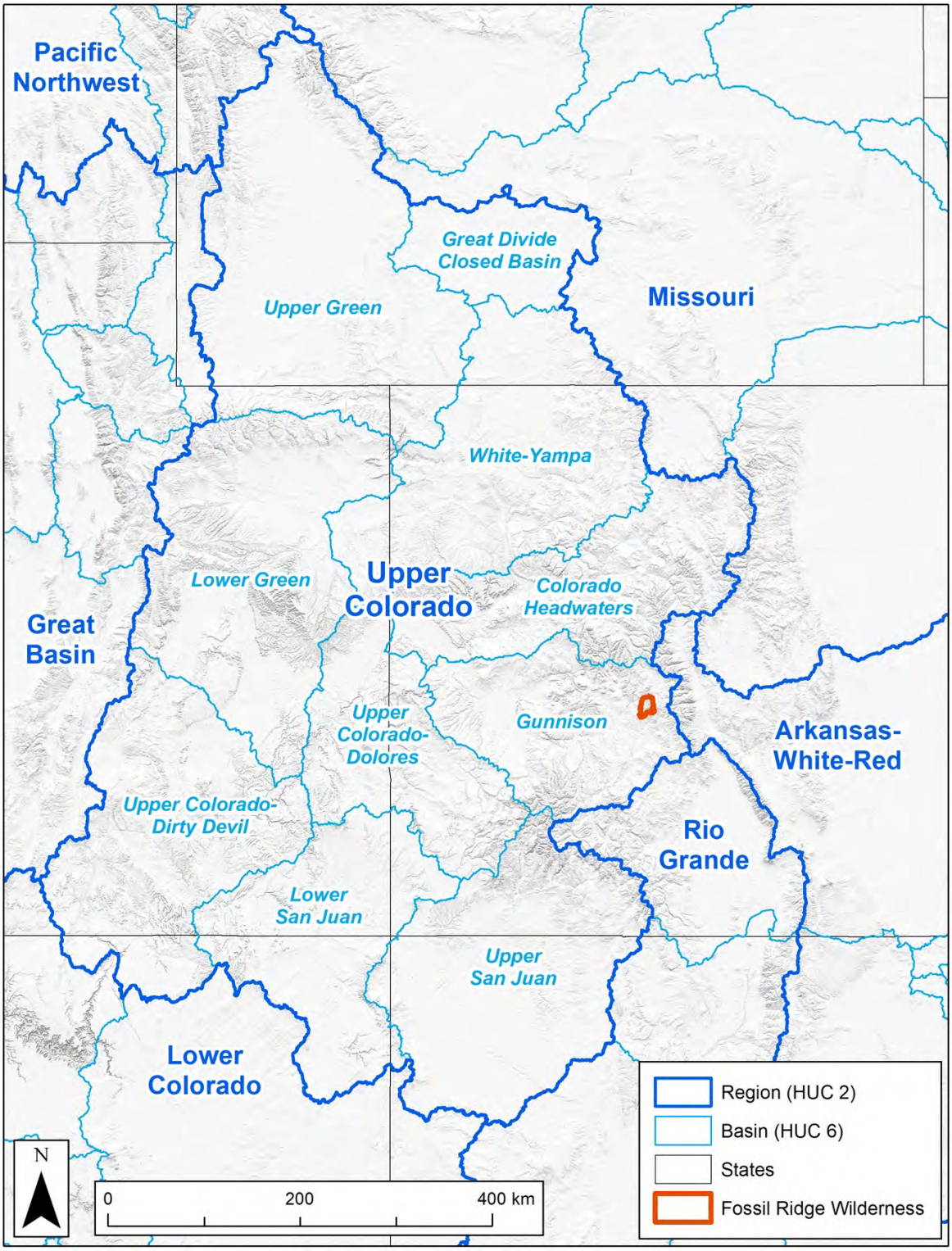


Figure 9. Basins of the Upper Colorado Region. (Map by Tobias Nickel, September 15, 2020)

Regardless of eventual taxonomic and regulatory status decisions, Colorado River cutthroat trout (blue and green lineages) remains a top conservation priority. The subspecies occupies only 7% of its historic range in Colorado (Hirsch et al., 2013) and is listed as a Tier 1 Species of Greatest Conservation Need (CPW, 2015). Both lineages are also identified as Sensitive Species by the Forest Service, Rocky Mountain Region (Forest Service, 2018g). A conservation agreement and strategy were developed for Colorado River cutthroat trout in 2006 (CRCT Conservation Team, 2006a and 2006b). The Forest Service is a signatory to the conservation agreement and participated in the development of the conservation strategy.

Threats to Colorado River cutthroat trout are manifold. Stocking of non-native salmonids, which has been a widespread practice across much of the American West since the 1880s, may have had the greatest impact on Colorado River cutthroat trout (Young, 2008; Hirsch et. al, 2013). Non-native salmonids affect native cutthroat trout through introgressive hybridization, food and space competition, and predation (CRCT Conservation Team, 2006b; Hirsch et al., 2013). For example, non-native rainbow trout (*Oncorhynchus mykiss*) inter-breed with Colorado River cutthroat trout, thus reducing the genetic integrity of the subspecies through back-crossing which creates hybrid swarms (Weigel et al., 2003; CRCT Conservation Team, 2006a; McKelvey et al. 2016). In another example, juvenile brook trout (*Salvelinus fontinalis*) have been found to be superior competitors when in sympatry with juvenile cutthroat trout, resulting in decreased recruitment into the cutthroat trout population and eventual extirpation (Peterson et al., 2004).

While introductions of non-native salmonids into existing populations of native trout by State and Federal fish and wildlife agencies have ceased, non-native salmonids have become established throughout much of the historic range of Colorado River cutthroat trout (Young, 2008; Hirsch et. al, 2013). Moreover, non-native salmonids invading from downstream and illegal fish stockings by private organizations or individuals continue to be a concern (CRCT Conservation Team, 2006b).

In addition, Colorado River cutthroat trout populations are adversely impacted by land management activities that affect aquatic and riparian habitat, including livestock and grazing management, mineral extraction, road construction, timber harvest, and water developments (CRCT Conservation Team, 2006b; Young, 2008; Hirsch et. al, 2013). Activities such as grazing, road construction, and timber harvest can increase erosion and instream sedimentation (Dunne and Leopold, 1978; Reid and Dunne, 1984; Potyondy and Geier, 2011). Because almost all trout spawn in clean gravel beds (redds) of well oxygenated gravel bars, instream sedimentation can clog the interstitial spaces between coarse gravel, thereby suffocating eggs or fry hidden there (Platts and Megahan, 1975; Cederholm, 1981). Additionally, sedimentation can have a similar effect on aquatic macro-invertebrates which are the primary food source for montane salmonids (Behnke, 2002).

Colorado River cutthroat trout are also susceptible to whirling disease (*Myxobolus cerebralis*) (Thompson et al., 1999), which can be transmitted to them by hatchery-reared salmonids or anglers wearing waders and wading boots laden with infected sediment (Bartholomew and Reno, 2002; Gates et al., 2008). Due to higher gradient, cold water, and lack of organic matter, habitat currently inhabited by Colorado River cutthroat trout is generally not optimal for most lineages of tubifex worms (*Tubifex tubifex*), which are essential to the life history of the whirling disease parasite (Ayre

et al., 2014). However, tubifex worms (specifically, pure lineage III populations) have been documented in high-elevation lakes and streams in Colorado (Nehring et al., 2014). Nehring et al. (2014) postulate that risk of establishment of whirling disease is high for aquatic habitats where cutthroat trout and lineage III tubifex worms are sympatric, resulting in potentially adverse effects on Colorado River cutthroat trout populations.

Climate change also presents a threat to the long-term persistence of Colorado River cutthroat trout populations throughout their range (Young, 2008; Haak et al., 2010; Neely et al., 2011; Wenger et al., 2011; Hirsch et al., 2013; Roberts et al., 2013). In addition to predicted increases in disturbance events like wildfire and landslides, rising stream temperatures have the potential to negatively affect native cutthroat trout (Haak et al., 2010; Wenger et al., 2011; Roberts et al., 2013). Colorado River cutthroat trout require water temperatures that do not exceed 26.0 °C and reach optimal growth and recruitment when summer water temperatures range between 9.0 and 18.0 °C (Roberts et al., 2013).

To plan for changes in thermal regimes of aquatic ecosystems, the Forest Service's Rocky Mountain Research Station has built predictive stream temperature models for several climate change scenarios (Isaak et al., 2017). Model outputs suggest that many stream segments may become too warm to support native cutthroat trout. Conversely, high-elevation streams that are too cold for cutthroat trout currently could become suitable if stream temperatures continue to rise. As a result, high-elevation streams could serve as cold-water thermal refugia for native cutthroat trout and increase the long-term resiliency of this subspecies to climate change.

Boulder Lake, immediately south of the wilderness boundary. (Tobias Nickel, July 10, 2020)

Current Status in the Fossil Ridge Wilderness

There are approximately 37 conservation populations of Colorado River cutthroat trout on the GMUG National Forest (Forest Service, 2018a). The *Conservation Strategy for Colorado River Cutthroat Trout* (CRCT Conservation Team, 2006b) defines a conservation population as "a naturally reproducing and recruiting population of native Colorado River cutthroat trout that is managed to preserve the historical genome and/or unique genetic, ecological, and/or behavioral characteristics." Populations are further defined by quantifying genetic introgression. In general, a conservation population is identified as containing at least 90% Colorado River cutthroat trout genes.

The majority of conservation populations on the GMUG National Forest are green lineage Colorado River cutthroat trout. Combined, blue and green lineage populations occupy over 120 stream miles within the GMUG National Forest (Forest Service, 2018a). Watershed area of streams occupied by these populations is over 250 square miles, about 5 percent of the total area of the forest. Trends for 11 conservation populations have been assessed based on sampling efforts between 1999 and 2016. Forest-wide native cutthroat trout were found to be stable, with an equal number of populations experiencing increases and declines in abundance over this period (Forest Service, 2018a).

The high-elevation lakes of the Fossil Ridge Wilderness have been stocked with salmonids since at least 1952 (Daniel Brauch, CPW, Fisheries Biologist, personal communication). The possibility for an outbreak of whirling disease in fish populations used by CPW to stock this region forced a halt in stocking operations from 1995 through 2000 (CPW, 2020d). A polymerase chain reaction (PCR) test was subsequently developed to screen fish from state hatcheries for whirling disease prior to stocking (Andree et al., 1998). Since 2001, CPW has biannually stocked blue lineage Colorado River cutthroat trout in the lakes of the Fossil Ridge Wilderness, including Crystal, Henry, Upper and Lower Lamphier, and Mill lakes (CPW, 2020d).

While Colorado River cutthroat trout are stocked, no conservation populations have been identified inside the Fossil Ridge Wilderness. Crystal Creek has naturally reproducing cutthroat trout present but sampling in 2009 revealed that this population is significantly hybridized (98%) with Yellowstone cutthroat trout (*O. c. bouvieri*) (Daniel Brauch, CPW, Fisheries Biologist, personal communication). This is likely due to historic stocking of Snake River fine-spotted cutthroat trout (which are considered a variety of Yellowstone cutthroat trout) as well as "Pikes Peak native cutthroat trout" which are a hybridized cutthroat trout (Colorado River x Yellowstone) (Daniel Brauch, CPW, Fisheries Biologist, personal communication). It is worth noting that Crystal Creek continues for approximately 5-6 miles above the sampling site (UTM: E354570, N4287271). If a natural barrier (at least a 4 to 6 foot waterfall) to fish migration exists, it is possible that there could be a population of pure Colorado River cutthroat trout further upstream. In addition to Crystal Creek, survey crews also sampled fish in Lottis Creek (1973, 1979, 1990, and 2016) and South Lottis Creek (1986), but only non-native trout were detected in these streams (Daniel Brauch, CPW, Fisheries Biologist, personal communication).

Crystal Creek flowing through dense stands of remote, rarely visited forest. (Tobias Nickel, July 5, 2020)

Management Objectives

1. Assess vulnerability of Colorado River cutthroat trout to climate change
2. Survey potential recovery streams
3. Identify natural barriers to fish migration
4. Evaluate need and feasibility of establishing a conservation population of Colorado River cutthroat trout in the cold-water refugia that is the Fossil Ridge Wilderness under future climate change scenarios
5. Monitor watershed conditions
6. Maintain high quality angling opportunities
7. Coordinate and cooperate with CPW to:
    a. Identify and manage toward a shared vision of Colorado River cutthroat trout conservation in the Fossil Ridge Wilderness
    b. Share fish stocking schedules and end-of-year stocking reports
    c. Prioritize trout indigenous to the Western Slope for fish stockings
    d. Support CPW's fish and wildlife objectives, to the extent such objectives are consistent with the Wilderness Act
    e. Renew MOU between Forest Service, Region 2 and CPW
    f. Minimize impacts to wilderness character
8. Achieve the above objectives with minimal adverse impacts to wilderness character
    a. To the extent possible, allow natural processes to unfold without human intervention
    b. Integrate principles of adaptive management and monitor the effectiveness of actions implemented to guide subsequent work and minimize trammeling
    c. Utilize the MRDG as an analytical tool to evaluate all administrative proposals that could potentially affect wilderness character

Colorado River cutthroat trout. (Photo © Alyssa Anduiza, courtesy of Aspiring Wild)

Management Recommendations

Coordination between CPW and U.S. Forest Service on fish stocking activities

Consistent with the AFWA (2006) Policies and Guidelines and the now expired MOU (Forest Service and CPW, 2015), the state and federal agencies will continue to coordinate and cooperate on fish stocking activities taking place inside the Fossil Ridge Wilderness. Staff from CPW will make fish stocking schedules available to the Forest Service, so that, in any given year, the line officer will know which lakes will be stocked with what species, in what numbers, and by what means. The line officer will work with CPW staff to identify mitigation measures to protect wilderness character and to minimize effects to the public. Fish that are indigenous to the Gunnison Basin will be prioritized for stocking inside the Fossil Ridge Wilderness whenever practicable.

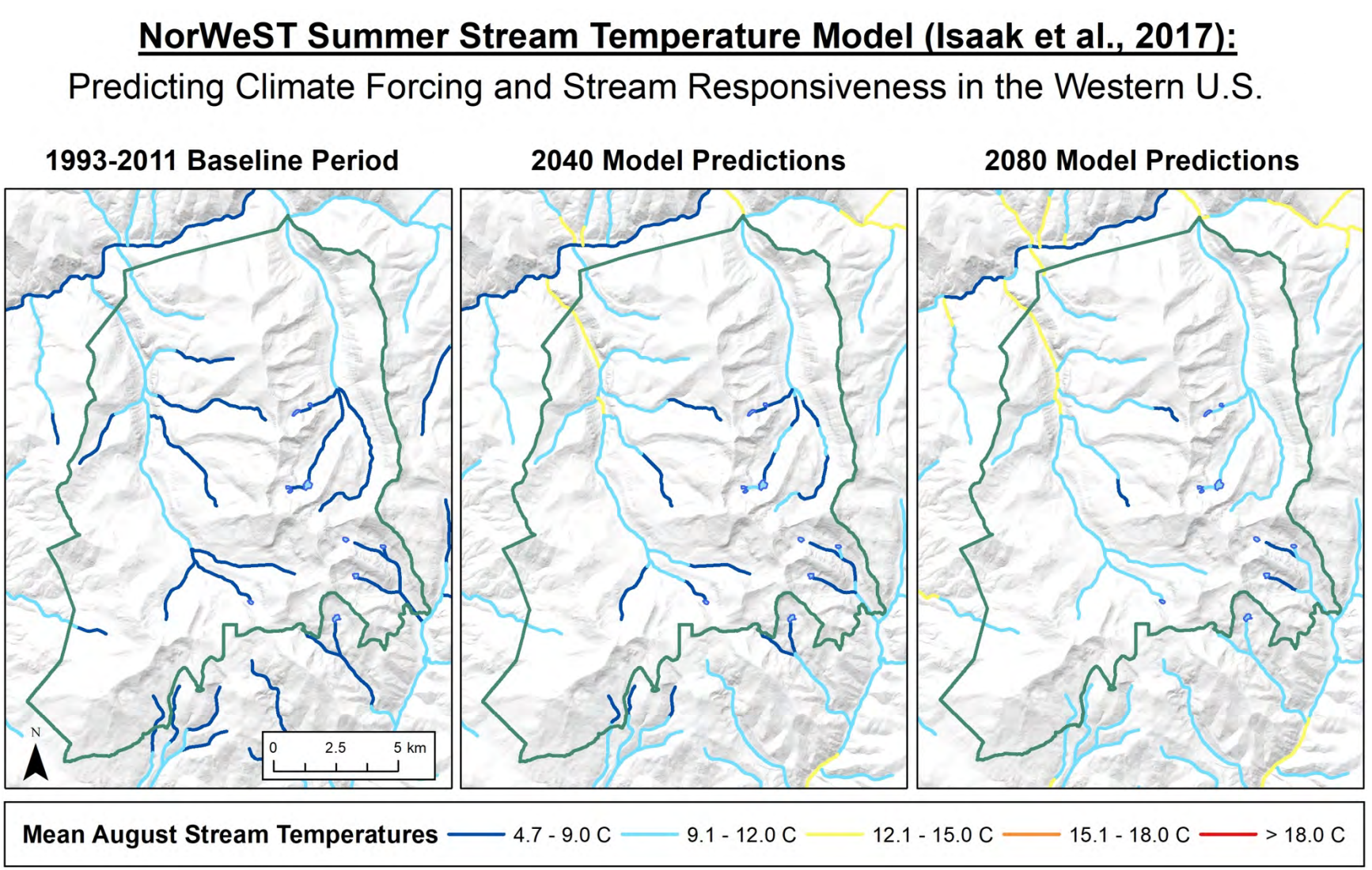
Renew MOU between Forest Service, Region 2 and CPW

The Forest Service, Rocky Mountain Region entered into an MOU with CPW in 2015. The MOU was effective through December 31, 2017. While this MOU guides collaboration between the Forest Service and CPW applicable to all fish and wildlife populations and their habitats inside the Fossil Ridge Wilderness, it is particularly relevant to the management of Colorado River cutthroat trout. Fish stocking inside wilderness has historically been a source of controversy, and a formal agreement would help facilitate collaboration between the two agencies and clarify what is and is not permissible in wilderness. In addition, renewing the MOU would raise WSP scores by 2 points for federally designated wilderness areas in Colorado that have selected the Fish and Wildlife Element.

Note: Renewal of the MOU needs to be addressed at the regional level and is outside the control of local wilderness managers. Collaboration between CPW and the Forest Service, Gunnison Ranger District must continue regardless and should rely as much as possible on the expired MOU as well as the AFWA (2006) guidelines and policies.

Assess vulnerability of Colorado River cutthroat trout to climate change

As discussed earlier, climate change presents a threat to the long-term survival of Colorado River cutthroat trout populations throughout their range (Young, 2008; Haak et al., 2010; Neely et al., 2011; Wenger et al., 2011; Hirsch et al., 2013; Roberts et al., 2013). Stream temperature models (Isaak et al., 2017) predict that some stream segments on the GMUG National Forest may become too warm to support native cutthroat trout under future climate change scenarios. High-elevation streams, such as Crystal and South Lottis creeks in the Fossil Ridge Wilderness, could serve as cold-water refugia for native cutthroat trout (Fig. 10). Using regional climate models and Colorado River cutthroat trout habitat requirements, the long-term viability of existing conservation populations should be assessed. In addition, stream segments that potentially serve as thermal refugia for native cutthroat trout populations should be delineated. Such a climate change vulnerability and habitat suitability assessment could be accomplished in collaboration with aquatic biologists from CPW, students from Western Colorado University, and/or other interested parties and partner organizations (e.g., Rocky Mountain Biological Laboratory, Trout Unlimited, Backcountry Hunters & Anglers).



Note: Colorado River cutthroat trout have been documented to reach optimal growth and recruitment when summer water temperatures range between 9.0 and 18.0 °C (Roberts et al., 2013). Stream temperatures depicted for 2040 and 2080 are simulated for the A1B emissions scenario from the 2007 IPCC report.

Figure 10. Model predictions of summer stream temperatures for the Fossil Ridge Wilderness. (Maps by Tobias Nickel, August 5, 2020)

Survey potential recovery streams

Streams should be evaluated for their capacity to support Colorado River cutthroat trout populations. In a study of isolated cutthroat trout populations, Hilderbrand and Kershner (2000) found that five miles of stream habitat provided enough space to support robust populations with a high likelihood of long-term persistence. While some more recent research (Peterson et al., 2013) suggests that cutthroat trout can persist in smaller habitat patches, only Crystal and South Lottis creeks would likely warrant in-depth consideration as potential recovery sites for native cutthroat trout.

Potential recovery streams should be surveyed using backpack electrofishing to assess resident fish populations. The parameters from the climate vulnerability and habitat suitability assessment should be ground-truthed. Additional criteria (e.g., cold, clean water, ability to support trout year round through all life stages, adequate food base) that each recovery stream must meet should also be developed and monitored whenever practical.

Identify natural barriers to fish migration

Natural barriers to fish migration consist primarily of bedrock waterfalls (Evans and Johnston, 1980; Powers and Osborn, 1985). The ability of fish to disperse upstream is affected by physical parameters (slope and height of the barrier), hydraulic conditions (velocity and depth of plunge pools approaching the barrier) and the jumping abilities of fish species during migration (Kondratieff and Myrick, 2006; Reiser et al., 2006; Meixler et al., 2009; Timm et al., 2016). In general, waterfalls in the Fossil Ridge Wilderness likely need to meet a minimum threshold of 4-6 feet in height to be considered a potential barrier that prevents non-native salmonids from invading upstream (Daniel Brauch, CPW, Fisheries Biologist, personal communication).

Survey crews sampling fish community composition should document such natural barriers that have the potential to obstruct fish passage. Alternatively, Forest Service and CPW staff and/or volunteers (e.g., students from Western Colorado University) could systematically record the presence of such barriers by hiking the length of potential recovery streams. If natural barriers are identified, waters upstream should be considered for surveying to determine if a pure, self-sustaining Colorado River cutthroat trout population exists. Such survey needs should be brought to the attention of Colorado River cutthroat trout recovery team for further evaluation during their annual workshop.

Monitor watershed conditions

Managing for Colorado River cutthroat trout at the watershed level is critical to maintaining ecological functions and processes that sustain this species and avoiding adverse impacts to aquatic habitats (CRCT Conservation Team, 2006b). The Forest Service has developed a framework to assess watershed condition based on a set of 12 indicators, including water quality, water quantity, aquatic habitat, aquatic biota, roads and trails, soils, riparian/wetland vegetation, fire regime or wildfire, forest cover, rangeland vegetation, terrestrial invasive species, and forest health (Forest Service, 2011b). Overall watershed health or integrity is reported in terms of watershed condition classes, ranging from class 1 (functioning properly) to class 3 (impaired function).

The Fossil Ridge Wilderness lies within the Gunnison Basin of the Upper Colorado Region (Fig. 9). The wilderness spans portions of the Taylor River and Quartz Creek watersheds, including six

subwatersheds: Lottis, Crystal, Beaver, Gold, and Alder Creeks and Lower Taylor River (Fig. 11). Watershed baseline conditions established in 2011 indicate that all subwatersheds overlapping the wilderness are functioning properly, except for the Gold Creek subwatershed, the function of which was determined to be at risk (Forest Service, 2013). However, conditions vary between indicators (Table 2). Additionally, the classifications and indicator ratings are semi-quantitative and are based on professional judgement (Forest Service, 2011b; Landres et al., 2019). In many cases, ground-truthing and local verification are necessary to improve data quality. Monitoring of indicators and condition class ratings for each watershed is planned at five-year intervals (Forest Service, 2011a).

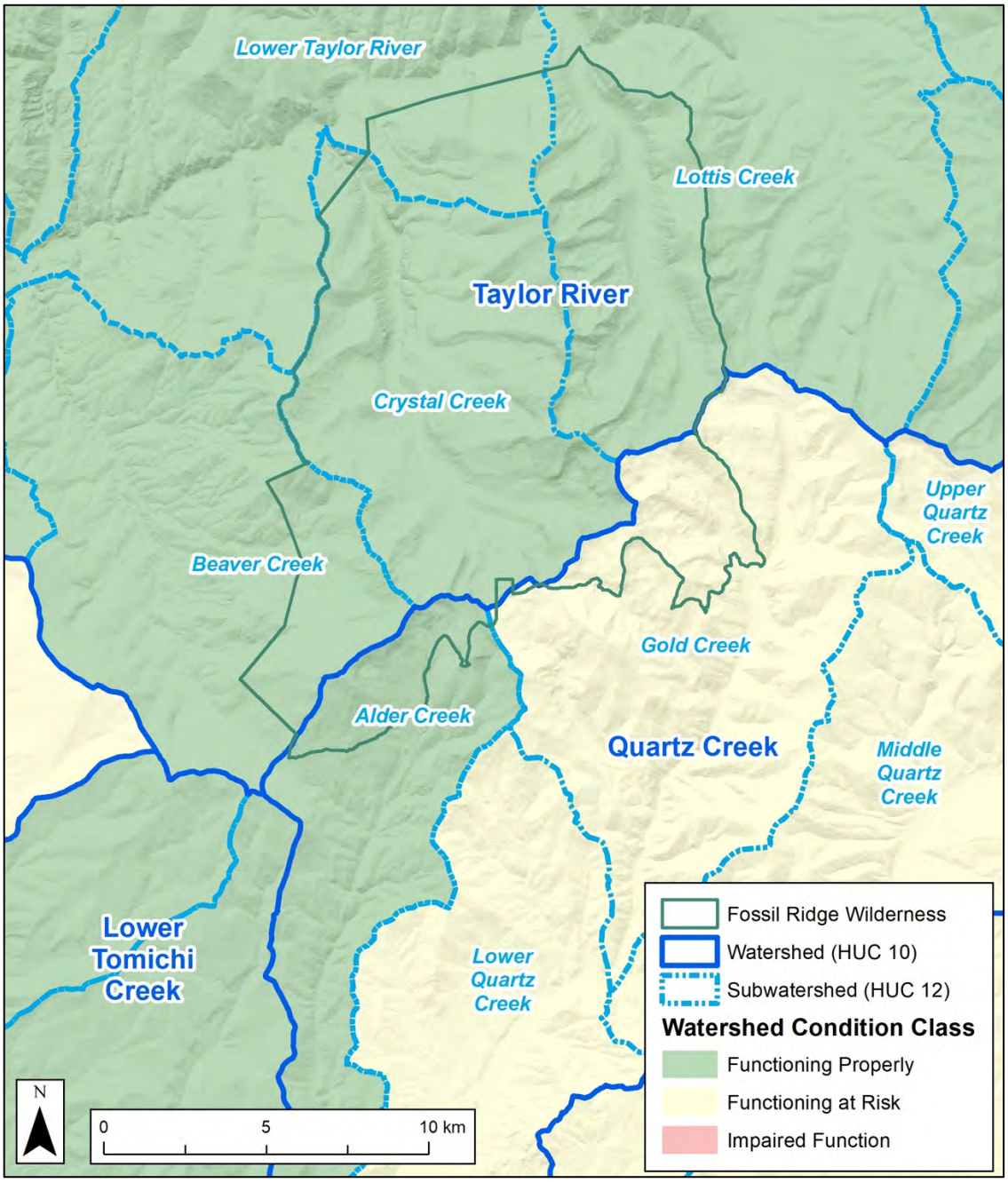


Figure 11. Watershed conditions for the Fossil Ridge Wilderness. (Map by Tobias Nickel, Sept. 16, 2020)

Table 2. Watershed condition classes and indicators for the Fossil Ridge Wilderness.

Watershed[a]	WCC[b]	Water Quality	Water Quantity	Aquatic Habitat	Aquatic biota	Riparian or wetland vegetation	Roads and Trails	Soils	Fire Regime or Wildfire	Forest Cover	Rangeland Vegetation	Terrestrial Invasive Species	Forest Health
Lottis Creek	Good	Good	Good	Fair	Poor	Fair	Fair	Good	Good	Good	Good	Good	Fair
Crystal Creek	Good	Good	Good	Good	Poor	Good	Good	Good	Good	Good	Good	Good	Fair
Beaver Creek	Good	Good	Good	Fair	Poor	Fair	Fair	Good	Fair	Good	Good	Good	Fair
Lower Taylor River	Good	Good	Fair	Fair	Poor	Good	Fair	Good	Fair	Good	Good	Good	Fair
Gold Creek	Fair	Good	Good	Poor	Poor	Fair	Fair	Good	Good	Good	Good	Good	Fair
Alder Creek	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Good	Good	Good	Fair

[a] The units of analysis are 6th level hydrologic unit code (HUC) watersheds from the USGS watershed boundary dataset. The 6th level units are also referred to as subwatersheds contained within larger 5th level watersheds. For future reference, the HUCs for the listed subwatersheds are: Lottis Creek = 140200010108; Crystal Creek = 140200010109; Beaver Creek = 140200010112, Lower Taylor River = 140200010113; Gold Creek = 140200030302; and Alder Creek = 140200030304.

[b] Watershed Condition Class (WCC) definitions: class 1 (good) = functioning properly, class 2 (fair) = functioning at risk, class 3 (poor) = impaired function. Additional information is available in the *Watershed Condition Classification Technical Guide* (Forest Service, 2011b).

Note: the watershed condition class and indicator rating are assessed for entire 6th level HUC subwatersheds. However, subwatershed boundaries often extend beyond the wilderness boundary (Fig. 11), and conditions outside of wilderness may drive the condition class and indicator rating listed for a given subwatershed.

Data source: All data were obtained from the watershed condition class geospatial layer retrieved from the FSGeodata Clearinghouse (Forest Service, 2013).

Adaptive Management and Contingency Planning

Contingent on findings from surveying efforts, the climate vulnerability and habitat suitability assessment, and evolving taxonomic and regulatory status decisions, Forest Service and CPW staff may determine that additional actions are warranted to manage Colorado River cutthroat trout inside the Fossil Ridge Wilderness. However, the options outlined below may be considered intrusive and contrary to the spirit of the Wilderness Act. Therefore, these management decisions must not be taken lightly and would require close coordination between state and federal personnel. The MRDG process and the framework proposed by Landres et al. (2020) should be used to carefully weigh the costs and benefits of ecological intervention and ensure that actions taken are the minimum necessary for the administration of the area as wilderness.

Instream fish barrier(s)

If a decision is made to establish a conservation population in the Fossil Ridge Wilderness, potential recovery streams should be surveyed for natural fish barriers as discussed above. If natural barriers are deemed insufficient, artificial fish barriers may be necessary to prevent non-native salmonids from invading upstream (CRCT Conservation Team, 2006b). Suitable sites for barrier construction should be identified on potential recovery streams outside of wilderness whenever feasible.

Mechanical or chemical treatment (removal) of non-native species

If a recovery stream has been selected as suitable for Colorado River cutthroat trout restoration and possesses a barrier but is currently occupied with non-native fish, it may need to be treated either mechanically or chemically. Mechanical treatment would involve electrofishing targeting all non-native fishes for removal. This method is labor-intensive and is only effective under certain conditions (small streams, low structural complexity, no deep pools, etc.). Given the complex and remote drainages of the Fossil Ridge Wilderness and the goal of eradication of non-native species, chemical treatment may be required (CRCT Conservation Team, 2006b). Chemical treatment is accomplished through the application of an approved piscicide (e.g., Rotenone) to the stream at prescribed concentrations. The piscicide is then neutralized downstream using potassium permanganate. In the event of chemical treatment, macroinvertebrates should be monitored pre- and post-treatment, with Colorado River cutthroat trout translocation occurring after macroinvertebrates have recovered.

Establish recovery population

Colorado River cutthroat trout (green-lineage, if feasible) reared at a fish hatchery are stocked in the recovery stream. To limit mortality and morbidity rates, fish transport is accomplished utilizing pure oxygen in stocking bags with ice to keep bags cool. Fish may be transported by packstock, backpack, or aircraft (whichever method constitutes the minimum tool to meet conservation objectives).

Maintain genetic purity

Stream segments selected for restoration are stocked with native Colorado River cutthroat trout that have been determined to be genetically unaltered. To prevent hybridization, non-native salmonids must be eradicated in the recovery stream prior to translocation and fish barriers need to be in place to prevent future invasions from downstream (CRCT Conservation Team, 2006b).

Monitor recovery population

Colorado River cutthroat trout populations are monitored every three years at a minimum. Monitoring is typically accomplished by backpack electrofishing in multiple sites throughout the recovery population. Stocked populations of Colorado River cutthroat trout are considered restored when natural recruitment has sustained them for ten years (CRCT Conservation Team, 2006b).

Augment recovery population

Recovery populations that have been negatively impacted by stochastic events such as wildfire or landslides may be considered for augmentation with genetically unaltered Colorado River cutthroat trout (from the same lineage as was stocked previously) from a fish hatchery. Fish may be transported by packstock, backpack, or aircraft, as deemed appropriate.

Public Outreach and Education

Enlisting the help of the public to prevent the introduction of invasive species, diseases, and illegal fish stocking is essential (CRCT Conservation Team, 2006b). Public outreach materials should be posted at trailheads and information centers to raise awareness about the Colorado River cutthroat trout recovery project, educate visitors on proper sanitation to reduce the spread of whirling disease, and encourage catch-and-release in the area.

Expansive northward vistas enjoyed from the crest of the Fossil Ridge. In the foreground, the waters of Crystal Lake shimmer near the base of Henry Mountain. Beyond that, the forested ecosystems of the Crystal Creek drainage basin stretch for many miles of rugged, rarely visited wilderness. In the far distance, the snow-capped peaks of the Elk Mountains adorn the horizon. (Tobias Nickel, July 11, 2020)

Top: Mill Lake (Tobias Nickel, September 21, 2020); bottom: Henry Lake (Tobias Nickel, July 16, 2020).

Wilderness Stewardship Considerations

Management actions within versus outside of wilderness

Given the historic, current, and desired future distribution of Colorado River cutthroat trout, there are numerous management opportunities on the GMUG National Forest that could result in conservation gains for the species without requiring intervention inside wilderness (Forest Service, 2018a). If sufficiently robust conservation populations of Colorado River cutthroat trout are present outside of wilderness, then it would be preferable to continue monitoring and augmenting these populations rather than establishing a new conservation population inside wilderness. However, future changes in thermal regimes of lower-elevation streams may require translocation of cutthroat to suitable high-elevation streams (Roberts et al, 2013; Isaak et al., 2017). Subject to taxonomic classification and regulatory status decisions, there may be scenarios where establishing a conservation population of Colorado River cutthroat trout in the Fossil Ridge Wilderness becomes necessary to ensure the persistence and recovery of this subspecies.

Fish stocking

Historically, in several areas of the National Wilderness Preservation System, fish stockings have been a source of controversy between land managers and public groups. Some state wildlife managers support traditional recreation use, some federal wilderness managers assert that stocking compromises some of the ecological and social values of wilderness, and different public groups that support one or the other position (Landres et al., 2001). Given the range of opinions and differing management goals, it is important to clarify current policies that guide fish stocking activities.

A formal agreement (AFWA, 2006) was entered into by the Forest Service, BLM, and AFWA representing the states to provide guidance for the management of fish and wildlife resources in wilderness. On the topic of fish stocking, the agreement states, "state agencies may continue to stock those waters traditionally stocked prior to wilderness designation." It further specifies, "aerial stocking of fish shall be permitted for those waters in wilderness where this was an established practice before wilderness designation." In addition, the AFWA (2006) agreement establishes that federally threatened or endangered species and indigenous species must be prioritized for stocking in wilderness. Lastly, currently unstocked, fishless waters may only be stocked with the approval from the federal land management agency.

Following the signing of the AFWA (2006) agreement, the Federal agencies agreed to enter into individual agreements with states in order to make AFWA guidelines as relevant to individual states as possible. To this end, the Forest Service, Rocky Mountain Region entered into a MOU with CPW (2015). The MOU affirms that "fish stocking is allowed where it was established prior to wilderness designation by means that were traditionally used." This includes aerial stocking of fish where this was an established practice prior to wilderness designation.

The Fossil Ridge Wilderness was designated under the Colorado Wilderness Act of 1993. CPW has been stocking the high-elevation lakes of the Fossil Ridge Wilderness since at least 1952. While no stocking records are available prior to 1952, stocking almost likely occurred even prior to that time (Daniel Brauch, CPW, Fisheries Biologist, personal communication). Therefore, the well-established

practice of stocking the lakes of the Fossil Ridge Wilderness with fish is allowed to continue, as explicitly stated in the cooperative agreements entered into by the Forest Service (AWFWA, 2006; Forest Service and CPW, 2015).

That being said, fish stocking is an act of trammeling and intentional manipulation of natural systems and processes. Introducing a top predator has the potential to have unintended consequences and significantly alter natural selection pressures. For example, a study of 2,200 lakes in the John Muir Wilderness and Kings Canyon National Park concluded that fish stocking had an adverse effect on native biota, especially amphibians (Knapp and Matthews, 2000).

Bahls (1992) found that more than 95% of nearly 16,000 high-elevation western lakes were historically fishless, raising serious questions about the appropriateness of continued fish stocking in wilderness lakes. Following more than a century of widespread fish stocking efforts, fishless lakes have become an ecological rarity. Selecting some alpine lakes in Rocky Mountain wilderness areas for restoration to their fishless condition may be an endeavor worthy of consideration in the future.

Ultimately, the goal for fish and wildlife management in wilderness is close cooperation and coordination between the state and federal agencies. If wilderness character and fish and wildlife are to flourish for future generations, both federal wilderness managers and state fisheries biologists must communicate and collaborate to identify and manage toward a shared vision.

To learn more about fish stocking in designated wilderness, please consult Appendix E, which lists key provisions from the interagency agreements cited above as well as the Forest Service Manual (FSM). In addition, Landres et al. (2001) provide an excellent – though somewhat dated – synopsis and discussion of the 1964 Wilderness Act, its judicial interpretation, related federal regulations and policies, and interagency agreements that affect fish stocking practices in wilderness areas.

Indigenous species

Per the AFWA (2006) policies and guidelines, indigenous species should be prioritized for fish stockings. Although not a distinct species or subspecies, blue lineage Colorado River cutthroat trout, which are stocked in the Fossil Ridge Wilderness, are not considered native to the Gunnison Basin (Metcalf et al., 2012). Blue lineage was introduced to this basin through stocking prior to the genetic research which helped clarify the historic ranges of different cutthroat trout lineages in Colorado. The green lineage is considered to be native to the Gunnison Basin (Metcalf et al., 2012). However, the numbers of green lineage Colorado River cutthroat trout currently reared at fish hatcheries limit stocking of this lineage. While stocking of blue lineage continues in the Fossil Ridge Wilderness at this time, opportunities to stock the native green lineage should be explored in the future.

Angling opportunities

Wilderness provides outstanding opportunities for primitive recreation in an environment that is relatively free from the encumbrances of modern society. Many visitors seek out the high-elevation lakes and streams of the Fossil Ridge Wilderness for their world-class fishing opportunities. Unless a self-sustaining conservation population of native cutthroat trout becomes established, maintaining these recreational opportunities into the future will require routine fish stockings by CPW.

Aircraft use

Aerial fish stocking of lakes inside the Fossil Ridge is allowed to continue, as specified in the AFWA (2006) Policies and Guidelines and the MOU between the Forest Service, Rocky Mountain Region and CPW (2015). However, the sights and sounds of aircraft threaten visitor opportunities for solitude and can temporarily shatter feelings of remoteness and wildness (Tarrant et al., 1995; McKenna et al., 2016). Low-altitude aircraft overflights can also affect wildlife stress levels, movement, and habitat utilization (NPS, 1994). Therefore, wilderness managers should coordinate with CPW personnel to minimize disturbance from aircraft flights over wilderness by considering season of year, time of day, route and altitude of flight.

Mechanical versus chemical treatment to remove non-native salmonids

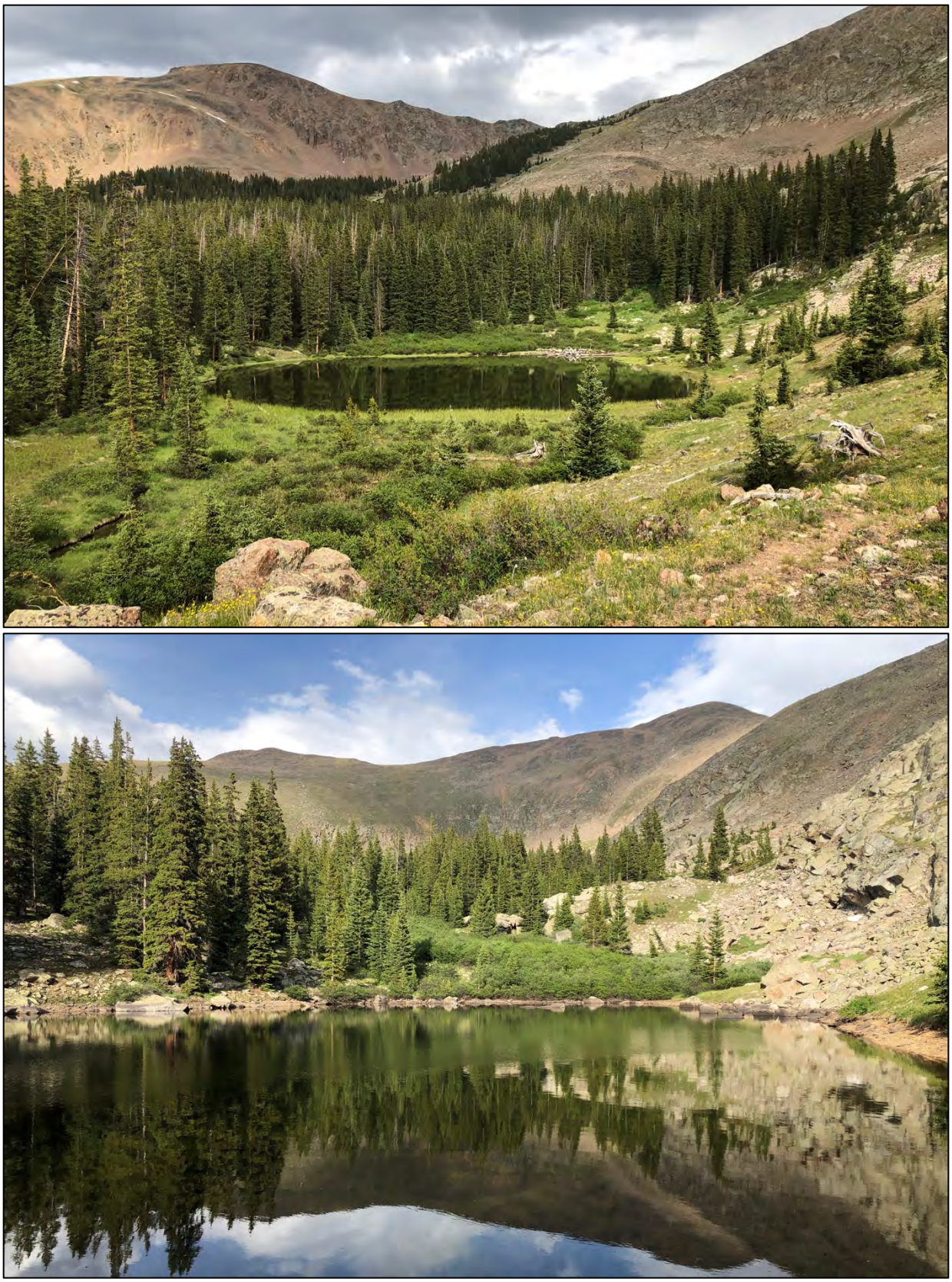
If removal of non-native fishes has been deemed the minimum necessary for administration of the Fossil Ridge Wilderness, mechanical treatment should be considered as a first resort for removing non-native salmonids in wilderness. Given the limitations of this approach, there may be instances when chemical treatment is the minimum tool to remove non-native fishes within and beyond wilderness. Applying chemical treatment to waters inside wilderness is a clear act of trammeling that intensely manipulates aquatic systems, including non-target species. Therefore, such an action should not be taken lightly and would necessitate further analyses and decisions through application of the MRDG and/or NEPA process.

Capitalize on disturbance events

Considering the limitations of mechanical treatments and the drawbacks of chemical treatments, the elimination of non-native fishes via disturbance events, like wildfires, debris flows, and landslides, may present an appealing management opportunity for restoring Colorado River cutthroat trout without such pronounced deleterious effects to wilderness character. These opportunities will be assessed and capitalized upon when appropriate from both a fisheries management and a wilderness stewardship perspective.

Artificial versus natural barriers to fish migration

Given the degradation of wilderness character associated with installations in wilderness, naturally occurring instream fish barriers (e.g., waterfalls) are far preferable to artificial ones. Manipulation of a natural barrier to enhance its efficacy is less preferable, but still superior to installing a completely human-made structure for this purpose. If natural barriers are insufficient to prevent non-native salmonids from invading native cutthroat trout populations upstream, then artificial fish barriers may need to be constructed. Suitable sites for barrier construction should be identified on potential recovery streams outside of wilderness whenever feasible. If that is not possible, installing a fish barrier inside wilderness may be considered as a last resort and only when supported by a minimum requirements analysis.



Unnamed lakes in the Fossil Ridge Wilderness along the Summerville Trail. (Tobias Nickel, July 5, 2020)

Effectiveness Monitoring

Given the importance of adaptive management to minimize trammeling actions in wilderness, the following monitoring questions will be considered when evaluating the effectiveness of actions to manage Colorado River cutthroat trout in the wilderness. Where possible, these questions will be considered in the context of the ongoing wilderness character monitoring strategy for the Fossil Ridge Wilderness (Warnick, 2016).

- What are trends in coordination between state and federal agencies on fish management activities in the wilderness? Are fish stocking schedules being shared and are wilderness managers communicating with CPW staff to minimize impacts to wilderness character?
- What proportion of known suitable historic Colorado River cutthroat trout habitat is occupied by the subspecies? What are the trends?
- What proportion of potential recovery streams has been evaluated for suitable habitat and temperature profiles to support Colorado River cutthroat trout?
- Have any suitable natural barriers to fish migration been identified in potential recovery streams? If so, have waters upstream of these barriers been surveyed for potential Colorado River cutthroat trout populations?
- What are trends in watershed condition class?
- What efforts have been made to focus management of Colorado River cutthroat trout in stream segments outside wilderness, to the maximum extent possible?
- What trammeling actions are being implemented to support Colorado River cutthroat trout recovery? Given the objective of minimizing interventions in wilderness, have trammeling actions achieved the desired species conservation outcomes?
- To what degree have prohibited uses (motorized equipment, aircraft, installations, etc.) been used to accomplish this work? Are these uses increasing?
- How much sampling effort was invested (e.g., proportion of stream miles surveyed) to evaluate current distribution, age structure, and genetic status of Colorado River cutthroat trout inside the Fossil Ridge Wilderness?
- If a conservation population has been established, what are trends in population abundance and natural recruitment? What are trends in introgressive hybridization?

A series of small waterfalls cascading down Crystal Creek. (Tobias Nickel, July 5, 2020)

Wilderness Management Strategy – Boreal Toad

Introduction

The boreal toad (*Anaxyrus boreas boreas*, formerly known as *Bufo boreas*) is a subspecies of the western toad (*Anaxyrus boreas*). There are two distinct populations of boreal toad, one in the Pacific Northwest and an Eastern population occurring in Utah, Wyoming, Colorado, and New Mexico (Goebel et al., 2009). The Southern Rocky Mountain population of the boreal toad is currently considered a subpopulation of the Eastern population (Switzer et al., 2009; USFWS, 2017a).

The primary threat to the boreal toad is from the disease chytridiomycosis, which is caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd) (Loeffler, 2001; Keinath and McGee, 2005; USWFS, 2017). One hypothesis postulates that the chytrid fungus has become widespread throughout the world due to the international pet trade (Fisher and Garner, 2007). Many amphibian declines and even extinctions have been associated with the human-caused spread of this fungal disease (Berger et al., 1998; Green and Kagarise-Sherman, 2001; Daszak et al., 2003). In Colorado, Bd infection has been found to be lethal to boreal toads (Carey et al., 2006) and to directly impact their chances for survival (Muths et al., 2003; Scherer et al., 2005; Pilliod et al., 2010).

Besides the spread of chytrid fungus, other stressors that can affect boreal toad populations include water developments, roads, livestock grazing, recreation, timber harvest, pollutants, geographic isolation, and predation, among others (Loeffler, 2001; Keinath and McGee, 2005; USFWS, 2017a). Increased frequency, duration, and severity of droughts due to climate change also presents a potential threat to boreal toad populations (Neely et al., 2011; USFWS, 2017a). In some regions, warmer temperatures, reduced precipitation, and declining snowpack may result in the drying of breeding ponds and subsequent desiccation of eggs and tadpoles (USFWS, 2017a).

As a result of observed decline, the Eastern population of the boreal toad was considered – but ultimately removed – as a candidate for listing under the federal Endangered Species Act. The decision not to list the Eastern population of the boreal toad was largely influenced by the fact that boreal toads within parts of their range exhibit a moderate to high resiliency to chytridiomycosis (Murphy et al., 2009; USFWS, 2017a). Therefore, the USFWS (2017a) determined that the Eastern population of the boreal toad will continue to maintain self-sustaining populations for the next 50 years and has a low extinction risk.

However, the Southern Rocky Mountain population of the boreal toad has been found to be particularly susceptible to Bd (Carey et al., 2006; Murphy et al., 2009; USFWS, 2017a) and has experienced significant population declines, warranting focused management attention. Mechanisms for these declines relative to other, more resilient populations are poorly understood, although differences in behavior, habitat, and genetics are likely contributing factors (Murphy et al., 2009).

In Colorado, Bd has been implicated in extirpations and die-offs in boreal toad populations since its discovery in the state in 1999 (Loeffler, 2001). Corn et al. (1989) documented an 83% decline of boreal toads in Colorado and southern Wyoming. In the face of these mass die-offs, Loeffler (2001) drafted a conservation and management plan for the Southern Rocky Mountain boreal toad. This plan

was signed by CPW, the U.S. Fish and Wildlife Service, and several other state and federal agencies. A current revision of the conservation agreement and plan is almost complete. The Forest Service, Rocky Mountain Region has a signatory representative on the recovery team and considers the boreal toad a Sensitive Species (Forest Service, 2018g). CPW (2015) further classifies the boreal toad as a Tier 1 (critically imperiled) Species of Greatest Conservation Need.

Top left and right: adult boreal toads (Bill Battaglin, USGS; Brad Lambert, CNHP); middle left: boreal toad tadpoles (Brad Lambert, CNHP); middle right: abandoned beaver pond along the Summerville Trail (Tobias Nickel, July 5, 2020); bottom left and right: wet meadows and shallow ponds along the Van Tuyl Trail that could provide breeding habitat for boreal toads (Tobias Nickel, July 4 and 11, 2020).

Current Status in the Fossil Ridge Wilderness

Some of the earliest documentation of boreal toads in the state of Colorado cited observations in Taylor Reservoir, approximately five miles northeast of the Fossil Ridge Wilderness (Burger and Bragg, 1947). Eleven populations of boreal toads were also documented in the nearby West Elk Mountains between 1971-1973, but all populations had been extirpated by 1982 (Carey, 1993). Within the GMUG National Forests, there are currently fifteen known boreal toad populations, with seven of those exhibiting successful breeding (Forest Service, 2018a).

Boreal toads are known to occur at high elevations between 6,500-12,200 feet with suitable breeding habitat, which includes shallow, quiet water in lakes, marshes, bogs, ponds, and wet meadows (Loeffler, 2001; Bartelt et al., 2004; Keinath and McGee, 2005). Intact samples of these ecosystems are thought to be present in the Fossil Ridge Wilderness, and there is a high likelihood that boreal toads have historically occupied these habitats and may even persist within the wilderness to this day (Daniel Cammack, Native Aquatic Species Biologist, CPW, personal communication).

Since 2017, CPW biologists have been translocating boreal toads to the Middle Quartz Creek Drainage, which lies only a few miles southeast of the wilderness. As of 2020, no amphibian surveys have been conducted inside the Fossil Ridge Wilderness, and the presence and population status of boreal toads in this wilderness are currently unknown (Daniel Cammack, Native Aquatic Species Biologist, CPW, personal communication). However, research suggests that high-elevation areas like the Fossil Ridge Wilderness may provide important refugia from disease for boreal toads and should be prioritized in conservation efforts (Mosher et al., 2018a).

Management Objectives

1. Identify suitable habitat for boreal toads in the Fossil Ridge Wilderness
2. Test suitable habitat sites for chytrid fungus
3. Survey current distribution of boreal toads in the Fossil Ridge Wilderness
4. Evaluate need and feasibility of reintroducing boreal toads to the Fossil Ridge Wilderness
5. Coordinate and cooperate with CPW to:
    a. Identify and manage toward a shared vision of boreal toad conservation and recovery
    b. Jointly pursue research and stewardship projects to recover boreal toad populations
    c. Support CPW's fish and wildlife objectives, to the extent such objectives are consistent with the Wilderness Act
6. Achieve the above objectives with minimal adverse impacts to wilderness character
    a. To the extent possible, allow natural processes to unfold without human intervention
    b. Integrate principles of adaptive management and monitor the effectiveness of actions implemented to guide subsequent work and minimize trammeling
    c. Utilize the MRDG as an analytical tool to evaluate all administrative proposals that could potentially affect wilderness character

Management Recommendations

Identify potentially suitable habitat

Based on current knowledge of boreal toad habitat use patterns, a simple habitat suitability model should be developed using available GIS data and remote sensing technology. The model will delineate potential boreal toad habitat and breeding sites. Model predictions will be ground-truthed during subsequent amphibian surveys, and additional habitat attributes, such as temperature and intermittency, will be evaluated in the field.

Survey current distribution

Potential habitat identified through the GIS model will be ground-truthed and surveyed for boreal toads using standardized protocols (e.g., Bailey et al., 2019). Surveys should be accomplished on foot and in collaboration with aquatic biologists from CPW, students from Western Colorado University, and/or partner organizations (e.g., Rocky Mountain Biological Laboratory). All field personnel should follow best management practices to minimize the spread of pathogens between survey sites (Loeffler, 2001). Field data collected will be used to map current distribution of boreal toads in the wilderness. Surveys will also be used to verify habitat model predictions and to focus subsequent surveys in suitable habitats. In addition, the survey team will identify and prioritize areas needing future inventories. Lastly, survey efforts will evaluate potential reintroduction sites for boreal toads and influence whether, when, and where future management actions for this species will take place.

Evaluate suitable habitat for possible threats

As discussed earlier, the fungal disease chytridiomycosis represents the single greatest threat to boreal toads. Testing should be conducted to determine if the chytrid fungus is present in suitable breeding sites, especially if translocation of tadpoles to establish a recovery population is being considered. Non-lethal Bd monitoring is done by collecting a skin swab from adult amphibians, which is then screened for target Bd genes by amplifying DNA using polymerase chain reaction (PCR) (Boyle et al., 2004). If no boreal toads are present in the wilderness, it may be possible to test other amphibians (e.g., tiger salamanders or chorus frogs) for the presence of the chytrid fungus. In the absence of amphibians, water samples may also be used for Bd testing (Kirshtein et al., 2007; Shin et al., 2014; Mosher et al., 2018b), but results should be interpreted with caution, as this method has proved to be somewhat unreliable (Hyman and Collins, 2012; Cristescu and Hebert, 2018). When possible, chytrid testing should be carried out in conjunction with boreal toad surveys.

Adaptive Management and Contingency Planning

Contingent on survey findings and other factors, Forest Service and CPW staff may determine that additional management actions are warranted to aid the recovery of boreal toads in the Fossil Ridge Wilderness. The MRDG process and the framework proposed by Landres et al. (2020) should be used to carefully weigh the costs and benefits of ecological intervention and ensure that actions taken are the minimum necessary for the administration of the area as wilderness.

Enhance population resilience and genetic exchange by promoting functional metapopulations

Many boreal toad populations have become increasingly isolated and precarious as subpopulations have been extirpated from suitable habitat. Reintroduction efforts should be evaluated with a focus on fostering distributions of the species across the landscape that can function more effectively by allowing for genetic exchange and resilience to disturbance events (e.g., wildfire, flooding, desiccation). Importantly, Mosher et al. (2018a) found that boreal toad metapopulations have a higher likelihood of long-term persistence in high-elevation settings where temperatures may be suboptimal for Bd growth and where small boreal toad populations may be below the threshold needed for efficient pathogen transmission.

Establish recovery population

Research suggests that high-elevation areas, such as the Fossil Ridge Wilderness, may provide important refugia from disease for boreal toads and should be prioritized for conservation initiatives like reintroductions (Mosher et al., 2018a). Reintroduction of boreal toads should proceed following the methods outlined by Loeffler (2001) and is typically accomplished through annual translocations of tadpoles into shallow ponds for 3-4 consecutive years. Fertilized eggs are currently collected from reproducing boreal toad populations and reared at the Aquatic Species Restoration Facility near Alamosa, Colorado. When done in wilderness, release sites should be accessed by foot or horseback. Tadpoles in water-filled bags would be transported using packstock or backpacks. Ideally, potential release sites should be tested negative for the presence of Bd prior to any translocations taking place. However, if testing for Bd proves to be inconclusive (e.g., due to absence of amphibians available for swabbing), it may be necessary to release boreal toads and collect survivors the following year to sample for Bd before implementing a full reintroduction effort (Wixson and Rogers, 2009).

Monitor recovery population

If a decision is made to translocate boreal toads to the Fossil Ridge Wilderness, a protocol following Loeffler (2001) will be established to closely monitor the outcome of such a reintroduction attempt. Translocated individuals should be monitored as closely as possible during the seasons of translocation and follow-up surveys should continue for at least five years after reintroduction. Surveys should be conducted to monitor for presence of Bd and collect data on movements, survival, reproduction, and other variables. Monitoring may be the most critical part of the reintroduction process. Boreal toads' responses to the translocation itself and to the new habitat may provide valuable information to guide subsequent conservation efforts of this priority species in the Fossil Ridge Wilderness and across their historic range.

Wilderness Stewardship Considerations

Management actions within versus outside of wilderness

Given the historic, current, and desired future distribution of boreal toads, there are management opportunities that could result in conservation gains for this subspecies without requiring intervention in wilderness. For example, CPW biologists have been translocating boreal toads to the Middle Quartz Creek drainage, located a few miles southeast of the Fossil Ridge Wilderness. If sufficiently robust populations of boreal toad are present outside wilderness, it may be preferable to monitor and augment these populations rather than establishing a new population inside wilderness.

However, some of the most favorable, unfragmented habitat for boreal toads is likely situated inside designated wilderness where many anthropogenic stressors are absent (e.g., water developments, roads, timber harvest) or significantly reduced (e.g., pollutants, grazing). Research also suggests that high-elevation areas like the Fossil Ridge Wilderness provide important refugia from disease for boreal toads and should be prioritized for conservation initiatives like reintroductions (Mosher et al., 2018a). Due to physiological constraints, relatively low mobility and site fidelity, boreal toads are unlikely to recolonize these areas on their own (Blaustein et al., 1992; Bartelt et al., 2004). As a result, reestablishing boreal toad populations in the Fossil Ridge Wilderness may be necessary to achieve important conservation gains and ensure the persistence and recovery of this priority species.

Benefits to the natural quality of wilderness character

Boreal toads can serve key ecological functions and would benefit the natural quality of wilderness character. Amphibian larvae are almost exclusively aquatic, feeding on algae, detritus, and other animals. As such they serve as one of the few primary consumers in the alpine aquatic community, converting ingested energy into biomass. As they mature, adult amphibians become insectivores and influence prey communities in terrestrial habitats. Throughout their lifecycle, amphibians serve as prey items for reptiles, birds, small mammals and even other amphibians. This linkage in the trophic food web becomes even more vital in alpine areas, where resources and energy are limited by climate. In face of the mass die-offs of amphibians worldwide, special consideration should be given to the protection and restoration of amphibians, such as the boreal toad. Due to the remote setting, unfragmented habitat, and suboptimal temperatures for Bd growth, the Fossil Ridge Wilderness provides a potentially valuable refuge supporting source populations of boreal toads in this region.

Impacts to the untrammeled quality of wilderness character

While reintroducing boreal toads is intended to reverse the human-caused decline of this subspecies and would benefit the natural quality, this action also constitutes a deliberate human intervention in the biophysical environment, thus affecting the untrammeled quality of wilderness character.

Traditional tools and skills

The wilderness program of the Forest Service, Gunnison Ranger District has a track record of valuing the maintenance of traditional skills. A component of this strategy is to continue seeking opportunities to build on this success by completing fish and wildlife conservation achievements with the use of traditional tools and skills. Restoration of boreal toads would be accomplished on foot and horseback and is unlikely to involve any prohibited uses. Therefore, it presents opportunities for species conservation gains using traditional tools and skills in a remote backcountry setting.

Effectiveness Monitoring

Given the importance of adaptive management to minimize trammeling actions in wilderness, the following monitoring questions will be considered when evaluating the effectiveness of conservation actions to recover boreal toads in the wilderness. Where possible, these questions will be considered in the context of the ongoing wilderness character monitoring strategy for the Fossil Ridge Wilderness (Warnick, 2016).

- What proportion of potential habitat has been evaluated for suitability?
- What proportion of suitable habitat has been surveyed for boreal toad presence?
- What proportion of suitable habitat is currently occupied by boreal toads?
- What proportion of suitable habitat has been tested for chytrid fungus?
- What proportion of tested sites reveal chytrid refugia?
- What are trends in abundance, survival, and recruitment of boreal toad populations?
- What are trends in connectivity and gene flow between boreal toad populations?
- How much sampling effort was invested annually (e.g., staff hours spent, number of sites surveyed) to evaluate current distribution of boreal toads?
- What additional information has been gained through survey efforts? To what extent have any lessons learned through these surveys informed wilderness management actions?
- What are the impacts of trammeling actions taken to support boreal toad recovery?
- What efforts have been made to focus management of boreal toads outside wilderness?
- To what extent have boreal toad surveys and recovery efforts promoted the use of traditional tools and skills?
- What are trends in coordination between state and federal agencies and other parties with an interest in boreal toad recovery? Are opportunities for collaborative research being pursued?

Henry Mountain, the highest point in the wilderness at 13,254 feet, as seen from an expansive, subalpine grassland meadow along the Van Tuyl Trail. (Tobias Nickel, July 4, 2020)

Species Considered but Not Selected

Preliminary research generated 27 potential priority species for the Fossil Ridge Wilderness. Detailed analysis and stakeholder interviews on these species resulted in the selection of the four priority species included in this strategy. Species not selected generally met one or multiple of these criteria:

- The species' habitat requirements are unlikely to be met and/or there are no known occurrences of the species in the Fossil Ridge Wilderness (e.g., lower elevation species)
- The species does not currently represent a substantial conservation concern as indicated by state and federal status assessments, and/or there is no perceived need to actively manage for the species inside the Fossil Ridge Wilderness. As a result, it would be difficult to demonstrate that management of the species inside wilderness constitutes the minimum necessary for the administration of the area, as is legally required by the Wilderness Act.
- Management and protection of the species is sufficiently accomplished through legislation or other planning documents (e.g., Migratory Bird Treaty Act, Forest Plan) and/or cannot be adequately addressed at the scale of the Fossil Ridge Wilderness, thereby extending beyond the scope of this strategy (e.g., wide-ranging species).

To re-emphasize, this strategy is not intended to be a comprehensive assessment or monitoring plan of all fauna in the Fossil Ridge Wilderness. Rather, this strategy identifies native fish and wildlife species for which there is a perceived management need inside the wilderness.

Below are listed some of the species that were considered closely for inclusion in this strategy, but were ultimately not selected. Rationales for exclusion of each species are provided. As climate change progresses and other anthropogenic stressors intensify, some of these species may become increasingly vulnerable and their conservation may become a management priority. In addition, some species are discussed here, because they may recolonize or be reintroduced to portions of their historic range. In such an event, these species may warrant management attention and need to be evaluated for inclusion in this strategy.

American Pika (*Ochotona princeps*)

American pikas primarily inhabit talus fields fringed by suitable vegetation in alpine or subalpine areas (Smith and Weston, 1990). A generalist herbivore that does not hibernate, this species relies on haypiles of summer vegetation stored within talus openings to persist through the winter (Smith and Weston, 1990). Pikas are thermally sensitive and highly susceptible to climate change (Beever et al., 2010; CPW, 2015). Increases in summer temperatures may affect pika foraging rates and induce heat stress (Beever et al., 2010). Conversely, cold stress may arise from reduced snowpack, which pikas rely on as an insulator in winter (Beever et al., 2010). Researchers have documented range contractions upward in elevation in the Sierra Nevada (Moritz et al. 2008) and extirpations of pika populations in the Great Basin Range (Beever et al. 2003, 2011; Wilkening et al., 2011).

These findings prompted a petition (Wolf et al., 2007) to list American pika under the Endangered Species Act. The USFWS subsequently partnered with the National Oceanic and Atmospheric Administration (NOAA) to develop local-scale climate models and determine if pikas would

experience significant risk of extirpation through the end of the 21st century. Based on the NOAA projections (Ray et al., 2010) and review of the best available science, the USFWS (2010a) determined that, while some mid- to low elevation populations may be at risk due to increased summer temperatures, the American pika (and its 36 recognized subspecies) will have sufficient high-elevation habitat across its range to ensure its long-term survival.

In Colorado, extensive survey efforts have shown that pika are well distributed and abundant throughout the state's alpine and even subalpine areas (CPW, 2009; Seglund, 2015). However, due to concerns over potential climate change impacts, American pika are recognized as a Tier 1 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015). The American pika is considered an early-warning indicator species for the effects of climate change, thus warranting continued monitoring of the species' distribution and population levels. At the local level, the talus habitats inhabited by pikas inside the Fossil Ridge Wilderness are relatively isolated. In the event of local extirpation, the likelihood of pikas recolonizing vacant habitat patches inside the Fossil Ridge Wilderness may be low due to distance from potential source populations, the species' limited dispersal ranges, and the insular nature of talus habitat (Hafner, 1994).

In conclusion, the widespread distribution and abundance of American Pika in Colorado does not currently warrant its inclusion as a priority species in this strategy. Of the alpine-obligate species considered, the southern white-tailed ptarmigan was identified as the species with the greatest management need in the foreseeable future. However, monitoring of American pika would yield valuable information about this species' ability to adapt and be resilient in the face of climate change. To address this information need, CPW has been conducting monitoring of pika populations throughout Colorado since 2008 (CPW, 2015). In addition, two citizen science initiatives (PikaNet and the Front Range Pika Project) are currently being implemented to monitor pika in Colorado. These projects provide useful data to researchers and land managers while simultaneously educating and engaging the general public in pika conservation. Opportunities available through CPW and these citizen science initiatives to establish long-term monitoring sites for pika surveys inside the Fossil Ridge Wilderness should be pursued when possible.

Brown-capped Rosy-Finch (*Leucosticte australis*)

Brown-capped rosy finches are endemic to mountain ranges from southern Wyoming to Colorado and northern New Mexico (Johnson et al., 2000). These birds spend most of the year well above tree line, feeding on seeds and insects on snow fields and in alpine vegetation, while moving to lower elevations for short periods during winter storms (Johnson et al., 2000). Breeding occurs only in high-elevation alpine areas, with suitable nest sites found in steep cliff faces or on rocky, talus slopes (Johnson et al., 2000; Seglund et al., 2018a). The brown-capped rosy finch is the highest elevation nester in the United States, with nest sites documented above 4,267 meters (Forest Service, 2018f).

Colorado's State Wildlife Action Plan (CPW, 2015) lists the brown-capped rosy finch as a Tier 1 Species of Greatest Conservation Need. The alpine ecosystems this species depends on are highly vulnerable to climate change (Neely et al., 2011). The warming climate is predicted to reduce snowfield persistence during the breeding season, alter insect abundance and phenology, and increase fragmentation of alpine ecosystems due to treeline expansion upslope (CPW, 2015; Rosenberg et al.,

2016). In addition, increasing recreation activities in the alpine environments of Colorado can disturb nest sites and may have a negative impact on this species (Johnson et al. 2000, CPW, 2015).

Johnson et al. (2000) reported a decline in brown-capped rosy finches using Christmas Bird County survey data. However, these data may not constitute an accurate assessment of the species' population trends as winter numbers are eruptive and nomadic (CPW, 2015). To develop a baseline population status assessment, CPW staff surveyed suitable alpine habitats in 52 sites across Colorado in 2018 and found 100% occupancy of brown-capped rosy finch (Seglund et al., 2018a).

Seglund et al. (2018a) developed a statewide predicted range model, which identified potential habitat inside the Fossil Ridge Wilderness. In September of 2020, during surveys for southern white-tailed ptarmigan, a total of 18 brown-caped rosy-finches were sighted in Mill Lake basin and on the ridge between Fossil and Henry Mountains:

- 2 of unknown sex: UTM E360550, N4281339, 3640m
- 1 male: UTM E359549, N4282610, 3859m
- 12 of unknown sex: UTM E359139, N4282986, 4,002m
- 2 female, 1 of unknown sex: UTM E359019, N4283170, 4,043m

Surveying for brown-capped rosy-finch in the Fossil Ridge Wilderness would contribute toward assessing the current species status and evaluating future changes in populations. While recognizing the need for reliable population data, brown-capped rosy finch was not selected as a priority species for this wilderness at this time. The remote, site-specific nature of breeding habitat (i.e., cliffs and rock crevices) limits opportunities to actively manage for this species (Johnson et al., 2000). Furthermore, of the alpine species considered, the southern white-tailed ptarmigan was identified as the species with the greatest management need in the foreseeable future. However, as climate change progresses and human use of the alpine increases, managers may find that conserving brown-capped rosy finch warrants additional attention.

Canada Lynx (*Lynx canadensis*)

The Canada lynx extends throughout the boreal and montane forests of North America with the largest populations found in Alaska and Canada (McCord and Cardoza 1982; McKelvey et al., 2000). Overharvest, unregulated trapping, loss or modification of habitat, and competitor range expansions, particularly of bobcats (*Lynx rufus*) and coyotes (*Canis latrans*), contributed to the decline of lynx populations (USFWS, 1998b). In 2000, lynx in the contiguous United States were designated a distinct population segment (DPS) and were listed as threatened under the Endangered Species Act. In its listing decision, the USFWS (2000) cited the lack of guidance to conserve the species in federal land management plans at the time as the single greatest threat to lynx. In response, the Southern Rockies Lynx Amendment (Forest Service, 2008) incorporated management direction to conserve lynx into regional forest plans. In its most recent species status assessment, the USFWS (2017b) concluded that lynx in the contiguous United States may no longer warrant protection under the Endangered Species Act and should be considered for delisting due to successful recovery.

Colorado represents the southern-most historical distribution of Canada lynx (McKelvey et al., 2000). Lynx were considered to be nearly extirpated from the state by the late 1970s (USFWS,

1998b). In 1999, CPW initiated a lynx recovery program intended to restore a viable population. Between 1999 and 2006, a total of 218 animals were transplanted from Canada and Alaska into the San Juan Mountains (Devineau et al. 2010). In 2010, CPW determined that a viable, self-sustaining population of lynx had been re-established in Colorado (Interagency Lynx Biology Team, 2013).

Based on radiotelemetry location data, a majority of the reintroduced lynx remained within the reintroduction area in the San Juan Mountains in southwestern Colorado, but additional home ranges have been established farther north in Colorado (Theobald and Shenk, 2011). The Gunnison Ranger District lies between these two main population centers, and several radio-collared lynx have been documented traveling through this area since reintroduction began in 1999 (Theobald and Shenk, 2011). A small lynx population has become established in the Taylor Park area, which lies a few miles northeast of the Fossil Ridge Wilderness (Forest Service, 2018c). In addition, the Southern Rockies Lynx Amendment (Forest Service, 2008) delineated the Cottonwood Pass linkage area, approximately 15 miles northeast of the Fossil Ridge Wilderness, to facilitate movement of Canada lynx between the Collegiate and Sawatch Ranges. Finally, using location data from radio-collared lynx, Ivan et al. (2012) developed a statewide model predicting lynx habitat use. The model identifies high quality lynx habitat inside and to the north and east of the Fossil Ridge Wilderness.

While lynx are a federally threatened species and individual animals likely have travelled through the Fossil Ridge Wilderness, this species was ultimately not included as a priority species in this strategy for several reasons. Being such a wide-ranging species (Ruggiero et al., 2000), lynx are difficult to manage for at the scale of the Fossil Ridge Wilderness. Addressing many of the contemporary challenges to lynx conservation (e.g., climate change impacts, insect infestations and disease outbreaks in forests, wildfire management, and habitat fragmentation) goes beyond the scope of this wilderness-specific strategy. These issues area already being addressed at the landscape level through the Southern Rocky Mountain Lynx Amendment (Forest Service, 2008) and as part of current GMUG forest plan revision (Forest Service, 2019). Moreover, many land uses that could affect lynx habitat, such as timber harvest, roadbuilding, and mineral and energy development, are generally prohibited in wilderness by the 1964 Wilderness Act. Finally, the Fossil Ridge Wilderness does not overlap with any Lynx Analysis Unit or linkage area, and no lynx are known to have established a home range that overlaps the Fossil Ridge Wilderness (Forest Service, 2018c). Therefore, there is no perceived urgency to actively manage lynx in this wilderness area at this time.

Gray Wolf (*Canis lupus*)

The gray wolf historically inhabited Colorado but was extirpated from the state by the 1940s due to human persecution (Young and Goldman, 1944). In the 1990s, wolves were reintroduced to Wyoming, Idaho, and Arizona (Bangs and Fritts, 1996; Brown & Parsons 2001). In recent years, wolves have recolonized parts of their former range, including in Washington, Oregon, and California (Jimenez et al., 2017). Several dispersing wolves have also been documented in Colorado (Jimenez et al., 2017, CPW 2020e). In January of 2020, CPW staff confirmed the presence of at least six wolves in northwestern Colorado (CPW, 2020e).

While long-distance dispersal may potentially lead to a self-sustaining wolf population in Colorado over the long term, the level of connectivity between Colorado and wolf populations in other states is

low (Carroll et al., 2003). Given substantial barriers to natural recolonization, reintroduction has been a favored approach among many conservationists. The Rocky Mountain Wolf Action Fund submitted more than 200,000 signatures to place restoration of wolves on Colorado's 2020 statewide ballot (CPW, 2020e). If the proposition passes, Colorado Parks and Wildlife Commission would be tasked with developing a plan to begin wolf reintroduction in Colorado by December 31, 2023 (Colorado General Assembly, 2020). However, wolves in Colorado are federally protected and remain under the jurisdiction of the USFWS. Unless the gray wolf is removed from the federal endangered species list, as is currently being proposed (USFWS, 2019b), the state would have to obtain federal approval prior to reintroduction.

Currently, no wolves are present in the Fossil Ridge Wilderness. If wolves naturally recolonize or are reintroduced to Colorado, they may become a management priority, especially because wolf presence frequently comes with potential for human-wildlife conflicts (Fritts et al. 2003; Mech, 2017).

Gunnison Sage-grouse (*Centrocercus minimus*)

Historically, the range of the Gunnison sage-grouse included parts of central and southwestern Colorado, southeastern Utah, northwestern New Mexico and northeastern Arizona (Schroeder et al., 2004). Since the early 1900s, the Gunnison sage-grouse has experienced a massive contraction of its occupied range, primarily due to conversion of sagebrush habitat to agriculture or residential and commercial development (USFWS, 2019c). Gunnison sage-grouse now occupies an estimated 10% of its historical range (Schroeder et al. 2004) and occurs in eight populations in southwestern Colorado and southeastern Utah (USFWS, 2019c). The Gunnison Basin population is the largest population, containing approximately 85 percent of the total number of birds (USFWS, 2019c). A range-wide conservation plan for Gunnison sage-grouse was developed (Gunnison Sage-grouse Rangewide Steering Committee, 2005), and the species was listed as threatened under the Endangered Species Act (USFWS, 2014a). In addition, the USFWS recently completed a species status assessment for Gunnison sage-grouse (2019c) and published a draft recovery plan (2019a).

The Gunnison sage-grouse requires large, contiguous areas of sagebrush across the landscape as well as healthy wetland and riparian ecosystems for long-term survival (USFWS, 2019c). Current and future threats to the Gunnison sage-grouse include small population size, habitat loss and fragmentation due to human development and associated infrastructure, invasive plants, pinyon-juniper encroachment, wildfire, improper grazing practices, and recreation, among many others (USFWS, 2019c). The Gunnison sage-grouse is also considered highly vulnerable to the effects of climate change, which will likely exacerbate many of these threats (Neely, et al. 2011). Please refer to the species status assessment report (USFWS, 2019c) for an in-depth, scientific review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain the species' viability.

The Gunnison-sage grouse was not included in this strategy, because the Fossil Ridge Wilderness does not contain any suitable habitat for this species. Using GIS to overlay the wilderness boundary with the best available Gunnison sage-grouse habitat information (CPW, 2019; USFWS, 2020) revealed no overlap between the Fossil Ridge Wilderness and current or historic Gunnison sage-grouse habitat. This is not surprising, as the Fossil Ridge Wilderness ranges in elevation from 8,880

feet to 13,254 feet and predominantly features forested and alpine ecosystems. A limitation of protected areas as a tool for biodiversity conservation is that they are biased to higher elevations and steeper slopes and often include places that are less likely to face land conversion pressures even in the absence of protection (Joppa and Pfaff, 2009). As a result, some ecosystem types are currently poorly represented within the protected areas network of the continental United States (Aycrigg et al., 2013). In the case of the Gunnison Basin, most wilderness areas are situated above 9,000, leaving lower-elevation ecosystems and associated species, such as the Gunnison sage-grouse, particularly vulnerable to anthropogenic pressures (Dietz et al., 2020).

North American Beaver (*Castor canadensis*)

Following overexploitation for the fur trade, protection and re-introduction programs have re-established the North American beaver throughout much of its historical range (Hill, 1982; Naiman et al., 1988). Today, beavers are widely recognized as ecosystem engineers that provide numerous ecological functions and benefits (e.g., Naiman et al., 1988; Pollock et al., 1995; Wright et al., 2002; Pollock et al., 2018). Through the construction of dams, beavers help to establish and maintain riparian areas and wetlands, which in turn affects animal and plant community composition and often increases local biodiversity (Pollock et al., 1995; Wright et al., 2002; Pollock et al., 2018).

Due to the ecosystem services associated with beaver presence, this species is of interest to many land managers and conservationists and was discussed during development of this strategy. While signs of recent beaver activity (e.g., dams and lodges) can be found in the Fossil Ridge Wilderness, the current distribution, or even presence, of beaver in this area is not well understood. From the standpoints of biodiversity conservation and climate adaptation, releasing beavers in stream reaches, where they have become extirpated, would be desirable and likely benefit a wide range of species (Nathan Seward, CPW, Wildlife Conservation Biologist, personal communication). For example, beaver activity could improve the quantity and quality of breeding habitat available for boreal toads, one of the priority species identified in this strategy (Loeffler, 2001; Keinath and McGee, 2005).

While there are ecological benefits to beaver restoration, active management of beaver inside the Fossil Ridge Wilderness is unlikely in the near future. According to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, the North American beaver is a species of least concern (Cassola, 2016), and NatureServe (2020) classifies the species as globally secure. Beaver have also not been listed as a special status species by either the Forest Service, USFWS, or CPW. As a result, there is no perceived urgency to take action and recover this species, and the minimum requirements for restoring beaver inside the Fossil Ridge Wilderness are unlikely to be met. Therefore, the North American beaver was not included as a priority species in this strategy at this time. However, managers may want to consider beaver reintroduction as an effective, low-impact habitat restoration and climate adaptation strategy in the future. In some scenarios, beaver reintroduction may be the minimum tool to restore ecosystem function and support the recovery of other indigenous species in the Fossil Ridge Wilderness.

North American Wolverine (*Gulo gulo luscus*)

Wolverines were nearly extirpated from the contiguous U.S. in the early 20th century due to broad-scale predator trapping and poisoning programs (Aubry et al., 2007). Until recently, the last

confirmed wolverine sighting in Colorado was in 1919 (Aubry et al., 2007). In spring of 2009, researchers tracked a wolverine via GPS-satellite collar from northwest Wyoming into north-central Colorado (Packila et al., 2017). The wolverine traveled approximately 500 miles to reach Colorado and was the first confirmed individual in the state in 90 years.

The USFWS (2010b) determined that wolverines occurring in the contiguous U.S. should be protected under the Endangered Species Act. In this wake, the USFWS (2013) proposed establishing a nonessential experimental population in the Southern Rocky Mountains. However, the USFWS (2014c) withdrew its proposals to list the wolverine under the Endangered Species Act and to reintroduce the species. This decision was overturned in court. As of August 2020, no final listing decision has been made, and conversations to reintroduce wolverines in Colorado continue.

Currently, wolverines do not warrant inclusion in this strategy. If wolverines are reintroduced in the Southern Rocky Mountains or naturally recolonize the area in the future, they may become a management priority at that time. As climate change is expected to adversely affect wolverine habitat and dispersal (McKelvey et al., 2011), it has been postulated that Colorado may retain some of the higher quality wolverine habitat in the lower 48 states (CPW, 2015). Therefore, places like the Fossil Ridge Wilderness may have a critical role to play in providing high-elevation refugia for this species.

Northern Goshawk (*Accipiter gentilis*)

Northern goshawks occupy a wide variety of boreal and montane forest habitats in parts of North America, Europe, and Asia (BirdLife International, 2016). The northern goshawk has been petitioned for listing under the Endangered Species Act on two occasions, and its status has been the subject of considerable litigation (Kennedy, 2003). The species is currently not listed as a threatened species but is considered a sensitive species by the Forest Service (2018g), Rocky Mountain Region and a Tier 2 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015). The primary threat to goshawk populations is alteration of its preferred habitat from timber management practices (Kennedy, 2003). In addition, goshawk nesting and foraging habitat has likely been impacted by fire suppression and widespread tree mortality due to insect infestations and disease outbreaks in this region (Graham et al., 1997; Kennedy, 2003; Forest Service, 2018e).

While goshawk habitat may be declining in the Southern Rocky Mountains (Kennedy, 2003; Forest Service, 2018f), this species was not included in this strategy for several reasons. The Wilderness Act prohibits timber harvest, and other threats to this species (e.g., effects from fire suppression and beetle kill) are already being addressed at the landscape level through forest plan revision. While northern goshawk can serve as an indicator species of forested ecosystems (Kennedy, 2003), the GMUG National Forests will evaluate monitoring of this species at the forest level and consider the northern goshawk as a potential species of conservation concern during the forest plan revision process. Routine surveys for northern goshawk are carried out frequently as part of environmental review processes to evaluate potential impacts of proposed projects (Kennedy, 2003). It is worth noting, however, that these surveys take place almost exclusively outside of wilderness. To advance our ecological understanding of this species, the Fossil Ridge Wilderness could serve as a control to compare goshawk densities, nesting success, and other variables inside wilderness to more intensely managed forested landscapes outside of wilderness.

Uncompahgre Fritillary Butterfly (*Clossiana improba acrocnema*)

The Uncompahgre fritillary butterfly (*Clossiana improba acrocnema*, formerly *Boloria acrocnema*) is endemic to alpine habitats in the San Juan Mountains of southwestern Colorado (Forest Service, 2018c). The species was discovered in 1978 (Gall and Sperling, 1980), and the USFWS was petitioned to list the species under the Endangered Species Act the following year. The butterfly was listed as endangered in 1991, because of its small geographic range and declining population (USFWS, 1991). The species recovery plan was published in 1994. Grazing, recreation, small population size, climate change, and illegal collecting constitute the principal threats to the Uncompahgre fritillary butterfly (USFWS, 1994 and 2009).

Currently, eleven known colonies exist in the San Juan Mountains, although one may have become extirpated in recent years (Dr. Kevin Alexander, Professor of Biology, personal communication). All known Uncompahgre fritillary butterfly populations are associated with large patches of snow willow (*Salix nivalis*) above 12,000 feet, which provide food and cover (Scott, 1982; USFWS, 1994). According to the Information for Planning and Consultation (IPaC) database (USFWS, 2020), the potential range of the Uncompahgre fritillary butterfly extends into the Elk Mountains and Sawatch Range, including alpine habitat in the Fossil Ridge Wilderness. However, no surveys for this species have been conducted this far north (Dr. Kevin Alexander, Professor of Biology, personal communication). While future survey work may change our understanding of Uncompahgre fritillary butterfly distribution, the species is currently considered endemic to the San Juan Mountains (Forest Service, 2018c). Therefore, this species was not included in this strategy at this time.

Western Bumble Bee (*Bombus occidentalis*)

The western bumble bee has a wide geographic range that stretches down the west coast from Alaska to California and reaches as far east as Nebraska and the Dakotas (Williams et al., 2014). During the last several decades, populations have declined range-wide, particularly in the western, coastal portions of the range (Cameron et al., 2011; Graves et al., 2020). The main cause of declines is thought to be disease and pathogen spread by non-native honeybees (Fürst et al., 2014; Hatfield et al., 2015; Forest Service, 2020h). Other causes of decline include habitat loss and alteration, climate change, and pesticide use (Hatfield et al., 2015; Forest Service, 2020h). The USFWS is currently considering the western bumble bee for listing under the Endangered Species Act, with publication of a species status assessment report anticipated in late 2020 (Graves et al., 2020). Western bumble bee is considered a sensitive species by the Forest Service (2018g), Rocky Mountain Region and a Tier 2 Species of Greatest Conservation Need by the state of Colorado (CPW, 2015).

Over the past few decades, researchers with the Rocky Mountain Biological Laboratory have consistently documented western bumble bees in three valleys in the northern part of the Gunnison Ranger District at elevations of 9,500 - 10,000 feet (Forest Service, 2018f). Non-native honey bees are currently unable to overwinter in the wild at such high elevations, thus reducing the potential for disease transfer to native pollinators (Forest Service, 2018f). As a result, bumble bees in the northern part of the Gunnison District are largely disease-free (Forest Service, 2018f).

The status of western bumble bee in the Fossil Ridge Wilderness is unknown, as no insect surveys have been conducted in this area. Ultimately, western bumble was not selected as a priority species,

because there are very limited opportunities to influence this species through management actions inside designated wilderness. Regulating honey bee keeping operations and transport and pesticide use within the Gunnison District extends far beyond the scope of this wilderness strategy. While range-wide declines of this species warrant monitoring of population trends, researchers with the Rocky Mountain Biological Laboratory are already carrying out long-term monitoring at a variety of sites in the northern Gunnison District. Finally, the GMUG National Forests will consider the western bumble bee as a potential species of conservation concern during the forest plan revision process and determine if forest-wide actions are needed to conserve this species.

White-Veined Arctic Butterfly (*Oeneis bore*)

The white-veined arctic butterfly is widespread on the arctic tundra of Alaska and Canada (NatureServe, 2020). Colorado represents the southern-most distribution of this species, with populations persisting in alpine habitats (Lotts and Naberhaus, 2017). As with many alpine species, changes in temperature and precipitation regimes could be a threat and lead to local extirpation of this butterfly (Forest Service, 2018f). At this time, however, the white-veined arctic has not been listed as threatened or endangered at the state or federal level. As a result, there is no perceived urgency to take conservation action, and the minimum requirements for managing white-veined arctics inside the Fossil Ridge Wilderness are unlikely to be met. Furthermore, of the alpine-obligate species considered, the southern white-tailed ptarmigan was identified as the species with the greatest management need. However, white-veined arctics may serve as an early-warning indicator species for the effects of climate change, and thus monitoring of this species may be warranted. The GMUG National Forests will evaluate these monitoring needs at the forest level and consider the white-veined arctic as a potential species of conservation concern during forest plan revision.

Lamphier Creek below Square Top and Fossil Mountains. (Tobias Nickel, June 15, 2020)

Top: a hiker camped near the shores of Lamphier Lake; bottom: the cold, clean waters of Lamphier Lake with Gunsight Pass in the background. (Tobias Nickel, June 15, 2020)

Strategy Application

Improving Wilderness Stewardship Performance: Fish and Wildlife Element

The desired outcomes for the Fish and Wildlife Element are to 1) improve the status of priority species whose persistence in a wilderness is threatened and/or 2) successfully reintroduce priority species to previously occupied range within a wilderness. To accomplish these outcomes, the *Wilderness Stewardship Performance Guidebook* (Forest Service, 2020) prescribes five steps that build on each other and incrementally improve the Wilderness Stewardship Performance (WSP) score of a wilderness. WSP scoring criteria for the Fish and Wildlife Element are included in Appendix A. The purpose of this section is to document progress made toward meeting those criteria for the Fossil Ridge Wilderness and to identify opportunities for future improvement.

Indigenous Fish and Wildlife Management Strategy (2 points)

This document fulfills the 2-point scoring requirement by providing an indigenous fish and wildlife management strategy for the Fossil Ridge Wilderness and puts the Gunnison Ranger District on a path toward stewardship excellence in the Fish and Wildlife Element of WSP. Implementing management actions identified in this strategy and subsequently monitoring and evaluating their effectiveness will continue to improve the WSP score of the Fossil Ridge Wilderness.

Management Actions to Conserve Priority Species (4 points)

The Forest Service, Gunnison Ranger District together with its partners has been implementing the management actions listed below to conserve Rocky Mountain bighorn sheep and Colorado River cutthroat trout in the Fossil Ridge Wilderness. These management actions and documentation thereof have been incorporated into this strategy. Together, these actions address the conservation of one terrestrial and one aquatic indigenous priority species in the Fossil Ridge Wilderness, thereby meeting the 4-point level WSP criteria for the Fish & Wildlife Element.

<u>Terrestrial Priority Species: Rocky Mountain bighorn sheep</u>

Inventory and population estimation: CPW personnel survey the Fossil Ridge bighorn herd every three to five years via aircraft (Kevin Blecha, CPW Wildlife Biologist, personal communication). CPW (2020b) publishes annual reports on hunting statistics that include population estimates for the Fossil Ridge bighorn herd. In addition, CPW (2020a) has delineated seasonal habitats and migration patterns for Rocky Mountain bighorn sheep including for the Fossil Ridge herd (Fig. 4).

<u>Aquatic Priority Species: Colorado River cutthroat trout</u>

Fish stockings: Since 2001, CPW has biannually stocked Colorado River cutthroat trout in lakes (Crystal, Henry, Upper and Lower Lamphier, and Mill) of the Fossil Ridge Wilderness. Stocked fish continue to provide outstanding angling opportunities to wilderness visitors. Daniel Brauch, CPW Fisheries Biologist, has shared stocking reports for years 1995-2019 with Forest Service staff. These reports are on file at the Forest Service, Gunnison Ranger District.

Effectiveness Monitoring of Implemented Conservation Actions (6 points)

The above management actions have been evaluated for their effectiveness utilizing the corresponding monitoring questions developed as part of this strategy. A brief narrative documenting monitoring and evaluation follow below. These efforts and documentation thereof satisfy the 6-point WSP criteria, which require that management actions for at least one terrestrial and one aquatic priority indigenous species have been implemented, monitored, and evaluated for effectiveness. As additional management actions to conserve and/or recover priority species in the Fossil Ridge Wilderness are implemented in the future, their effectiveness will also be monitored and evaluated. When practicable, future effectiveness monitoring should be conducted during review of the wilderness character monitoring strategy for the Fossil Ridge Wilderness (Warnick, 2016).

Terrestrial Priority Species: Rocky Mountain bighorn sheep

Management action implemented: Inventory and population estimation

Relevant monitoring question(s):

- *What are trends in abundance, survival, and recruitment in the Fossil Ridge bighorn herd?*
  Survey data show that the Fossil Ridge bighorn herd increased from 15 to 30 animals between 2009 and 2019 (CPW, 2020b), indicating that lamb survival and recruitment remain low following a disease-related all-age die-off during the winter of 2007-2008.
- *What are trends in coordination between state and federal agencies on bighorn sheep management activities in the wilderness?*
  This fish and wildlife management strategy was developed in collaboration with CPW wildlife biologists, who generously shared their knowledge and provided valuable input and feedback. In the future, Forest Service and CPW staff should pursue opportunities for collaborative research to support achievement of bighorn sheep management objectives.
- *Are bighorn population estimates and observations being shared?*
  Yes, CPW publishes annual reports on hunting statistics that include population estimates for the Fossil Ridge bighorn herd (CPW, 2020b). Geospatial datasets of seasonal habitats and migration patterns for Rocky Mountain bighorn sheep are also publicly available through the CPW Hunting Atlas (2020a) and the ArcGIS.com website (see supporting resources for additional information).
- *Are Forest Service staff communicating with CPW staff to preserve wilderness character?*
  Yes, during the development of this strategy, information on wilderness character was shared and trade-offs of fish and wildlife management in wilderness were discussed. To increase communication and transparency among wilderness managers, wildlife biologists, and other stakeholders, these conversations should be carried on in the future. This document will be shared with partners as a reference and educational tool.

Effectiveness Evaluation: The information gained from aerial bighorn surveys is critical to achieving management objectives for this priority species. Survey data is also essential to monitoring and evaluating the effectiveness of future management actions taken to recover the Fossil Ridge bighorn herd. Therefore, the Forest Service should support CPW biologists in their survey efforts. State biologists and federal managers should share data and observations on an annual basis.

Aquatic Priority Species: Colorado River cutthroat trout
Management action implemented: Fish stockings

Relevant monitoring question(s):

- *Are fish stocking schedules being shared?*
  Yes, Dan Brauch, CPW fisheries biologist, shared fish stocking reports for years 1995-2019. These reports are on file at the Forest Service, Gunnison Ranger District.
- *What are trends in coordination between state and federal agencies on fish management activities in the wilderness? Are wilderness managers communicating with CPW staff to minimize impacts to wilderness character?*
  This fish and wildlife management strategy was developed in collaboration with CPW aquatic biologists, who generously shared their knowledge and time and provided valuable input and feedback. Through written correspondence and virtual meetings with CPW staff, information on the concept of wilderness character was shared and trade-offs of fish and wildlife management in wilderness were discussed. This document will be shared with partners as a reference and educational tool.
- *To what degree have prohibited uses (motorized equipment, aircraft, installations, etc.) been used to accomplish this work? Are these uses increasing?*
  CPW carries out bi-annual fish stockings of lakes in the Fossil Ridge Wilderness via small plane. Stocking reports indicate that aircraft use related to management of Colorado River cutthroat trout in the Fossil Ridge Wilderness has not changed significantly over time.

Effectiveness Evaluation: Whether or not fish stockings are effective in accomplishing the goals of wilderness stewardship, recreation management, and conservation biology is a multi-layered question that defies a simple answer. Aerial fish stocking is a well-established practice in the Fossil Ridge Wilderness that dates back to at least 1952, and one that will continue in the foreseeable future. Given that this practice has the potential to affect several qualities of wilderness character, it is critical that CPW and Forest Service staff collaborate to develop and manage toward a shared vision of native cutthroat trout conservation in the Fossil Ridge Wilderness. The level of communication achieved during development of this strategy indicates a positive, desirable trend in state and federal cooperation – one that should be maintained and built upon. In the future, Forest Service and CPW staff should jointly pursue opportunities identified in this strategy to conserve Colorado River cutthroat trout populations in the Fossil Ridge Wilderness. In particular, opportunities to stock green-lineage Colorado River cutthroat trout and establish a conservation population should be explored.

Indigenous Fish & Wildlife Management Strategy Implementation (8 points)

The 8-point level requires that all management actions identified in this strategy *and determined to be the minimum necessary for the administration of the area as wilderness* have been implemented, monitored, and evaluated. To be clear, implementation of some of the management actions discussed in this document may not be appropriate at this time. This particularly applies to some of the more intrusive conservation actions identified under the contingency planning and adaptive management sections for each priority species. For example, contingent upon evolving taxonomic and regulatory status decisions and changes in thermal regimes of streams due to climate change, this strategy discusses establishing a conservation population of Colorado River cutthroat trout in the Fossil Ridge

Wilderness, which would likely involve chemical treatment of identified recovery streams. Managers may determine that this action is currently not the minimum tool to support conservation of this priority species. If such a determination is made, action should not be implemented at this time. In fact, it would be prohibited under the Wilderness Act to do so. In this case, merely evaluating whether this action meets the minimum requirements is sufficient to satisfy the scoring criteria under the Fish and Wildlife Element of WSP. As environmental conditions shift, new research becomes available, or new species are listed under the Endangered Species Act, determinations of what actions constitute the minimum necessary may need to be revisited in the future.

That being said, this strategy also recommends several conservation measures that are non-intrusive and should be considered for implementation in the near-term. Each management recommendation is described in detail in the respective priority species section of this document. Implementation, monitoring, and evaluation of recommended measures would move the Fossil Ridge Wilderness closer toward meeting the 8-point level criteria for the Fish and Wildlife Element of WSP. Most importantly, these conservation initiatives will contribute to the Fossil Ridge Wilderness remaining a refuge for fish and wildlife species in a time of rapid socio-ecological change. Amidst the unfolding global biodiversity crisis, land managers have a profound responsibility to practice collaborative, thoughtful, and forward-thinking stewardship of Earth's remaining wilderness areas.

MOU between Forest Service, Region 2 and CPW (2-point checkbox)

The 2-point checkbox for the Fish and Wildlife Element of WSP requires that 1) the Forest Service has a current, signed MOU addressing wilderness topics with the state fish and wildlife agency, tribes, or other federal agencies (as appropriate); and/or 2) a coordination meeting has been held with representatives from that agency/those agencies in a given fiscal year to discuss issues specific to fish and wildlife management in a given wilderness.

The Forest Service, Rocky Mountain Region entered into an MOU with CPW in 2015. The MOU incorporated the policies and guidelines for fish and wildlife management in wilderness from the AFWA (2006) agreement and implemented them at the state level. The MOU was effective through December 31, 2017. Renewal of the MOU needs to be addressed at the regional level and is outside the control of local wilderness managers.

In the meantime, collaboration between CPW and the Forest Service, Gunnison Ranger District must continue regardless and should rely as much as possible on the expired MOU as well as the AFWA (2006) guidelines and policies. CPW fish and wildlife biologists contributed significantly to the development of this strategy by providing valuable feedback and generously sharing their expertise, data, and time. This document should be considered as evidence that state and federal staff are working together to protect the fish and wildlife resources of the Fossil Ridge Wilderness.

Collaborative Stewardship: Opportunities for Future Partnerships

The successful application of this strategy requires collaboration between the Forest Service, CPW, partner organizations, and interested members of the public. The Gunnison Ranger District is fortunate to have a strong, local network of partners, volunteers, and friends that are ready to rise to the challenge of protecting our National Wilderness Preservation System in times of rapid social and ecological change and uncertainty. Effective, mutually beneficial partnerships with Western Colorado University's Undergraduate Biology, Master in Environmental Management (MEM) and M.S. in Ecology programs, Center for Public Lands, High Country Conservation Advocates, Trout Unlimited, National Forest Foundation, Volunteers for Outdoor Colorado, Colorado Mountain Club, and others have resulted in measurable wilderness stewardship gains.

Implementation of this strategy provides several opportunities to build on existing partnerships and develop new ones. Many of the monitoring, survey, and research needs identified in this strategy should be accomplished in collaboration with biologists from CPW, students from Western Colorado University, researchers affiliated with Rocky Mountain Biological Laboratory, local chapters of Trout Unlimited and Backcountry Hunters & Anglers, and others. Not only would collaborative stewardship improve outcomes and leverage increasingly limited government resources, but it would also facilitate community conversations, build trust, and increase capacity for future conservation endeavors between the ranger district and its partners in the Gunnison Valley.

Drawing on the strengths of non-government partners, the Gunnison Ranger District has the opportunity to be a national leader and steward the wilderness lands it administers towards preservation excellence. The future of the National Wilderness Preservation System hinges on strategic leveraging of leadership and existing resources both within and outside the agency, on expanding partnerships across traditional and non-traditional boundaries, and on nurturing a new generation of wilderness stewards.

Views from Signal Peak of the subalpine forests and cragged peaks of the Fossil Ridge Wilderness rising from the sea of sagebrush characteristic of the Gunnison Basin. (Tobias Nickel, August 7, 2020)

A Living Document: Planning in the Context of Uncertainty

Given increasing pace of ecological and social change, planning must be ongoing, with multiple time horizons, short- and long-term goals, frequent updates, and flexibility to adjust to unexpected changes (Chapin et al., 2010). Recognizing uncertainty about future conditions, particularly in light of a rapidly changing climate, this document provides a flexible strategy to guide the management of fish and wildlife in the Fossil Ridge Wilderness.

The management actions identified in this strategy are not intended to be prescriptive. Rather, this strategy explores management actions that would allow wilderness managers to respond to current threats to individual species independently and prepare for a range of possible future scenarios. For example, as climate change progresses and taxonomic and regulatory status decisions change, managers may need to consider actions to ensure the long-term persistence of Colorado River cutthroat trout. Establishing a conservation population for Colorado River cutthroat trout in the cold-water refugia of the Fossil Ridge Wilderness may be one such action. By assessing risks and opportunities and analyzing the trade-offs involved from fish and wildlife and wilderness perspectives, this strategy empowers managers to make more informed decisions and respond more effectively to emerging threats.

To integrate adaptive management into wilderness stewardship, this strategy pairs potential management actions with monitoring questions. Additionally, where possible, this strategy should be tied to the ongoing wilderness character monitoring for the Fossil Ridge Wilderness (Warnick, 2016). Adaptive management requires constant feedback from monitoring that documents the outcomes of management actions. As succinctly stated by Schindler and Hilborn (2015), “Without monitoring and assessment, we have no way to determine when changes to management are needed.”

Given the importance of minimizing trammeling actions in wilderness, building feedback, flexibility, and adaptation into the management process is particularly important for wilderness stewardship. Due to the high stakes involved in intervening in wilderness (e.g., Kaye, 2018; Landres et al., 2020), there should be meaningful gains from each management action taken to conserve or recover indigenous fish and wildlife. If monitoring reveals that trammeling actions fail to achieve the desired conservation outcomes, future management actions must be adjusted or halted.

For adaptive management to be effective, the planning process itself must be iterative and dynamic, taking into account new information and adjusting to changing socio-ecological conditions. Therefore, this strategy is a living document that should be revisited and revised as needed by an interdisciplinary team on an annual basis to reflect up-to-date information on fish and wildlife management priorities, newly identified threats to indigenous species, and emerging information needs. This is important to ensure that content reflects current priorities, changes in available data, and captures any desired modifications to the priority indigenous species list. If major revisions are to be pursued in a given year then the process of updating the strategy should include stakeholder and partner engagement, a review of status shifts for priority species, and documentation of key findings in an updated version of the strategy.

Conclusion: Wilderness Stewardship in the Anthropocene

The Wilderness Act of 1964 promised current and future generations that they can forever find special places of solitude and refuge from the sights and sounds of civilization, places where ecosystems remain intact and natural processes unfold without direct human intervention. More than half a century later, anthropogenic stressors from climate change and invasive species to pollution and land fragmentation threaten wilderness values and raise serious questions about what it means to preserve wilderness in the twenty-first century (Cole and Yung, 2010; Minteer and Pyne, 2015).

In the early days of the National Wilderness Preservation System, wilderness stewardship largely involved protecting autonomous nature from visitor use impacts and incompatible land uses, such as roadbuilding, mining, and logging (Yung et al., 2010). Management actions inside wilderness boundaries used to be largely confined to clearing trails, greeting visitors, picking up trash, and cleaning up campfire rings (Cole, 2001). During this time, wilderness management was almost exclusively about managing people and trying to leave wilderness itself alone.

However, in the Anthropocene, a time of accelerating global change due to human agency, threats to ecosystems are mounting and ubiquitous (Vitousek et al., 1997; McKibben, 2006; Steffen et al., 2007). As climate change progresses, ecological processes are expected to further deviate from ranges of natural variation (IPCC, 2013). Warmer temperatures, reduced precipitation, declining snowpack, and extreme weather events will continue to pressure and displace native plant communities, giving invasive species further opportunities to establish and proliferate (Walther et al., 2002; Walther et al., 2009). Changes in vegetation composition and water availability will inevitably also affect the animal communities that depend on them.

Wilderness areas in their role as biodiversity reserves are not immune to intensifying anthropogenic stressors. Place-based conservation of native biota is becoming increasingly difficult, and ecologists are recognizing that a passive approach to wilderness management – drawing lines around particular places and leaving nature alone – may no longer preserve everything we value in these places (Cole and Yung, 2010). This has resulted in a growing clash between traditional wilderness advocates, who champion a passive approach to wilderness management, and those who call for more active ecosystem management in the name of biodiversity (Callicott and Nelson, 1998; Nelson and Callicott, 2008; Marris, 2011; Minteer and Pyne, 2015).

However, this debate frames protected area management in black and white terms and overlooks the nuances involved in stewarding the enduring resource of wilderness. As highlighted throughout this strategy, wilderness stewardship is complicated by the competing qualities of wilderness character. Therefore, decisions taken to benefit one quality may degrade another, but this does not mean that a completely hands-off approach is always the right answer. Wilderness preservation is compatible with fish and wildlife conservation, at least to the degree that such conservation uses minimum tools. Only when more intrusive measures are used can wilderness preservation and biological conservation part company (Woods, 2017; Landres et al., 2020).

As anthropogenic stressors increase both in extent and magnitude, wilderness managers will likely need to stake out a middle ground position between passive, hands-off wilderness preservation and hyperactive management. In doing so, managers must resist action-bias, carefully weigh the costs and benefits of ecological intervention, and choose a course of action (or inaction) that best respects and preserves overall wilderness character. To this end, this strategy seeks to provide managers with a tool to approach fish and wildlife management and wilderness stewardship with humility, respect and a deeper understanding. Ultimately, it is the author's most sincere hope that areas like the Fossil Ridge Wilderness can, with collaborative, thoughtful, and forward-thinking management, provide a refuge for plants, animals, and humans alike for many years to come.

A fritillary butterfly pollinating a bright yellow Old-Man-of-the-Mountain flower near the shores of Crystal Lake. (Tobias Nickel, July 4, 2020)

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List of Acronyms and Abbreviations

AFWA	Association of Fish and Wildlife Agencies
AUMs	Animal unit months
BD	*Batrachochytrium dendrobatidis*
BLM	Bureau of Land Management
CNHP	Colorado Natural Heritage Program
CPW	Colorado Parks and Wildlife
CRCT	Colorado River cutthroat trout
ECOS	Environmental Conservation Online System
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FRRMA	Fossil Ridge Recreation Management Area
FSM	Forest Service Manual
GIS	Geographical Information System
GMUG	Grand Mesa, Uncompahgre, and Gunnison National Forests
HUC	Hydrologic Unit Code
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MEM	Master in Environmental Management
MOU	Memorandum of Understanding
MRA	Minimum Requirements Analysis
MRDG	Minimum Requirements Decision Guide
NEPA	National Environmental Policy Act
NFS	National Forest System
NPS	National Park Service
NOAA	National Oceanic and Atmospheric Administration
NRIS	Natural Resource Information System
NWPS	National Wilderness Preservation System
SCC	Species of Conservation Concern
SGCN	Species of Greatest Conservation Need
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCU	Western Colorado University
WSP	Wilderness Stewardship Performance

Glossary

Fish and wildlife management and wilderness stewardship require the use of technical terms. Some of the most important are defined in this section. Terms in ***bold italics*** are defined separately in this glossary.

Adaptive Management – An approach to natural resource management where actions are designed and executed and effects are monitored for the purpose of learning and adjusting future management actions, which improves the efficiency and responsiveness of management. (Forest Service, 2019)

Allotment (Grazing) – Rangelands are managed as allotments and pastures. An allotment is a designated area of land available for permitted livestock grazing. Grazing is authorized for a specified number and kind of livestock expressed in ***animal unit months*** (Forest Service, 2019)

Animal Unit Months (AUMs) – The amount of forage required by a 1,000-pound cow, or the equivalent, for 1 month. (Landres et al., 2019)

At-Risk Species – A term used to collectively refer to federally recognized threatened, endangered, proposed, and candidate species and species of conservation concern within the planning area. (Forest Service, 2019)

Candidate Species – A species for which the USFWS possesses sufficient information on vulnerability and threat to support a proposal to list as endangered or threatened, but for which no proposed rule has yet been published. (Forest Service, 2019)

Conservation – Actions taken to safeguard indigenous fish and wildlife species or populations against a known threat. (Forest Service, 2020)

Conservation population (Colorado River cutthroat trout) – A conservation population is a naturally reproducing and recruiting population of native Colorado River cutthroat trout that is managed to preserve the historical genome and/or unique genetic, ecological, and/or behavioral characteristics. Populations are further defined by quantifying introgression. In general, a conservation population is at least 90% cutthroat trout (<10% introgression), but may be lower depending on circumstances. (CRCT, 2006b)

Critical Habitat – The federal Endangered Species Act of 1973 (ESA) (16 U.S.C.A. §§ 1531 et seq.) defines critical habitat as:

> "(i) the specific areas within the geographical area occupied by the species, at the time it is listed, … on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed, … upon a determination by the Secretary that such areas are essential for the conservation of the species."

Ecosystem – A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. An ecosystem is commonly described in terms of its:

1. **Composition** – The biological elements within the different levels of biological organizations, from genes and species to communities and ecosystems.

2. **Structure** – The organization and physical arrangement of biological elements such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity.

3. **Function** – Ecological processes, such as energy flow; nutrient cycling and retention; soil development and retention; predation and herbivory; and natural disturbances such as wind, fire, and floods that sustain composition and structure.

4. **Connectivity** – Ecological conditions, existing at several spatial and temporal scales that provide for the movement and population interchange of species, providing landscape linkages that permits daily and seasonal movements of species within home ranges, facilitates dispersal and genetic interchange between populations, and allows long distance range shifts of species, such as in response to climate change. (FSM 2020.5)

Electro-fishing – A scientific fish-sampling technique that uses electricity to temporarily stun fish so they can be captured. Electro-fishing is a common scientific survey method to sample fish populations for abundance, density, and species composition. When performed correctly, electro-fishing results in no permanent harm to fish, which return to their natural state shortly after being affected by electro-fishing equipment. (NPS, 2013)

Extirpated – Local extinction, in which a species ceases to exist in a specific geographic area, though it still exists elsewhere. (NPS, 2013)

Endangered Species – The federal Endangered Species Act of 1973 (ESA) (16 U.S.C.A. §§ 1531 et seq.) defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range."

Forest Plan – Source of management direction for an individual national forest that specifies activity and output levels for a period of time. Management direction in the plan is based on the issues identified at the time of the plan's development. (Forest Service, 2019)

Forest Plan Revision – The process for revising a forest plan includes working identification of the need to change the plan based on the assessment, development of a proposed plan, consideration of the environmental effects of the proposal and preparation of a draft environmental impact statement, providing an opportunity for the public to comment on the proposed plan, providing an opportunity for the public to object before the proposal is approved, and finally, approval of the plan and preparation of the final environmental impact statement. (Forest Service, 2019)

Hydrologic Unit Code (HUC) – The numerical identifier of a specific hydrologic unit or drainage area. Drainage areas are delineated to nest in a multilevel, hierarchical arrangement. consisting of a two digit sequence for each specific level within the delineation hierarchy. The hydrologic unit hierarchical system has six levels. HUCs consist of two to twelve digits based on the six levels of

classification: 2-digit HUC first-level (region); 4-digit HUC second-level (subregion); 6-digit HUC third-level (basin); 8-digit HUC fourth-level (subbasin); 10-digit HUC fifth-level (***watershed***); 12-digit HUC sixth-level (***subwatershed***). (USGS, 2013)

Indigenous Species – Those fish and wildlife species that historically occurred within a wilderness area without human assistance (Forest Service 2020). For purposes of this strategy, the terms indigenous and ***native species*** are used interchangeably.

Installation – Anything made by humans that is not intended for human occupation and is left unattended or left behind when the installer leaves the wilderness. (NPS, 2013)

Invasive Species – A species is considered invasive if it meets two criteria: 1) it is non-***native*** to the ***ecosystem*** under consideration; and 2) its introduction causes or is likely to cause unacceptable effects to human health or the environment. (Forest Service, 2020)

Linkage – Broader regions of connectivity that are important to facilitate the movement of multiple species and maintain ecological processes. (Forest Service, 2019)

Lynx Analysis Unit – An area of at least the size used by an individual lynx, from about 25 to 50 square miles. (Forest Service, 2019)

Mechanical Transport – Any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This includes, but is not limited to, sailboats, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snowshoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts. (FSM 2320.5)

Memorandum of Understanding (MOU) – A legal agreement between the Forest Service and other agencies resulting from consultation between agencies that states specific measures the agencies will follow to accomplish a large or complex project. (Forest Service, 2019)

Minimum Requirements Analysis (MRA) – The minimum requirements analysis is a two-step process that documents 1) the determination as to whether or not a proposed management action is appropriate and necessary for the administration of the area as ***wilderness***, and does not pose a significant impact to the wilderness resources and character; and, 2) the selection of the ***minimum tool*** that causes the least amount of impact to ***wilderness character***. (NPS, 2013)

Minimum Requirements Decision Guide (MRDG) – The Minimum Requirements Decision Guide is a process that was developed by the Arthur Carhart National Wilderness Training Center to assist wilderness managers with completing a ***Minimum Requirements Analysis*** for wilderness projects and making appropriate, defensible management decisions that comply with the Wilderness Act.

Minimum Activity – The least intrusive method, tool, equipment, device, force, regulation or practice that will achieve the wilderness management objective. It is commonly referred to as "minimum tool." (NPS, 2013)

Minimum Tool – A use or activity determined to be necessary to accomplish an essential task that makes use of the least intrusive tool, equipment, device, force, regulation, or practice that will achieve the management objective. (NPS, 2013)

Motorized Equipment – Machines that use a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, snowmobiles, generators, motorboats, and motor vehicles. It does not include small battery or gas powered handcarried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment. (FSM 2320.5)

National Wilderness Preservation System (NWPS) – The NWPS is the sum total of all ***wilderness areas*** designated under the Wilderness Act of 1964 and subsequent legislation. The Forest Service, USFWS, NPS, and BLM are the federal agencies that share the responsibility of managing the nation's wilderness. As of August 2020, there are 803 wilderness areas in the NWPS, protecting about 5% (111,687,310 acres) of the entire United States. Alaska contains just over half of America's wilderness, leaving 2.7% of the contiguous United States designated as wilderness. (wilderness.net)

Native Species – See ***indigenous species***. For purposes of this strategy, the terms indigenous and native are used interchangeably.

Permanent Improvement – A structural or nonstructural improvement that is to remain at a particular location for more than one field season. Permanent improvements include such items as trails, toilet buildings, cabins, fences, tent frames, fire grills, and instrumentation stations. (FSM 2320.5)

Priority Species – Those species that have been highlighted by Forest Service staff and partners at the local level as management priorities in a given ***wilderness*** in the foreseeable future. They may or may not be listed as ***Threatened***, ***Endangered***, ***Species of Conservation Concern*** (Forest Plans developed under the 2012 Planning Rule) or for some other reason singled out for special treatment by federal agencies, state agencies, or non-governmental organizations. The only requirement is that they fit the definition of ***indigenous*** as provided in the *Wilderness Stewardship Performance Guidebook* (Forest Service, 2020).

Prohibited Uses – Human land uses and activities taking place in ***wilderness*** that are prohibited under Section (4c) of the Wilderness Act. These include: temporary roads, use of motor vehicles, ***motorized equipment*** or motorboats, landing of aircraft, any other form of ***mechanical transport***, and ***structures*** or ***installations*** within a ***wilderness area***. These are sometimes also referred to as non-conforming uses.

Recovery – (1) Improvement in status of a ***priority indigenous fish or wildlife species*** whose persistence in a ***wilderness*** is threatened or (2) successful reintroduction of a priority indigenous fish or wildlife species that was previously ***extirpated*** from a wilderness or portion thereof. (FSM 2020.5)

Resilience – The ability of a social or ecological system to absorb disturbances while retaining the same basic ***structure*** and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change. (FSM 2020.5)

Restoration – The process of assisting the recovery of an ***ecosystem*** that has been degraded, damaged, or destroyed. Ecological restoration focuses on establishing the ***composition***, ***structure***, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, ***resilience***, and health under current and future conditions. (FSM 2020.5)

Sensitive Species – Those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: 1) Significant current or predicted downward trends in population numbers or density; 2) Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Sensitive Species must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for federal listing. (FSM 2670.5)

Species of Conservation Concern (SCC) – This is a special category developed by the Forest Service to proactively plan for species in the plan area for which there are substantial concerns about their ability to persist. Federally listed species will continue to be afforded all protections under ESA, including carrying out actions leading to recovery and consulting on federal actions affecting the species or their critical habitat. While the Regional Forester is responsible for deciding which species will be placed on the GMUG's SCC list, the Forest Supervisor, specialists, and the public will provide input and assist throughout the review process. (Forest Service, 2019)

Social Trail – A trail which was not created by an authorized action. Sometimes also referred to as a user-created trail. (Landres et al., 2019)

Structure – Anything made by humans that is intended for human occupation, or their possessions, and is left behind when the builder leaves the wilderness. (NPS, 2013)

Subwatershed – A subdivision of a ***watershed***. A Subwatershed is the sixth-level, 12-digit unit of the ***hydrologic unit code*** hierarchy. Subwatersheds generally range in size from 10,000 to 40,000 acres. (USGS, 2013)

Threatened Species – The federal Endangered Species Act of 1973 (ESA) (16 U.S.C.A. §§ 1531 et seq.) defines an endangered species as "any species which is likely to become an ***endangered*** species within the foreseeable future throughout all or a significant portion of its range."

Traditional Skills – The proficient use of non-***motorized*** tools and non-***mechanized*** forms of transport (e.g., axe, crosscut saw, hand drill, rigging, and packing with stock). (Forest Service, 2020)

Trammeling Action – An action or persistent ***structure*** that intentionally manipulates "the earth and its community of life" inside a designated ***wilderness area***. Further information on trammeling actions are contained in Appendix B.

Unconfined Recreation – A type of recreation in which visitors experience a high degree of freedom over their own actions and decisions. This encompasses the sense of discovery, adventure, exploration, and mental challenge presented by ***wilderness areas*** in which one can travel widely and explore unique and unknown environments on one's own without having to conform to society's norms or rules. (Landres et al., 2019)

Watershed – The term watershed has two meanings when used in the context of the USGS National Watershed Boundary Dataset and the Forest Service Watershed Condition Framework:

1. In the hierarchy of ***hydrologic units***, a 10-digit (fifth-level) hydrologic unit is also known as a watershed, and it is a subdivision of an 8-digit (fourth-level) unit, also known as a subbasin. These 10-digit hydrologic units range in size from 40,000 to 250,000 acres and are further subdivided into 12-digit (sixth-level) units, referred to as ***subwatersheds***.
2. The term watershed also refers to the divide that separates one drainage basin from another or to a combination of hydrologic units of any size. (USGS, 2013)

Watershed Condition – The state of the physical and biological characteristics and processes within a watershed that affect the soil and hydrologic functions supporting aquatic ecosystems. Watershed condition reflects a range of variability from natural pristine (functioning properly) to degraded (severely altered state or impaired). (Forest Service, 2011b)

Watershed Condition Class – Within the Watershed Condition Framework, this describes the ***watershed condition*** in terms of discrete categories (or classes) that reflect the level of watershed health or integrity: Class 1 = functioning properly, Class 2 = functioning at risk, or Class 3 = impaired function. (Forest Service, 2011b)

Wilderness Area – Federal land designated by Congress as a component of the ***National Wilderness Preservation System***. An area of wilderness is defined in Section 2(c) of the Wilderness Act:

> "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness character – Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature. Taken together, these tangible and intangible values define wilderness character and distinguish wilderness from all other lands. (Landres et al., 2015)

Wilderness character (Qualities) – Qualities are the primary elements of wilderness character that link directly to the statutory language of the 1964 Wilderness Act. The same set of qualities applies nationwide to all ***wilderness areas*** managed by all agencies. The five qualities of wilderness character are: Untrammeled, Undeveloped, Natural, Solitude or Primitive and Unconfined Recreation, and Other Features of Value. (Landres et al., 2015)

Wilderness Character Monitoring – The process of assessing the overall trend in ***wilderness character*** using the interagency strategy described in *Keeping it Wild 2* (Landres et al., 2015).

Wilderness Stewardship – Mandated by the Wilderness Act of 1964 such that each agency administering any area designated as ***wilderness*** shall be responsible for preserving the ***wilderness character*** of the area. (Landres et al., 2019)

Wilderness Stewardship Performance (WSP) – WSP is a framework to track how well the Forest Service is fulfilling its primary responsibility under the Wilderness Act of 1964 – which is to preserve ***wilderness character***. Under this framework, specified wilderness stewardship accomplishments contribute to improvement in performance scores for individual ***wilderness areas***. For more information, please consult the *Wilderness Stewardship Performance Guidebook* (Forest Service, 2020).

Appendix A – Wilderness Stewardship Performance: Fish and Wildlife Element

Table 3. Wilderness stewardship performance criteria for the fish & wildlife element. (Forest Service, 2020)

Score	Description	Deliverables / Outcomes	Recommended NRM Documentation
2 points[1]	An indigenous fish and/or wildlife management strategy has been established for this wilderness, in coordination with the state fish and wildlife agency and U.S. Fish and Wildlife Service/National Marine Fisheries Service, as appropriate.	• Strategy is in place and signed by appropriate line officer, and has been reviewed and (if needed) updated within the past year.	• Title of indigenous fish and/or wildlife management strategy and signature date (MM/YYYY)
4 points[2]	Management actions to conserve and/or recover at least one terrestrial and one aquatic priority indigenous species in this wilderness have been implemented.	• Management action map in GIS with narrative	• Name of indigenous species • Description of implemented management actions (brief) • Date of management action map (MM/YYYY)
6 points[3]	Management actions for at least one terrestrial and one aquatic priority indigenous species in this wilderness have been monitored and evaluated for effectiveness.	• Narrative detailing priority actions • Project file contains documentation of action effectiveness	• Description of management action evaluated for effectiveness (brief) and date of evaluation (MM/YYYY)
8 points[4]	All management actions identified in the strategy and determined to be the minimum necessary for the administration of the area as wilderness have been taken and evaluated, with changes to these actions implemented as needed.	• Narrative detailing management actions • Changes listed in strategy appendices	• Description of management actions evaluated (brief) and date of last evaluation (MM/YYYY)
2 point checkbox	The Forest Service has a current, signed Wilderness Memorandum of Understanding (MOU) with the state fish and wildlife agency, tribes, or applicable federal agencies (as appropriate) and/or a coordination meeting has been held with representatives from that agency/those agencies this fiscal year to discuss issues specific to fish and/or wildlife management in this wilderness.	• Current MOU on file and/or meeting notes from yearly meeting are available in corporate database	• Title, signature date, and expiration date of MOU (MM/YYYY) • Upload to WSP Pinyon folder

Appendix B – What is a Trammeling Action

An excerpt from *Keeping It Wild 2* (Landres et al. 2015, pp. 101-106).

This appendix provides guidelines and examples to clarify what is and is not a trammeling action. These are intended to capture about 90% of the cases and provide sufficient guidance for local staff to figure out the novel and rarer cases as they occur. A trammeling action is defined as an action that intentionally manipulates "the earth and its community of life" inside a designated wilderness or inside an area that by agency policy is managed as wilderness.

The following terms and phrases clarify this definition above:

- Intentional: done on purpose; deliberate; willful.
- Manipulation: an action that alters, hinders, restricts, controls, or manipulates "the earth and its community of life" including the type, amount, or distribution of plants, animals, or physical resources.
- Intentional manipulation: an action that purposefully alters, hinders, restricts, controls, or manipulates "the earth and its community of life."

Two concepts are crucial for understanding what is and is not a trammeling action: restraint and intention. Restraining our power to manipulate or control the earth and its community of life is at the core of the Untrammeled Quality of wilderness character. Trammeling actions occur when opportunities for restraint are ignored or bypassed; when there is no opportunity for restraint, there is no opportunity to trammel. Wilderness legislation and policies mandate that managers exercise restraint when authorizing actions that interfere with or control wilderness ecological systems. While other agencies, organizations, and the public are not beholden to these same restrictions, activities that have not been authorized by the federal land manager and that manipulate the wilderness environment are counted as trammeling actions.

The second concept central to the idea of trammeling is intentionality. Actions that deliberately interfere with, manage, or control an aspect of wilderness ecological systems are intentional and clear instances of trammeling. As explained in the chapter on the Untrammeled Quality, intentional actions are counted as a trammeling regardless of the magnitude of their effects (including areal extent, intensity, frequency, and duration). For pragmatic reasons, however, some actions are not monitored if they fall below a minimum practical threshold of scale and scope (for example, hand pulling a few individual noxious plants). Much more complex and nuanced is determining whether to include actions whose purpose is not to manipulate the earth and its community of life, but some manipulation of the environment is required to produce the desired outcome. These types of actions can be confusing because the biophysical environment is intentionally manipulated even though it is not the purpose behind the action. In general, when such actions have substantial and foreseeable effects on the wilderness ecosystem, they are counted as a trammeling.

The following sections describe three types of activities: those that are trammeling actions, those that are not trammeling actions, and those that may be trammeling actions. Following these sections, a flowchart provides general guidance for making these determinations.

Activities that are trammeling actions:

There are two broad classes of trammeling actions: those that are authorized by the federal wilderness manager, and those that are not. Three subclasses under each of these reflect whether the action is taken on a biological resource, on a physical resource, or on a resource outside the wilderness with the intent to manipulate biophysical resources within the wilderness.

Agency authorized trammeling actions. These are actions that are authorized by the federal wilderness manager as well as actions by other agencies, organizations, or individuals that have been approved or permitted by the federal land manager.

1. Actions taken inside the wilderness on a *biological* resource to intentionally affect "the earth and its community of life." Examples include:
    a. Removing or killing indigenous or non-indigenous vegetation or fish and wildlife.
    b. Adding or restoring indigenous or non-indigenous vegetation or fish and wildlife.
    c. Using chemicals or biocontrol agents to control indigenous or non-indigenous vegetation or fish and wildlife.
    d. Collecting, capturing, or releasing plants and animals under a research permit.
    e. Enclosing or excluding fish and wildlife from an area.

2. Actions taken inside the wilderness on a *physical* resource or natural process to intentionally affect "the earth and its community of life." Examples include:
    a. Suppressing naturally-ignited fire.
    b. Lighting fire (under management prescription) for any purpose.
    c. Constructing or maintaining a dam, water diversion, guzzler, or other persistent installation intended to continuously alter wilderness hydrology; each agency will need to determine their counting rules for monitoring such installations.
    d. Adding acid-buffering limestone to water to neutralize the effects of acid deposition.

3. Actions taken *outside* the wilderness on a physical or biological resource or process to intentionally affect "the earth and its community of life" inside a wilderness. Examples include:
    a. Cloud seeding to intentionally increase precipitation inside the wilderness.
    b. Damming a river outside a wilderness to intentionally alter the hydrology inside the wilderness.
    c. Killing fish and wildlife outside the wilderness, or planting or stocking fish or wildlife outside the wilderness, to intentionally affect the population or distribution of this species inside the wilderness.

Unauthorized trammeling actions. These are citable or other actions taken by other agencies, organizations, or individuals that have not been authorized, approved, or permitted by the federal wilderness land manager.

1. Actions taken inside the wilderness on a *biological* resource to intentionally affect "the earth and its community of life." Examples include:
    a. Adding or removing plants or fish and wildlife.

b. Other direct manipulation of plants or fish and wildlife.
c. Indirect manipulation of fish and wildlife, such as changing hunting regulations with the goal of decreasing predator populations within the wilderness.

2. Actions taken inside the wilderness on a *physical* resource or natural process to intentionally affect "the earth and its community of life." Examples include:
   a. Setting arson fire.
   b. Modifying water resources to provide water for wildlife, or otherwise store water or alter the timing of water flow.

3. Actions taken *outside* the wilderness on a physical or biological resource to intentionally affect "the earth and its community of life" inside a wilderness. Examples include:
   a. Releasing or killing species outside of the wilderness with the intention to affect populations whose ranges expand into the wilderness.

In some situations, staff may assume that they do not have the opportunity for restraint because an action is required to comply with other laws or agency policies, or to protect human life or property. Examples of such situations include restoring habitat for a listed endangered species, spraying herbicides to eradicate an invasive non-indigenous plant that is degrading wildlife habitat, transplanting an extirpated species back into the wilderness, or suppressing a naturally-ignited fire. These are still considered trammeling actions because even in these situations staff are deciding to take action as well as deciding the type and intensity of action.

<u>Activities that are not trammeling actions:</u>
Actions for which there is no opportunity for managerial or individual restraint are not considered a trammeling. For example, climate change, air pollutants wafting into a wilderness, and the presence of non-indigenous species that naturally dispersed into a wilderness are not intentional decisions or actions, and therefore do not provide an opportunity for management restraint. Accidental unauthorized actions, such as escaped campfires and oil spills, similarly lack an opportunity to restrain our power over the landscape. Past actions that manipulated the biophysical environment before the area was designated as wilderness are not considered a trammeling because the provisions of the 1964 Wilderness Act did not apply to the area prior to designation.

Another group of examples that are not a trammeling encompass those small-scale actions with no intent to manipulate the earth and its community of life, such as installing meteorological or other science instrumentation, landing a helicopter for SAR operations, and removing trash. Camping violations, unauthorized motorized incursions, and other illegal activities that are not intended to manipulate the biophysical environment are also not counted as trammeling actions; legality is irrelevant in determining whether an action is a trammeling.

Hunting, for sport or subsistence, has provoked an enormous amount of discussion about whether it degrades the Untrammeled Quality. The consensus from the Lessons Learned Workshop was that hunting is generally not a trammeling action because individual hunters are taking individual animals without the intention to manipulate the wildlife population. However, if a state wildlife agency

manipulates hunting quotas (or takes other management action) to alter the predator/prey relationship in order to maximize certain hunting opportunities, this manipulation of the "community of life" would degrade the Untrammeled Quality (see above).

Activities that may be trammeling actions:

There are two types of actions that may or may not be considered trammeling actions. The first includes intentional manipulations that interfere with or control an aspect of wilderness ecosystems but are too small in scale or scope to be practically monitored. The second type encompasses those nuanced cases where the primary purpose of the action is not to manipulate the ecosystem but a foreseeable and substantial effect on the earth and its community is required to achieve this purpose. As shown in Table 4, several hypothetical situations illustrate how an action may or may not be a trammeling depending on the extent of the action and its effects. Each bullet in the table presents a situation where the action being taken likely would, or would not, be considered a trammeling.

Table 4. Examples of trammeling and non-trammeling actions.

Action	Likely Not a Trammeling	Likely a Trammeling
Treating non-indigenous invasive plants	▪ Hand pulling a small area of non-indigenous invasive plants	▪ Spraying herbicide
Permitting scientific activities	▪ Installing research plot monumentation, such as rebar stakes or nails ▪ Installing most scientific instrumentation ▪ Collecting a limited number of voucher specimens with no impact on species distribution or abundance	▪ Installing enclosures or exclosures ▪ Installing instrumentation that disrupts the movement or behavior of plants, or fish and wildlife ▪ Capturing, collaring, and releasing wildlife
Building system trail	▪ Routing a trail around a rock slide ▪ Building a bridge across a stream to prevent stream bank erosion ▪ Installing a small section of corduroy across a wet area ▪ Installing in waterbars or building rock-cribbing	▪ Routing a trail through an area of sensitive alpine butterfly habitat ▪ Building a large amount of trail to go around a section of river or cliff ▪ Building a trail that requires extensive earth movement or tree cutting
Obliterating non-system trail	▪ Piling vegetation or rocks at the beginning and end of trail sections that cut a switchback	▪ Obliterating a large section of non-system trail that requires extensive earth movement
Restoring campsites	▪ Restoring a single, isolated campsite ▪ Restoring a number of campsites that don't require disrupting the soil or vegetation in the surrounding area	▪ Restoring a number of campsites that requires moving a significant amount of soil or number of plants in the surrounding area
Removing hazard trees	▪ Removing one or a few hazard trees that threaten designated campsites or that are along a trail	▪ Removing all of the hazard trees over a large area

Flowchart:

The flowchart (Fig. 12) below is intended to provide general guidelines to help agency staff determine when an action should be considered a trammeling. The first question asks if there is an opportunity for restraint, and is placed first to help avoid confusing those actions that are beyond the scope of management control, or are unauthorized accidents, from actions that managers or others do have an opportunity to influence. Political considerations are not a factor in determining whether or not there is an opportunity for restraint. The second question examines the intentionality of the action and whether the purpose is to manipulate the earth and its community of life. If there is a clear intent to manipulate, then the action is counted as a trammeling unless it does not meet a minimum threshold for practicable monitoring. If the purpose of the activity is not to manipulate the ecological system, the action is nonetheless considered a trammeling if it results in foreseeable and substantial effects to the wilderness ecosystem.

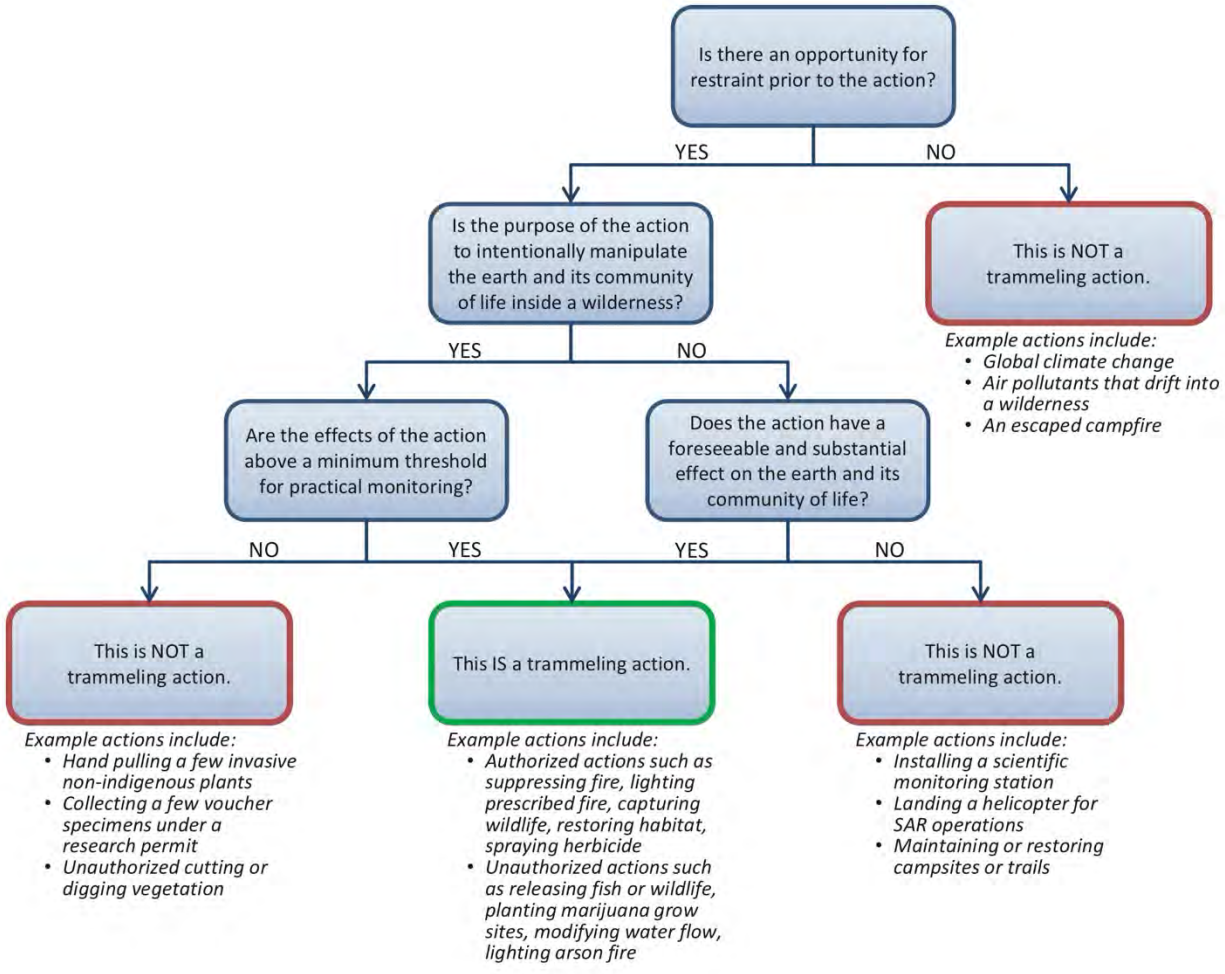

Figure 12. Flowchart to determine when an action should be considered trammeling.

Appendix C – Stakeholder Analysis

The World Wildlife Fund defines a stakeholder as "any individual, group, or institution who has a vested interest in the natural resources of the project area and/or who potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same" (Golder and Grawler, 2005). Stakeholder engagement is critical to gaining public support, considering a diversity of viewpoints, and anticipating potential conflicts (Vogler et al., 2017). Stakeholder involvement can also create valuable opportunities for partnerships, collaboration, and knowledge sharing, thus improving decision-making processes and project outcomes (Bryson, 2004). Moreover, identifying and involving "hidden" stakeholders can reduce negative impacts on vulnerable and disadvantaged groups (Golder and Grawler, 2005). While no guarantee for success, a thoughtful and honest stakeholder analysis provides a valuable foundation for development and implementation of this strategy.

The stakeholder identification and analysis techniques outlined in Vogler et al. (2017 and Golder and Grawler (2005) were generally followed and informed this project. The "Grand Mesa, Uncompahgre, and Gunnison National Forests' Rapid Stakeholder Assessment Report in Preparation for Plan Revision" (Ricco and Schultz, 2016) and "Grand Mesa, Uncompahgre, and Gunnison National Forests Public Participation Strategy: Land and Resource Management Plan Revision 2017-2021" (Forest Service, 2017) were also consulted. The Stakeholder Analysis Matrix (Table 5) lists the parties that potentially have a vested interested in or might be affected by the management of fish and wildlife resources in the Fossil Ridge Wilderness.

For each stakeholder, their potential roles are described, including gatekeepers, allies, beneficiaries, participants, and interested parties. Gatekeepers control assets, information, or other resources essential to the success of the project. Allies are partners that support the project and can contribute valuable resources and/or information. Beneficiaries stand to gain something from the project. Participants are parties actively involved in project planning, decision-making, and/or implementation. Interested parties have some stake in the project but – unlike gatekeepers, allies, or participants – do not yield any or very little influence on the project. Some stakeholders may also assume more than one role over the course of a project. Besides these roles, parties are further categorized into either internal or external stakeholders. Internal stakeholders are directly involved in the development and operations of the project. By contrast, external stakeholders are affected by the project in some way and/or yield influence upon the project from the outside.

In addition, Table 5 also describes each stakeholder's interest(s) in the project as well as their anticipated level of support (or opposition) to the project. The final column notes if a stakeholder is considered marginalized, thus potentially lacking recognition or capacity to participate in collaborative efforts on an equal basis. Particular effort must be made to ensure and enable the participation of these "hidden stakeholders" (Vogler et al., 2017).

After identifying potential stakeholders, the second step in a stakeholder analysis is to assess the influence, interest, importance, and level of impact of the stakeholder groups (Vogler et al., 2017; Golder and Grawler, 2005). The Stakeholder Analysis Grid (Fig. 13) visualizes the relative influence

(on one axis) and level of interest (on the other axis) for each stakeholder. The identified stakeholders for this project fall primarily in one of two quadrants: high interest paired with high influence and low interest paired with low influence (Fig. 13). The three government agencies (Forest Service, CPW, and the USFWS) are all critical stakeholders with concurrent authority over and shared responsibility for the fish and wildlife present in the Fossil Ridge Wilderness. As this project aligns directly with the agencies' missions, high involvement can be expected (though agency staff will be stretched thin with different projects demanding their attention, and time and resources will be limited). As a project sponsor, Western Colorado University also has substantial influence over the project and a vested interest in delivering excellent results for and sustaining a positive partnership with the government agencies.

On the other side of the spectrum, are various user groups and civic organizations that have at least some interest in and connection to the Fossil Ridge Wilderness but generally have little influence on this project. It is important to note that this indigenous fish and wildlife management strategy is not a decision document. This strategy is primarily intended for a target audience of managers who have responsibilities for stewarding fish, wildlife, and wilderness resources. This strategy is supplemental and complementary to existing statutes, regulations, policies, and forest plan components. As a result, development of this strategy does not fall under the purview of National Environmental Policy Act (NEPA) and is not subject to the public consultation requirements outlined in NEPA.

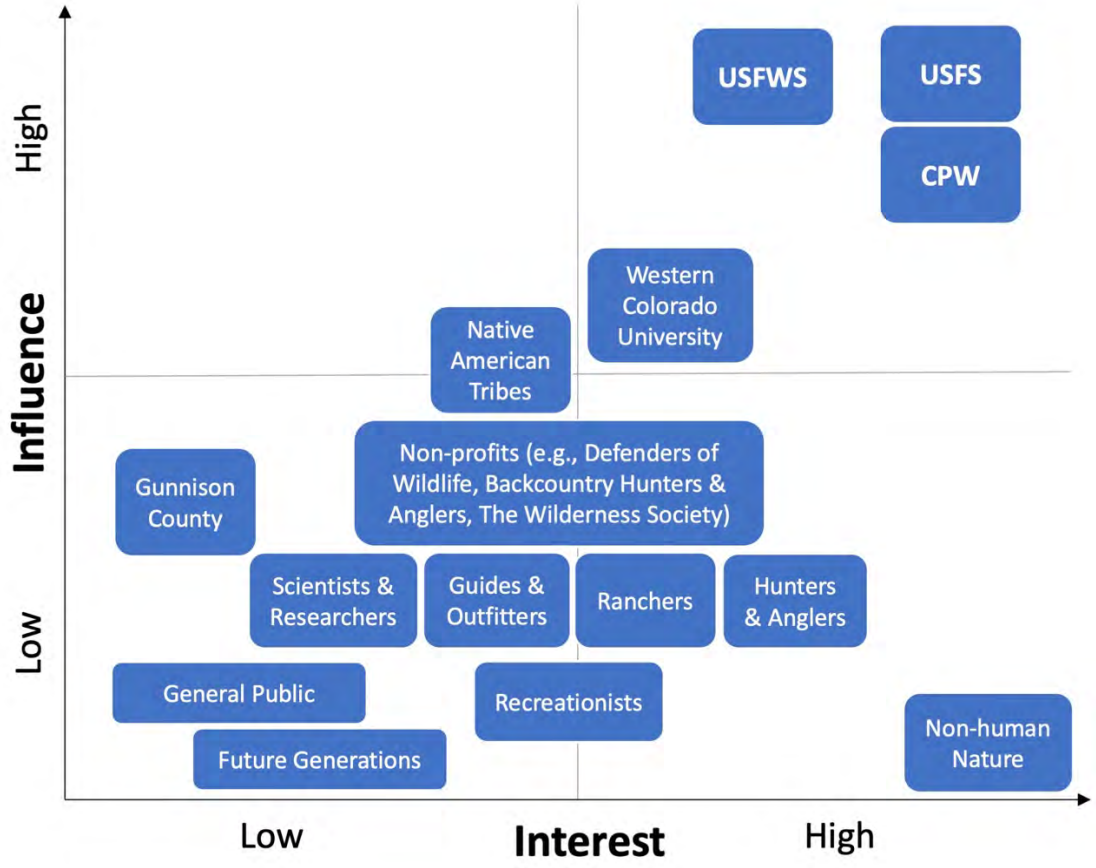

Figure 13. Stakeholder analysis grid.

Table 5. Stakeholder analysis matrix.

Stakeholder	Role	Interest(s)	Anticipated Level of Support	Marginalized
Western Colorado University (specifically, School of ENVS, Center for Public Lands, and MEM faculty)	Internal, project sponsor, critical ally, gatekeeper beneficiary	Contractually bound to provide deliverables; interested in sustaining and improving mutually beneficial partnership with the Forest Service; mission of environmental stewardship; promotes students' educational growth and professional development	Supportive	No
U.S. Forest Service	Internal, project sponsor, client, critical ally, gatekeeper, beneficiary	Administers Fossil Ridge Wilderness; responsible and accountable for preservation of wilderness character, which includes fish and wildlife resources	Generally supportive	No
Colorado Parks and Wildlife	External, critical ally, gatekeeper, beneficiary	Manages fish and wildlife resources in the state of Colorado	Generally supportive, though disagreements over historical practices and state vs. federal authority are possible	No
U.S. Fish & Wildlife Service	External, critical ally, gatekeeper, beneficiary	Jurisdiction over species listed under the federal Endangered Species Act	Generally supportive	No
Native American Tribes	External, potential ally, potential participant	Archaeological and ethnographic resources; cultural, spiritual, and historical ties to the land	Not known	Potentially
Gunnison County	External, potential beneficiary	The Fossil Ridge Wilderness lies entirely within the Gunnison County boundaries. Outdoor recreation is an important regional economic driver and source of revenue for the county.	Not known	No
The Wilderness Society, High Country Conservation Advocates, Rocky Mountain Wild, Wilderness Watch, Sierra Club, Defenders of Wildlife, Center for Biological Diversity, and other conservation-oriented non-profit organizations	External, interested party, potential ally, beneficiary	Vested interest in biodiversity conservation and the stewardship of the National Wilderness Preservation System	Generally supportive, though disagreements are possible over diverging wilderness management philosophies, priorities, and values	No
Commercial Guides, Outfitters (and organizations representing them)	External, interested party, potential ally, participant, and beneficiary	Economic livelihoods at least partially depend on access to and ecosystem services provided by the Fossil Ridge Wilderness	Mixed	Potentially

Stakeholder	Role	Interest(s)	Anticipated Level of Support	Marginalized
Ranchers, especially local grazing permittees and organizations representing them (e.g. Gunnison County Stockgrowers Association)	External, interested party, potential ally and participant	Economic livelihoods at least partially depend on access to and ecosystem services provided by the Fossil Ridge Wilderness	Mixed	Potentially
Day hikers, backpackers (and organizations representing them, e.g. Back Country Horsemen of America)	External, interested party, potential ally and participant, beneficiary	Seek out Fossil Ridge Wilderness for enjoyment, inspiration, tranquility, among many other reasons.	Generally supportive, though management actions may temporarily affect recreational opportunities	No
Hunters, anglers (and organizations representing them, e.g. Trout Unlimited, Backcountry Hunters & Anglers)	External, interested party, potential ally, participant, and beneficiary	Seek out Fossil Ridge Wilderness for world-class fishing and hunting opportunities, thus affected by management actions that affect fish and game populations or restrict traditional harvest practices	Mixed, as management actions may improve or compromise hunting and fishing opportunities	No
Scientists and researchers, Rocky Mountain Biological Laboratory	External, interest party, potential ally, participant, and beneficiary	Designated wilderness areas are natural laboratories that can provide invaluable educational and research opportunities across many academic disciplines	Generally supportive, though disagreements are possible over management decisions	No
General Public	External, potential participant or interested party, ideally beneficiary	The Fossil Ridge Wilderness and the fish and wildlife contained therein are managed in the public trust and are the collective heritage of all Americans	Mixed	Potentially
Future Generations	External, interested party, ideally beneficiary	The Fossil Ridge Wilderness and the fish and wildlife species contained therein are intended to be passed on for future generations to enjoy and appreciate	Unknowable	Always
Non-Human Nature	External, ideally beneficiary	Directly affected by wilderness management actions and decisions to intervene in ecological processes	Unknowable	Always

Appendix D – General Interview Questions Guiding Priority Species Selection

When considering species for inclusion in this strategy, the following general questions were used to guide interviews with subject matter experts and stakeholders.

- What species are currently or foreseeably being actively managed (not including routine harvest as managed by CPW) in the Fossil Ridge Wilderness?
- What fish and wildlife management actions have taken place in the Fossil Ridge Wilderness (or its immediate vicinity) in the past?
- What species have a core historic or current range that falls largely or entirely within the Fossil Ridge Wilderness? What species are especially reliant upon habitat within the wilderness for their persistence or recovery?
- What are the primary anthropogenic stressors threatening indigenous species in the Fossil Ridge Wilderness?
- What management objectives have been identified for indigenous species populations and their habitats in the Fossil Ridge Wilderness?
- What additional supporting resources, scientific literature, and data are available to inform fish and wildlife management in the Fossil Ridge Wilderness? What data gaps exist? What future surveys, assessments, and monitoring may be needed to inform management actions?
- What species indigenous to the Fossil Ridge Wilderness are listed as threatened or endangered, or being considered for listing under the Endangered Species Act?
- What species indigenous to the Fossil Ridge Wilderness are identified by the State of Colorado as conservation or management priorities?
- What species indigenous to the Fossil Ridge Wilderness are identified as at-risk by the Forest Service?
- What species indigenous to the Fossil Ridge Wilderness are of particular interest to partner organizations, recreationists, and/or the general public?
- What species indigenous to the Fossil Ridge Wilderness may serve as an umbrella species and/or indicator of ecosystem health?

Appendix E – Key Provisions Guiding Fish Stocking in Wilderness

Forest Service Manual (FSM): Chapter 2320 – Wilderness Management

2323.34 - Fisheries Management

2323.34a - Stocking Programs

In cooperation with the States, develop fish-stocking programs that meet wilderness management objectives. Recognize the probability of increased visitor use of stocked waters and their full impact and effect on the wilderness resource. Direct practices at achieving quality fishing opportunities. Regional Foresters shall develop with each State a supplement to the State-Forest Service Memorandum of Understanding (FSM 2600) that establishes a stocking policy for each wilderness. Spell out basic stocking decisions in the forest plan or in implementation schedules for each wilderness.

2323.34b - Stocking Methods

Stocking shall normally be done by primitive means, however, Regional Foresters may permit dropping of fish from aircraft for those waters where this practice was established before the area was designated a wilderness. Conduct aerial stocking pre- or post-visitor seasons. Landings are prohibited. Specify mitigation for stocking methods in wilderness implementation schedules.

2323.34c - Stocking Policy

1. Do not stock exotic species of fish in wilderness. The order of preference for stocking fish species is:
    a. Federally listed threatened or endangered, indigenous species.
    b. Indigenous species.
    c. Threatened or endangered native species if species is likely to survive and spawn successfully.
    d. Native species if species is likely to survive and spawn successfully.
2. Stock barren waters only after determining that the scientific and research values of such barren waters will not be eliminated from a wilderness and documenting the desirability of such action in the forest plan.
3. Consider on a case-by-case basis presently unstocked waters that at one time supported an indigenous fish population and that could provide suitable habitat for an indigenous species with unusual wilderness appeal.

Policies and Guidelines for Fish and Wildlife Management in National Forest and Bureau of Land Management Wilderness (AFWA, 2006)

Section 10. Fish Stocking

Fish stocking may be conducted by the State agency in coordination with the Federal administering agency to perpetuate or recover a threatened or endangered species, or to reestablish or maintain indigenous fish species. Any species of fish introduced for management purposes prior to wilderness designation may be managed as indigenous fish species if the species is likely to survive. State agencies may continue to stock those waters traditionally stocked prior to wilderness designation. State and Federal agencies should carefully evaluate stocking those waters that consistently require supplementation for reasons other than angler-induced mortality.

Selected species for stocking will be determined by the State agency in close cooperation and coordination with the Federal agency. In order of preference for stocking fish species is (a) Federal threatened or endangered species, and (b) indigenous species. Numbers and size of fish and time of stocking will be determined by the State in coordination with Federal agencies.

Lakes and streams currently without fish may be considered for stocking, if there is mutual agreement that no appreciable loss of scientific values or adverse effects on wilderness resources will occur. It is generally undesirable to stock previously unstocked waters. Because these areas generally reflect natural ecosystem processes, they may possess high scientific values. Proposals for fish stocking that would involve uses generally prohibited under Section 4 (c) of the Wilderness Act will be considered and may be authorized by the Federal administering agency through application of the MRDP as outlined in Section E., General Policy.

Guidelines for Fish Stocking

a. The State agency shall make fish stocking schedules available to the Federal administering agency, indicating what species and numbers are planned for each water within a wilderness.
b. Adjust stocking rates to minimize the likelihood of exceeding the carrying capacity of the water being stocked so as to reduce the chance of producing a population imbalance.

Section 11. Aerial Fish Stocking

Aerial stocking of fish shall be permitted for those waters in wilderness where this was an established practice before wilderness designation or where other practical means are not available. Proposals that would involve uses generally prohibited under Section 4 (c) of the Wilderness Act will be considered and may be authorized by the Federal administering agency through application of the MRDP as outlined in Section E., General Policy.

Guidelines for Aerial Fish Stocking

a. The State agency will supply the Federal administering agency a list of those waters where stocking with aircraft was an established practice before wilderness designation, indicating the type of aircraft used (fixed-wing or helicopter).
b. To stock waters that had not been aerially stocked before wilderness designation, the State agency will demonstrate to the Federal administering agency the need for using aircraft.
c. Plan aircraft flights over wilderness to minimize disturbance. Consider season of year, time of day, route and altitude of flight, and location of landing areas on the perimeter of wilderness.

Master Memorandum of Understanding for the Management of Wildlife, Fisheries and Recreational Resources on National Forest System Lands in Colorado (Forest Service and CPW, 2015)

Note: This MOU expired on December 31, 2017 and is awaiting renewal at the regional level.

Appendix C: Management of Fish and Wildlife in Wilderness on NFS Lands

Management Actions Requiring a Federal Decision:

Any action involving a Section 4(c) prohibition, including:

- Use of chemicals (piscicides, pesticides or herbicides).
- Habitat alteration.
- Stocking previously unstocked waters.
- Transplanting (removal, reintroduction, or supplemental introduction) wildlife, including of federally listed threatened and endangered species into previously occupied habitat.
- Fish stocking using motorized equipment or mechanical transport unless established prior to wilderness designation. Includes all aerial fish stocking as authorized under agreement. The State to provide a list of stocked waters by type of aircraft.

Management Actions That Do Not Require a Federal Decision

The following actions do not require federal agency approval (provided the project does not include the use of Section 4(c) prohibitions on motorized equipment, mechanical transport, landing of aircraft, structures or installations):

- Aerial counts and observations.
- Scientific sampling, capturing and marking animals and using radio telemetry.
- Angling, hunting, trapping.
- Animal research and survey work.
- Fish surveys using gill-netting or battery operated electrofishing.
- Spawn taking.
- Ongoing fish stocking of indigenous species that were established prior to wilderness designation.

Appendix F – Supporting Resources

This section lists key supporting documents and resources available to inform management of each species. GIS datasets utilized in development of this strategy are listed separately in Table 6.

Rocky Mountain bighorn sheep

- Colorado Bighorn Sheep Management Plan 2009-2019 (2009) https://cpw.state.co.us/learn/Lists/Wildlife%20Species/DispForm.aspx?ID=22
- Rocky Mountain Bighorn Sheep (*Ovis canadensis*): A Technical Conservation Assessment (2007) https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5181936.pdf

Southern white-tailed ptarmigan

- White-tailed Ptarmigan (*Lagopus leucura*): A Technical Conservation Assessment (2006) https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5182070.pdf
- Southern White-tailed Ptarmigan (*Lagopus leucura altipetens*) Population Assessment and Conservation Considerations in Colorado (2018) (unpublished report, on file at CPW)
- Species Status Assessment Report or the Southern White-Tailed Ptarmigan (*Lagopus leucura altipetens*) (anticipated for late 2020)

Colorado River cutthroat trout

- Range-wide Status of Colorado River Cutthroat Trout: 2010 (2013) https://cpw.state.co.us/Documents/Research/Aquatic/CutthroatTrout/CRCTRangewideAssessment-08.04.2013.pdf
- Colorado River Cutthroat Trout: A Technical Conservation Assessment (2008) http://www.fs.fed.us/r2/projects/scp/assessments/coloradorivercutthroattrout.pdf
- Conservation Strategy for Colorado River Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*) in the States of Colorado, Utah, and Wyoming (2006) https://cpw.state.co.us/Documents/Research/Aquatic/pdf/CRCT_Conservation_Strategy_Jun06.pdf
- Summer Stream Temperature Model and Climate Change Scenarios for the Western U.S. (Isaak et al, 2017). Interactive temperature scenario viewer and geospatial data available at: https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html

Boreal toad

- Species Status Assessment Report for the Eastern Population of the Boreal Toad, *Anaxyrus boreas boreas* (2017) https://www.fws.gov/mountain-prairie/es/borealToad.php
- Boreal Toad (*Bufo boreas boreas*): A Technical Conservation Assessment (2005) http://www.fs.fed.us/r2/projects/scp/assessments/borealtoad.pdf
- Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (*Bufo boreas boreas*) (2001) https://cpw.state.co.us/Documents/WildlifeSpecies/SpeciesOfConcern/BorealToad/BorealToadRecovery.pdf

Table 6. Geospatial data resources utilized in development of this strategy.

Category	Dataset	Organization	Public Access Link
Land cover	National Land Cover Database (NLCD): 2016 Land Cover (CONUS)	Multi-Resolution Land Characteristics (MRLC) Consortium	https://www.mrlc.gov/data
Ecosystems	Terrestrial Ecological System Patches (TESP)	Colorado Natural Heritage Program	https://cnhp.colostate.edu/maps/cnhp-spatial-layers/
Land ownership	Colorado Surface Management Agency	BLM, Colorado State Office	https://navigator.blm.gov/home
Hydrology	Watershed Boundary Dataset (WBD)	U.S. Geological Survey	https://www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products This data can also be viewed interactively through the National Map: https://viewer.nationalmap.gov/advanced-viewer/
	National Hydrography Dataset (NHD)		
	Watershed Condition Class	Forest Service	https://data.fs.usda.gov/geodata/edw/datasets.php
	NorWeST summer stream temperature model for the western U.S.	Forest Service	https://data.fs.usda.gov/geodata/edw/datasets.php This data can also be viewed interactively at: https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=-bf3ff38068964700a1f278eb9a940dce
Mining	Colorado Abandoned Mine Land (AML) Information	Colorado Geological Survey	https://www.colorado.gov/pacific/cdphe/WQ-Mine-Impacted-Streams-Task-Force This data can also be viewed interactively at: https://erams.com/map/
Roads	TIGER/Line Shapefiles	U.S. Census Bureau	https://www.census.gov/programs-surveys/geography.html
Political boundaries	Cartographic Boundary Files		
Wilderness	Wilderness areas	Wilderness Connect	https://wilderness.net/visit-wilderness/gis-gps.php
Trails	NFS Trails	Forest Service	https://data.fs.usda.gov/geodata/edw/datasets.php
Motorized trails	Motor Vehicle Use Map		
Rangelands	Grazing Allotments		
Game Management Units (GMUs)	CPW administrative boundary data	CPW	https://www.arcgis.com/home/item.html?id=21466179657d4196a59441e414cc61f4 Includes GMUs for huntable species in Colorado, including bighorn sheep and mountain goats. This data can also be viewed interactively through the CPW Hunting Atlas: https://ndismaps.nrel.colostate.edu/index.html?app=HuntingAtlas

Category	Dataset	Organization	Public Access Link
Bighorn sheep	Migration corridors	CPW	https://www.arcgis.com/home/item.html?id=d1359dc6cf6e44979cacbfdbc34691e4 This data can also be viewed interactively through the CPW Hunting Atlas: https://ndismaps.nrel.colostate.edu/index.html?app=HuntingAtlas
	Overall range		
	Production area		
	Winter range		
	Winter concentration		
	Summer range		
	Summer concentration		
Mountain goat	Overall range	CPW	https://www.arcgis.com/home/item.html?id=42b32f485fe24a83ad6dd7c8af11ef33 The data can also be viewed interactively through the CPW Hunting Atlas: https://ndismaps.nrel.colostate.edu/index.html?app=HuntingAtlas
	Concentration area		
	Summer range		
	Winter range		
Boreal toad	Population range	CPW	https://www.arcgis.com/home/item.html?id=3723aadaf0eb41acaed0b95289e1b5f6
Canada lynx	Designated Critical habitat	USFWS	https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=3652
	Potential habitat	CPW	http://www.arcgis.com/home/item.html?id=99b332578f454122927ab2258f0c1181
Southern White-tailed ptarmigan	Overall range	CPW	https://www.arcgis.com/home/item.html?id=6cbc3ffbc0e947bb8e52d66214bb0120
	Winter range		
Gunnison sage-grouse	Designated Critical habitat	USFWS	https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6040
	Historic habitat	CPW	https://www.arcgis.com/home/item.html?id=1bab23cd9f274742ae1e38afa6e6c44f
	Occupied habitat		
	Winter range		
	Brood area		
Uncompahgre fritillary butterfly	Current range	USFWS	https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=4419

Appendix G – Systems Diagram

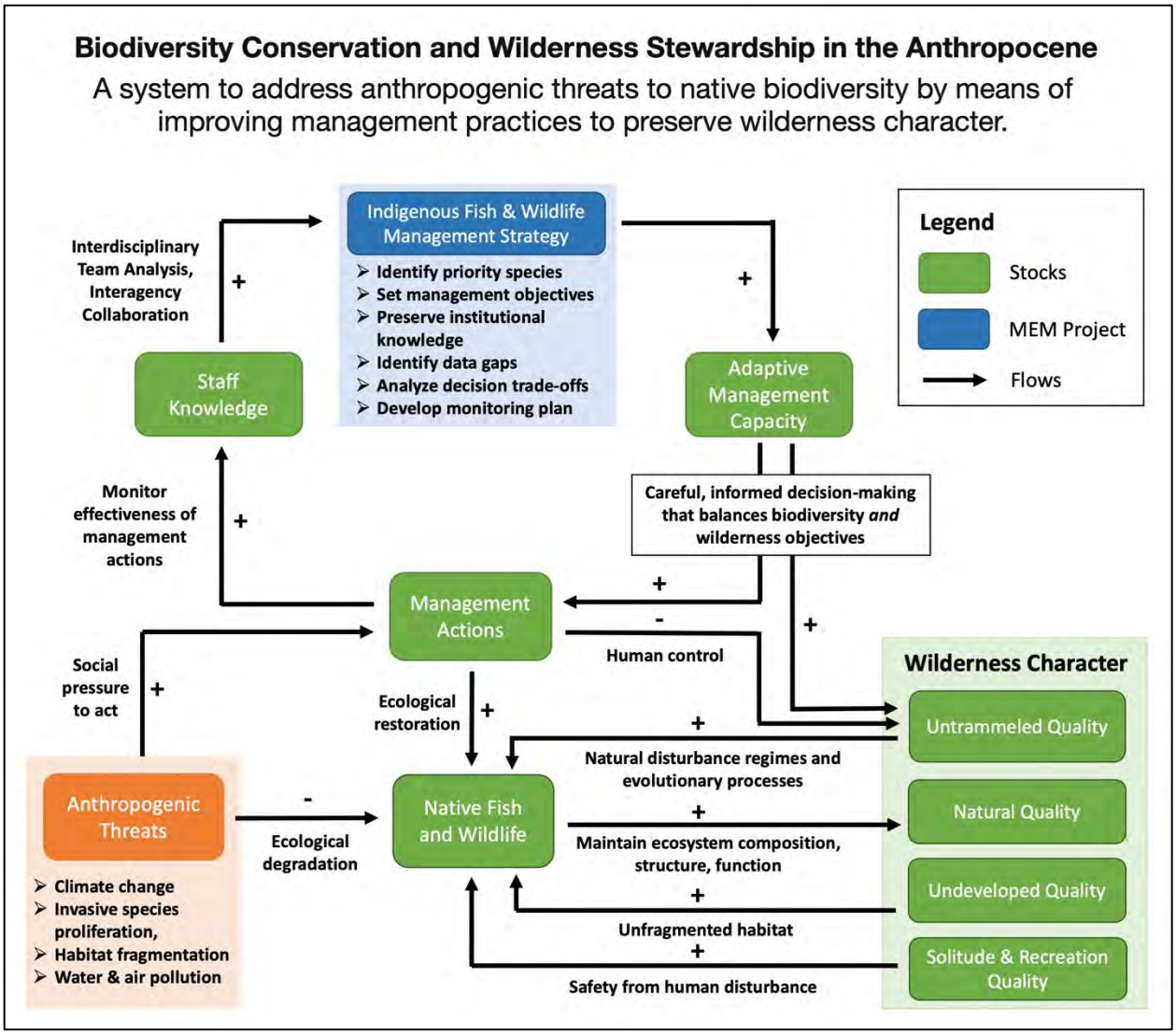

Figure 14. Systems diagram of fish and wildlife management in a wilderness context.

Forest Service
U.S. Department of Agriculture

In Partnership with Western Colorado University

Grand Mesa, Uncompahgre, and Gunnison National Forests
Gunnison Ranger District
216 N. Colorado St.
Gunnison, CO 81230

Western Colorado University
The Center for Public Lands
1 Western Way
Gunnison, CO 81231

"Without the gadgets, the inventions, the contrivances whereby men have seemed to establish among themselves an independence of nature, without these distractions, to know the wilderness is to know a profound humility, to recognize one's littleness, to sense dependence and interdependence, indebtedness, and responsibility."

– Howard Zahniser, *The Need for Wilderness Areas*