

**Ungulate (Elk and Moose and Mule Deer) Literature Review
Construct New Housing Destroyed by East Troublesome Fire in Rocky Mountain National Park
#316133
Rocky Mountain National Park
Grand Lake County, Colorado**



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ON THE COVER

View looking west at proposed Colorado River District housing area, Rocky Mountain National Park
Image credit: DHM Design, 2021

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List of Acronyms

Best Management Practices	BMPs
Burned Area Emergency Response	BAER
Data Analysis Unit	DAU
Colorado Parks and Wildlife	CPW
Environmental Impact Statement	EIS
Game Management Unit	GMU
Geographic Information System	GIS
National Park Service	NPS
Species Activity Mapper	SAM

Executive Summary

On October 21, 2020, the East Troublesome Fire made an 18-mile and over 100,000-acre run, causing widespread destruction in Grand County and consuming thousands of acres of Rocky Mountain National Park's Colorado River District (west unit). Within the Park boundaries, the fire destroyed or damaged 29 buildings and caused extensive damage to the trails and wilderness campsites. To replace the lost seasonal housing, the National Park Service (NPS) is proposing to construct a new housing complex near the existing Colorado River District housing area. This new complex would consist of dormitories and one- and two-bedroom units, three RV sites, and a residential support facility (22 bedrooms total). The NPS would also construct utility infrastructure, abandon and replace the water well and associated infrastructure at the Colorado River District housing area, and remove or abandon utilities and debris from the Green Mountain-Onahu seasonal housing area. These construction actions make up the NPS's Construct New Housing Destroyed by East Troublesome Fire in Rocky Mountain National Park, which is hereafter referred to as *the proposed project*.

In order to understand ungulate use in the proposed project area and how it could be impacted by the construction of new housing and infrastructure, several resources were reviewed and staff from NPS and Colorado Parks and Wildlife (CPW) were consulted as part of writing this document. Ungulate species studied include Rocky Mountain elk (*Cervus canadensis nelson*), Shiras moose (*Alces shirasi*), and mule deer (*Odocoileus hemionus*), along with their current and historic use of the proposed project area. Sources reviewed focused specifically on migration routes and frequency of use in or near the project area, rut and associated activities in or near the project area, and seasonal use in the project area, especially winter versus summer use. Limited information and data were available regarding movements of ungulate species through the area. Additionally, resources examined included those that analyzed the impacts of development and recreation on ungulate species, documented the extent of the East Troublesome Fire, and provided information regarding best management practices (BMPs) that aim to protect wildlife species during construction activities.

The review found that the proposed project area overlaps with several CPW-mapped seasonal ranges and provides habitat for elk, mule deer, and moose. Preliminary site investigations found the presence native wetland plants and willows outside of the proposed project area, which provide forage and cover for the ungulate species. Much of the proposed project area was recently burned however, and habitat is of lower quality than in the surrounding Kawuneeche Valley meadows and wetlands. In the long-term, habitat in the proposed project area and surrounding fire-impacted zones is expected to regenerate and provide high-quality habitat for the species evaluated.

Based on the literature review, activities in the proposed project area are likely used by Elk, Moose, and Mule Deer. The proposed new housing plan includes clustering the proposed new housing area in a small zone, while leaving surrounding areas open for wildlife. Research suggests that clustering housing developments to a more concentrated area reduces the overall impact zone of a development to wildlife.

1. Introduction

1.1. Project Area Description

The proposed project area is located approximately 1.3 miles northwest of Grand Lake and 0.43 miles west of the Kawuneeche Visitor Center in Rocky Mountain National Park (Park) in Grand County, Colorado (*Appendix A – Figure 1*). For the purpose of this literature review, the proposed project area includes the area of direct impacts where the permanent development will be constructed. From a broad ecological perspective, the area encompassing the proposed project area consists of a mix of subalpine and montane forests and meadows, with burned over lodgepole pine (*Pinus contorta*) woodlands composing the majority of the site. The vegetation within the proposed project area is dominated by lodgepole pine as the overstory species, with minimal understory establishment. Additional vegetation communities compose the large meadows of the Kawuneeche Valley and wetland communities associated with aquatic features, which leads to more species diversity. Forage for ungulate species is present within the proposed project area, but higher quality browse is available in the Kawuneeche Valley meadows, located outside of the proposed project area.

1.2. Purpose

The purpose of this literature review is to gain a better understanding of ungulate use in the proposed project area and to provide a summary of research that evaluates the potential effects development may have on wildlife. In particular, resources reviewed focus on the impacts of housing developments to wildlife and characteristics of ungulate populations in the region of the proposed project area. Specifically, the literature review seeks to:

1. Determine whether the spacing of the proposed new housing area could affect wildlife use of the area;
2. Determine the functional use of the proposed project area for ungulate species if spacing of housing developments are found to affect wildlife land use; and
3. Determine how and what aspects of the proposed new housing area affects ungulate use of the area.

This review will help to guide decisions regarding the development of the proposed new housing area that may impact ungulate species in the area.

2. Discussion

2.1. Elk, Moose, & Mule Deer Habitat Ranges

A review of CPW's SAM GIS data was completed as part of the literature review. Maps displaying the data are included as supplemental attachment to this document (*Appendix A – Supporting Maps*). CPW mapped habitat types that overlap with the proposed project area for elk, moose and mule deer are indicated in *Table 1* below and descriptions of habitat types are described in further detail below.

Table 1 - Elk, moose and deer mapped habitat types within proposed project study area.

Species	Mapped Habitat Type (SAM)
Rocky Mountain elk (<i>Cervus canadensis nelson</i>)	• Severe Winter Range

Species	Mapped Habitat Type (SAM)
	<ul style="list-style-type: none"> • Winter Concentration Area • Summer Concentration Area • Production Area • Migration Pattern
Shiras moose (<i>Alces shirasi</i>)	<ul style="list-style-type: none"> • Priority Habitat • Concentration Area • Winter Range
Mule deer (<i>Odocoileus hemionus</i>)	<ul style="list-style-type: none"> • Summer Range
Data source: Colorado Parks and Wildlife – Species Activity Mapper (SAM).	

Elk Habitat Definitions (CPW SAM Data Definition)

Severe Winter Range: That part of the range of a species where 90 percent of the individuals are located when the annual snow pack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten. The winter of 1983-84 is a good example of a severe winter.

Winter Concentration Area: That part of the winter range of elk where densities are at least 200% greater than the surrounding winter range density during the average five winters out of ten from the first heavy snowfall to spring green-up, or during a site-specific period of winter as defined for each Data Analysis Unit.

Summer Concentration Area: Those areas where elk concentrate from mid-June through mid-August. High quality forage, security, and lack of disturbance are characteristics of these areas to meet the high energy demands of lactation, calf rearing, antler growth, and general preparation for the rigors of fall and winter.

Migration Pattern: A subjective indication of the general direction of the movements of migratory ungulate herds.

Production Area: That part of the overall range of elk occupied by the females from May 15 to June 15 for calving. (Only known areas are mapped and this does not include all production areas for the DAU).

Moose Habitat Definitions (CPW SAM Data Definition)

Priority Habitat: Habitat types associated with the food and cover requirements of moose. Significant loss of these habitats would change moose distribution and/or would adversely affect the population. These habitat types include but are not limited to willow dominated riparian areas, sub-climax coniferous forest mixed with shrub lands, and dense climax coniferous forests.

Concentration Areas: That part of the overall range where densities are at least 200% greater than the surrounding area.

Winter Range: That part of the overall range where 90 percent of the individuals are located during the winter months. This winter time frame will be delineated with specific start/end dates for each moose population within the state (ex: November 15 to April 1).

Mule Deer Habitat Definitions (CPW SAM Data Definition)

Summer Range: That part of the overall range where 90% of the individuals are located between spring green-up and the first heavy snowfall. Summer range is not necessarily exclusive of winter range; in some areas winter range and summer range may overlap.

2.2. Habitat Description

The existing habitat in the proposed project area is dominated by lodgepole pine as the overstory species, with minimal understory establishment. Herbaceous vegetation characteristic of the wetland communities found during preliminary site investigations to the north and south of the proposed project area includes blue joint reedgrass (*Calamagrostis canadensis*), scratchgrass (*Muhlenbergia asperifolia*), tufted hairgrass (*Deschampsia cespitosa*), Colorado rush (*Juncus confuses*), arctic rush (*Juncus arcticus*), Slenderbeak sedge (*Carex athrostachya*) and clustered field sedge (*Carex praegracilis*). Willows (*Salix* spp.) are not typically a distinguishing feature in the wetland communities in close proximity to the proposed new housing area site, but based on field observations, there is evidence of scattered regeneration of willows following the fire.

Willow is the dominant woody shrub on almost all wet meadow or riparian areas in Rocky Mountain National Park. Much of the elk and moose preferred habitat is in montane riparian willow wetlands in the Kawuneeche Valley (EVMP, Purpose and Need, 2008). The East Troublesome fire burned a significant amount of riparian willow habitat used by ungulate species. As a result of the fire, a decrease in willows that provide foraging material and thermal cover are likely to temporarily affect elk and moose in the Grand Zone. Part of the East Troublesome herd includes elk that have summer range in the Kawuneeche Valley. These elk move during the winter to areas outside of the Park boundary, to land that was affected by the East Troublesome fire. As a result of the fire, the reduction in available forage and cover in the burn area may affect the carrying capacity of the herd. However, as time progresses, desirable vegetation will recover in areas where it was previously present and also in areas where beetle-killed lodgepole pine dominated and did not provide foraging opportunities. In the long-term, the carrying capacity of the herd is likely to rebound from an overall increase in foraging opportunities (NPS 2020).

The human residential population of Grand County has continued to increase, and as of 2020, the county was the 13th fastest growing in the state (DOLA 2022). Human activity in areas that provide elk habitat has dramatically increased, including people biking, hiking, jogging, and walking dogs (Oldham 2010). The presence of humans and pets in important habitat areas often results in ungulates being displaced to areas that have less human activity. This movement of ungulates to new areas could be increasing their use of transitional ranges that are usually occupied during spring and early winter (Oldham 2010).

Moose use wetland habitat extensively, with over 91% of their summer diet comprised of willow species (Dungan & Wright 2005). The willow carr along Onahu Creek, in the vicinity of Green Mountain housing, burned entirely, as did much of the willow along the Colorado River to the north of the proposed project area. Both of these areas held high concentrations of moose and may have served as calving and nursery locations for cows and their calves. Moose rely heavily on forested slopes adjacent to wetlands for thermal cover during diurnal periods (NPS, 2020, pg. 85)

2.3. Summer vs. Winter Range

Rocky Mountain Elk - The Rocky Mountain National Park/Estes Park elk population migrates seasonally between the primary winter range and primary summer range. Elk summer range is largely in the tundra and the west side of the Park and includes burned areas in the Kawuneeche Valley and timbered slopes that border the valley to the east and west (NPS, 2020, p. 83). Elk within the East Troublesome herd use a portion of Park throughout summer and fall and migrate during the winter (Oldham 2010).

Elk use the primary summer range, which includes the Kawuneeche Valley and subalpine and alpine areas within the Park as well as areas outside the Park, primarily during June, July, and August (NPS 2008). In 2012, elk in the Park began to change migration patterns, presumably due to culling pressures (Clatterbuck 2022). A portion of the Kawuneeche Valley elk travel west towards Kremmling, while the bulk of the Park's summer elk herds move east and down to lower elevations near Loveland. Prior to this change, it was common for more than 1,000 elk to winter in the Park, whereas now, the number is down to 100 to 200 individuals (Clatterbuck 2022). In May and September, elk begin to migrate between these two ranges (NPS 2008).

Shiras Moose – Moose utilization of the proposed project area is uncertain due to a lack of available data for the area. However, it is deduced from available sources that moose are likely to move through the vicinity of the proposed project area due to the presence of preferred forage and habitat features such as willows and sedges. Moose are likely to make seasonal elevational migrations through the area based on availability of resources and environmental influences, but behaviors vary by individual. The following information is provided as context for the moose utilization of the proposed project area:

“Preliminary analysis of GPS collar locations (NPS 2020), show that moose in the Colorado River District heavily utilize willow and sedge dominated habitat in the Kawuneeche Valley during the summer and move up in elevation to high elevation wet meadows and subalpine forests during the winter (NPS, 2020, p. 85). Moose winter and summer ranges have not yet been delineated in the Park by the NPS. This is the focus of ongoing work, and so summarizing a percentage of the moose summer and winter ranges that burned is not possible at this time. Moose exhibit mixed migratory behavior, where they move within a relatively small home range and up and down elevational gradients within that home range in response to forage availability, temperature and the availability of thermal cover. Some areas in the home range are used largely during the winter, some largely during the summer, and some areas may be used in both seasons and during times of transition. There is more variation in habitat selection across individuals than is seen in other local ungulate species (NPS, 2020, p. 84, 85).”

Mule Deer – During the summer months, deer can be found throughout Middle Park, which is a mountain valley located in Grand County, on the southwest slope of Rocky Mountain National Park. Summer range (2,387 mi²) is vast and overall healthy, in particular habitat at higher elevations. In the winter, deer move from productive summer range habitat to limited and lower quality winter range at lower elevations. There is no mapped winter range within or around the proposed project area. Mule deer utilization is limited within the proposed project area.

2.4. Housing Spacing & Location

Limited information is available regarding the effects of housing spacing and location on ungulate species. However, there is growing interest in the research community regarding the development of

“exurban” areas and how development of these zones may affect wildlife and associated habitats. Exurban areas are defined as development that occurs along the urban-rural gradient beyond urban and suburban areas (Polfus 2012, p. 2). Although the proposed new housing area does not compare to the extent and scale of large, exurban housing developments in reference documents, it falls within the exurban zone considering its location.

The spacing and proximity of individual houses within a development have been tied to wildlife impacts. Within housing developments, the spatial arrangement of the individual units can greatly impact the amount of habitat affected. Individual houses within a development that are distributed over a greater area, have larger impact zones (Theobald et al. 1997). Housing developments that are clustered and confined to a smaller area have a reduced impact zone within a similar overall area (Theobald et al. 1997). Clustering units in a smaller area reduces the acreage of impact and the overall impact zone of a development, which extends beyond the boundary of the physical structure (Theobald et al. 1997). In relation to ungulates, a study of elk in Colorado found that individuals were found to avoid habitat areas less than 0.04 km² and prefer areas over 0.24 km² (Polfus 2012). Therefore, clustering housing allows larger tracts of land outside direct impact areas, that would provide attractive habitat for ungulate species.

Regardless of the new housing area arrangement, a decrease in native species and an increase in generalist, human-adapted species have been correlated with an increase in housing density (Lenth et al. 2006; Theobald et al. 1997; Polfus 2012). Both clustered and dispersed housing have been found to result in the attraction of non-native plant and wildlife species and human-adapted species (Lenth et al. 2006).

The proposed new housing area is clustered and confined to a small area (approximately 7 acres). Although the development is a new disturbance to the area, the position of the units will create less of a disturbance than if it were dispersed over a larger area. Ample habitat is present outside of the proposed project area that will allow for wildlife movement, foraging activities, and provide cover. A decrease in native species and an increase in generalist, human-adapted species may occur near the proposed project area as a result introducing the new housing area. However, BMPs will be employed to reduce the likelihood of non-native plant species establishing following construction.

2.5. Development Impacts

Development has the potential to affect wildlife and associated habitats both directly and indirectly (Theobald et al. 1997). Direct impacts include the removal of vegetation both permanently and temporarily during construction. Revegetating temporary disturbance areas may often result in the proliferation of non-native plant species, that do not provide as high quality of forage as native plant species. Permanent removal of vegetation alters the landscape and may result in the change to forage and cover utilized by wildlife (Theobald et al. 1997) and an overall reduction in available habitat (Polfus 2012; Theobald et al. 1997). Vegetation removal would occur as a result of the proposed project and could impact the availability of forage and cover for ungulate species. However, higher quality forage for ungulates is present in the nearby Kawuneeche Valley meadows, which is outside of the proposed project area. Additionally, temporarily disturbed areas would be reseeded with native plant species and monitored for success.

Creating fenced areas as a result of the proposed project may also introduce direct and indirect effects to ungulates. Temporary fences during construction activities are used to cordon off dangerous areas or revegetation zones. Permanent fences are often established following construction to enclose parcels of land or areas for pets. Fences act as barriers to wildlife species and can cause negative indirect impacts to wildlife populations, by limiting migration routes and reducing the availability of habitat (Hanopy et al. 2009; Theobald et al. 1997). Wildlife also may be directly impacted by becoming entangled in plastic construction fencing, which can lead to serious injury or death (Hanopy 2009). Currently, there are no plans to construct permanent fencing as part of the proposed project. However, temporary fencing will likely be used during construction for safety purposes and vegetation recovery. Wildlife-friendly fencing practices may be followed as described in *Fencing with Wildlife in Mind* (Hanopy 2009) to reduce the potential for negative impacts of temporary fencing to ungulate species. Additionally, no migration routes were mapped by CPW SAM data in the proposed new housing area, so fencing is unlikely to impact ungulate migrations in the proposed project area.

Construction of the proposed new housing area may indirectly impact ungulate species during and following construction by introducing human activities to the landscape. Loud construction equipment, the presence of construction staff, and the presence of residents and pets (if allowed) following construction could encourage ungulate species to relocate away from the proposed project area. Human activities could provoke changes to feeding and sleeping patterns, or cause animals to flush when a human or pet is encountered (Theobald et al. 1997). Flushing distances for elk are estimated to be between 15 to 300 meters and 100 to 300 meters for mule deer (Theobald et al. 1997). Elk in Montana were found to travel faster within 750 meters from houses and trails, and selected for areas at least 1,200 meters from human development (Polfus 2012). Amplified stressors likely result in decreases in energetic reserves, which can subsequently affect an animal's survivorship and health (Theobald et al. 1997). Although construction and human presence could temporarily and permanently affect ungulates in the area, some animals exhibit habituation to the presence of humans and pets. Elk are commonly found bedding down in residential areas and near Highway 34, close to the proposed project area. Elk habitation may vary depending on habitat type, predator presence, and the type of development (Polfus 2012). Mule deer have been found to habituate to humans in some cases, but research suggests they are not as adaptable to human presence as white-tailed deer (Polfus 2012).

The development of the exurban areas, which includes housing on the fringe of urban and rural areas, has been found to increase the presence of non-native plant and wildlife species near the developments (Lenth et al. 2006; Hansen et al. 2005). The development of the proposed new housing area for the proposed project site could potentially create similar environment. An introduction of non-native plant species and increased abundance of human-adapted wildlife could indirectly impact ungulate populations in the area by decreasing the quality of forage and displacing native wildlife species with human-adapted or non-native species.

Lastly, construction of the proposed new housing area could indirectly affect ungulate populations in the area by creating fragmented habitats. The proposed new housing area would result in the creation of patches of habitat in an area that was previously intact. Fragmentation of habitats creates disjunct islands of land that are less likely to be inhabited by larger species and inhibit the safe movement of animals from one area to another (Theobald et al. 1997). Elk in Colorado were found to avoid islands of habitat less than 0.04 km² and preferred areas over 0.24 km² (Polfus 2012). The approximate area between the existing Colorado River District housing and South Columbine Lake neighborhood is

approximately 0.17 km². The estimated area of permanent disturbance from the proposed new housing area project is approximately 0.02 km². Taking this into consideration, approximately 0.15 km² of existing undisturbed area will exist once the proposed project is completed. Although the housing development will fragment the landscape, large tracts of high-quality habitat are present outside of the proposed project area and will not be affected by development activities. Ample connected habitat corridors are present within the Park and in the surrounding area.

2.6. Conservation Measures

Conservation measures for natural resource protection include actions that avoid, minimize, and mitigate impacts. The three types of measures may be implemented based on the actions taking place. Definitions for the three measures are listed below (Colorado Trails with Wildlife in Mind Taskforce 2021, p. 18):

- Avoid: Strategies that place trails or sites for ancillary facilities (e.g., parking lots, trailheads) outside of biologically sensitive habitat types.
- Minimize: Strategies that reduce biological impacts through the application of Best Management Practices to reduce the extent, severity, significance, or duration of unavoidable impacts.
- Mitigate: Strategies that compensate for unavoidable adverse impacts to wildlife and habitat, including habitat replacement, on- or off-site habitat enhancement, or contribution to larger scale conservation projects.

Some measures that are commonly implemented to help protect natural resources include seasonal timing restrictions and buffer zones. These two concepts are described in more detail below (Colorado Trails with Wildlife in Mind Taskforce 2021, p. 18):

- Seasonal Timing Restrictions: A restriction on construction or recreational activity during defined date ranges that captures an important and sensitive life history stage for a given species. Examples include reproduction and wintering periods when animals are in a vulnerable state.
- Buffer Zone: A defined distance (radius) surrounding a sensitive wildlife location, where human activities should be limited to protect the given wildlife resource from disturbance. Disturbance within the buffer could cause a decline in wildlife reproduction or survival. Each recommended buffer distance is based on the best available science and field staff expertise.

Using the methods described above can help to better balance the need for development and the conservation of natural resources. Conservation measures recommended for the proposed project, as discussed with CPW and NPS staff, are provided below.

- Revegetate areas that are disturbed during construction with native species.
- Treat any non-native plants that are toxic to ungulates (yew and lupine).
- Restrict housing occupants from planting non-native landscape species that are known to be toxic to ungulates, such as chokecherry (*Prunus virginiana*).
- Carefully consider potential human-wildlife conflicts if planting forage that attracts wildlife, such as young aspen trees or willows, within the proposed housing area.
- If fencing is required during and post-construction, follow guidance provided in the document Fencing with Wildlife in Mind (Hanopy 2009).

- Educate residents to keep pets on leashes while outside to reduce the likelihood of human-wildlife conflicts. Park regulations require pets be on leashes six feet or shorter.

3. Literature Review Summary

A total of nine documents were examined for this literature review. Materials evaluated included peer-reviewed scientific journal articles, technical reports, state and federal management plans, and BMPs for wildlife publications. Additionally, NPS staff provided observational data, Colorado Parks and Wildlife (CPW) staff were consulted, and the CPW Species Activity Mapper (SAM) geographical information system (GIS) data was reviewed and analyzed. A summary of evaluated documents is included below.

Document Title: *Emergency Stabilization and Burned Area Rehabilitation Plan East Troublesome Fire (2020)*

Following the East Troublesome Fire in October 2020, a burned area emergency response (BAER) team conducted a rapid assessment of burned watersheds to identify imminent post-wildfire threats to human life and safety, property, and critical natural or cultural resources on federal lands and take immediate actions to implement emergency stabilization measures before the first major storms (NPS 2020). A combination of aerial imagery, elk and moose location data, and fire boundary data were used to analyze the fire's impact to elk winter and summer range habitats (NPS 2020, pg. 74).

As it relates to the proposed project area, this planning document provided relevant qualitative and quantitative data for vegetation and wildlife pre- and post-fire within and around the proposed project area. Based on the vegetation and habitat descriptions in the report, the habitat further north of the proposed project area includes higher value habitat for ungulates than what has been observed within and near the proposed project area.

Document Title: *Elk and Vegetation Management Plan, Final Environmental Impact Statement, Rocky Mountain National Park, CO, 70342 [E7-23936], Purpose and Need for Action (2008)*

The focus of this plan/Environmental Impact Statement (EIS) is the elk population that winters in Rocky Mountain National Park, the geographic areas used by that population throughout the year, and the vegetation associated with the population. The EIS finalized five alternatives, including a no action alternative, to manage elk and vegetation within Rocky Mountain National Park (NPS 2008). The EIS primarily focuses on the east side of the Park but it includes pertinent information on vegetation and habitat utilization by elk, moose and mule deer in the Kawuneeche Valley (NPS 2008). The EIS describes that historic habitat utilization by ungulates within and around the project area was included Kawuneeche Valley and Onahu Creek. Despite the fact that there are no specific references to the proposed project area within the EIS document, on-site observations of habitat are not what is described as high-quality browse and production habitat in Kawuneeche Valley and Onahu Creek.

As it relates to the proposed project area, the fire altered the vegetative successional stage and composition of the plant species at the site temporarily will change, but the overall vegetative communities present at the site post-fire will remain the same or be similar to those present before the fire. This study is still relevant to the proposed project analysis despite the temporary change in vegetation.

Document Title: *Troublesome Elk Herd Management Plan Data Analysis Unit E 8, Game Management Units 18 and 181 (2010)*

The Data Analysis Unit (DAU) Report provides CPW direction in managing a big game species in a given geographical area. It identifies suitable habitat, describes the herd history and current status, identifies issues and problems, and provides direction for future management. The objectives defined in the DAU plan guide a long-term cycle of information collection, information analysis, and decision making. DAU E-8 is located near the headwaters of the Colorado River in northcentral Colorado (Grand County) surrounding the towns of Kremmling and Grand Lake and contains Game Management Units (GMU) 18 and 181 (Oldham 2010). The DAU covers a total of 519,770 acres, the proposed project impact area is a small fraction of the DAU at approximately 7 acres. As such, the proposed project is anticipated to have little impact to ungulates in the DAU as a whole.

As it relates to the proposed project area, the DAU and GMUs encompass the herds that are present in the proposed project area. Although this study was completed prior to the fire, it is still relevant to the project as the boundaries of the GMUs and DAU remain the same, and the herds present will continue to occupy the same range, although there may be some changes in migration routes and habitat use on a smaller scale.

Document Title: *Multi-Scale Analyses of Habitat Use by Elk Following Wildfire (2009)*

The effects of large ungulate herbivory on plant community structure and composition can vary considerably in regions susceptible to frequent wildfires (Biggs et al. 2009). The Cerro Grande Fire of May 2000 burned 17,400 hectares of elk transitory-use range in the Jemez Mountains, north-central New Mexico. The study objective was to determine if habitat use changed temporally following the fire and if graminoid cover offset use of regenerating woody species. The study team assessed female elk habitat use at the landscape, home range, and burned area scales using distance analyses techniques, diet analyses, and browsing data (Biggs et al. 2009).

Results from this study found that across the landscape, elk selected home ranges with a grassland component (Biggs et al. 2009). Selection of home ranges across the landscape was not influenced by the burned area within four years post-fire. Within home ranges, preference for burned area was similar to other habitats, suggesting the burned area played a more important role at the home range scale compared to the landscape scale, particularly during drought. The presence of graminoids in elk pellets collected from the burned area increased while shrubs decreased over time. The decrease in shrubs may have been due to an increase in graminoid production after the fire (Biggs et al. 2009).

As it relates to the proposed project area, the article suggests that elk use of the proposed project area is unlikely to have substantial changes since the fire. The existing habitat within the proposed project area is dominated by burned lodgepole pine forest with minimal understory of forbs and grasses.

Document Title: *Effects of Winter Recreation on Northern Ungulates with Focus on Moose (Alces alces) and Snowmobiles (2012)*

This study evaluated the impacts of winter recreation on ungulate species and created guidelines for wildlife managers to assist with predicting when winter recreation may disturb ungulates (Harris et al. 2014). The authors first synthesized existing studies to draft guidelines and then completed a field study on moose response to snowmobiles to further solidify two of the guidelines. The guidelines of the study include (Harris et al. 2014):

- Impacts from recreation tend to increase when disturbances occur for longer time periods, in larger areas, and are unpredictable.
- Motorized recreational activities generally cause a higher number of disturbances as a result of them covering larger areas but the disturbances cause less of an effect on wildlife.
- Winter recreation disturbs wildlife less when individual animals are able to relocate to nearby, suitable habitat.

As it relates to the proposed project, continued use of the existing snowmobile trail will have little effect on ungulates. If ungulates are disturbed from use of the trail they are likely to relocate to suitable habitat nearby, including habitat further north in Kawuneeche Valley, which will result in less of a disturbance than if there were no suitable habitat nearby. Additionally, disturbances for long periods of time that are in larger habitat areas would not occur from the use of the snowmobile trails in the proposed project area, as it is a small area with existing disturbances from human presence.

Document Title: *Literature Review and Synthesis on the Effects of Residential Development on Ungulate Winter Range in the Rocky Mountain West (2012)*

The author of this study summarized 80 sources of information on the effects of human disturbance and residential development on five ungulate species: white-tailed deer, mule deer, elk, American pronghorn and bighorn sheep (Polfus 2012). Limited information is available in the literature regarding the effects of residential development on ungulates, with only a total of 22 studies available. Therefore, the author also included resources on the effects of other disturbances, such as roads, industrial development and hunting on ungulate populations (Polfus 2012). Relevant species summaries were reviewed as part of this proposed project. This study provided a breadth of information about development impacts to ungulate species, including how exurban developments are growing and how they may have impacts to wildlife species such as habitat fragmentation and introduction of non-native plant species.

As it relates to the proposed project, this study provides applicable information about how the proposed new housing area may affect ungulate species. Specifically, the study indicates that human presence at the proposed new housing area will likely flush elk and mule deer present if individuals are present within 300 meters. Mule deer are less likely to become habituated to the presence of humans at the proposed new housing area and therefore may avoid the development. Lastly, the proposed new housing area may create some habitat fragmentation in the area but large tracts of land that provide ample habitat areas are present outside of the development impact zone.

Document Title: *Estimating the Cumulative Effects of Development on Wildlife Habitat (1997)*

This study evaluates the cumulative effects of residential housing developments on wildlife by reviewing actions that contribute to habitat degradation and removal, evaluating housing development plan arrangements, and determining how to delineate a wildlife disturbance zone based on housing density and impact areas (Theobald et al. 1997). The study concluded that clustering housing developments reduces the effects to wildlife habitat, spatial pattern of housing developments influence the extent of disturbances as much as housing density, and the spatial pattern of housing developments influence the extent of landscape fragmentation effects on wildlife migrations (Theobald et al. 1997).

As it relates to the proposed project, this study indicates that the clustering of the proposed housing would reduce the overall impact to ungulates when compared to dispersed housing, as a result of disturbing less area and reducing the amount of habitat fragmentation.

Document Title: *Dynamics of Interacting Elk Populations Within and Adjacent to Rocky Mountain National Park (2002)*

This study is focused on population subdivision and density-dependent and independent factors influencing population processes between 1965 and 2001 for elk (*Cervus elaphus nelsoni*) inhabiting Rocky Mountain National Park and the adjacent Estes Valley, Colorado, USA (Lubow et al. 2002). It specifically assessed the population characteristics and habitat utilization (winter and summer) for elk in and adjacent to the Park. Though this study focuses on the east side of the Park and elk within Estes Park, it provides good insight and data for elk population trends and behavioral influences within a large developed human population (Lubow et al. 2002).

As it relates to the proposed project, this study provides valuable information on elk behavior in and around the proposed project area and Grand Lake. Habituation of elk in and around the proposed project area exists currently and the proposed project will most likely not affect the long-term behavioral actions of elk in this area including potential migration routes.

Document Title: *Fencing with Wildlife in Mind (2009)*

This publication provides guidelines and details for constructing fences with wildlife in mind. The information it contains was contributed by wildlife managers, biologists, land managers, farmers, and ranchers. Over time, their observations and research have built a body of knowledge concerning wildlife and fences, including (Hanopy 2009):

- A basic understanding of how ungulates cross fences, and the fence designs that cause problems for moose, elk, deer, pronghorn, and bighorn sheep.
- Fence designs that adequately contain livestock without excluding wildlife.
- Fence designs that effectively exclude ungulates, bears, beavers, and other small mammals.

As it relates to the proposed project, this study helps to inform future phases of the design project and to better understand materials and design for wildlife-friendly fencing. For instance, the park may allow residents to install fences in the future to keep pets contained. However, the proposed project does not include any plans for permanent fences at this time. Additionally, this document does not contain information about temporary construction fencing similar to what will be used in the project.

4. Public Agency Coordination

Colorado Parks and Wildlife

An informal consultation with CPW Staff was completed as part of this review. CPW biologists, Serena Rocksund and Elissa Slezak, communicated that they have observed elk and moose using similar habitat and migration routes pre and post fire, including high points and swales or draws where regeneration of forbs and other forage species has been prolific. CPW stated that the publicly available SAM data for the proposed project study area is approximately four years old and is due to be updated in 2022/2023. CPW staff conveyed that although the data is due for updating, it is still accurate at a macro habitat level. This data was analyzed as part of this literature review and is discussed below under habitat utilization.

CPW currently have collared tracking data for elk within the proposed project area but are not able to provide it as part of this analysis. They do not have collared moose in the area. In general, ungulates in this area are relatively habituated to humans, and elk have been observed bedding down along Highway

34 in close proximity to the road and park visitors. CPW recommended studying seasonal timing restrictions in relation to elk calving, including time of day and year restrictions. CPW stated if fencing is utilized to fence out wildlife from restoration areas, wildlife friendly fencing materials and techniques should be utilized. A review of Colorado Parks and Wildlife *Fencing with Wildlife in Mind* was completed as part of this review.

National Park Service

National Park Service (NPS) staff provided observational data for this assessment. In addition, Park biologists and ecologists provided observational data for wildlife utilization within and around the proposed project area. The Park has radio collared data for moose within the proposed project assessment area and is continuing to analyze this data as part of the fire recovery planning. No NPS wildlife GPS or GIS data was used as part of this review. NPS vegetative cover data (pre-fire) was used to review vegetation within and around the proposed project area.

5. Conclusion

The proposed project includes constructing a housing complex near the existing Colorado River District housing area, which would include housing facilities, RV sites, and associated utilities. The development is much needed to replace housing destroyed in the 2020 East Troublesome Fire. This report analyzed the proposed project plans, the presence of ungulate populations and habitats, and the potential impacts of the development on local ungulate populations.

A review of CPW SAM data found that several seasonal ranges for elk, moose, and mule deer overlap with the proposed project area. As a result, it is presumed that these species use the proposed project area throughout the year. Habitat for ungulates is also known to be present at the site. Field investigations found that the proposed project area contains habitat for elk, mule deer, and moose, but was recently burned and is currently recovering from disturbance. Wetland communities are present near the proposed project that provide foraging and cover for ungulate species, but are not anticipated to be directly impacted by the proposed project. Although habitat is present, it is of lower quality when compared to surrounding areas.

Housing spacing has been found to affect wildlife use of an area depending on certain factors (Lenth et al. 2006, Theobald et al. 1997). The proposed new housing area spatial arrangement is likely to have less of an impact on ungulate species because it is clustered in one area. The overall impact zone of clustering the development is less than if it were dispersed over a larger area. This allows for larger, intact habitats to exist outside of the housing development. Regardless of the arrangement, housing developments have been tied to an increase in non-native species and human-adapted species, which may affect ungulate habitat quality directly surrounding the development. Ultimately, the proposed project will permanently remove approximately 0.02 km² of habitat for ungulate species, but the surrounding areas will still provide functional habitat for individuals present.

Other aspects of development have the potential to affect ungulate use of the proposed project area and surrounding lands. Long- and short-term impacts are likely to result to ungulate populations as a result of the proposed project due to construction and the permanent establishment of a structure. During construction, vegetation removal, noise, and the presence of construction personnel will disturb ungulates in the area and remove habitat. Temporary construction fencing has the potential to harm individuals in the area if they become entangled in materials. Longer-term impacts include the presence of residents and pets in the area that may disturb ungulates, contributing to habitat fragmentation

which disturbs ungulate movements and availability of habitat, and a decline in vegetation in the vicinity of the proposed project as a result of the introduction of non-native plant species. Although impacts could occur, conservation measures outlined in Section 4.6 may be employed during construction to reduce potential effects of construction to elk, mule deer, and moose.

Literature Cited

- Biggs J, VanLeeuwen D, Holechek J, Valdez R. 2009. Multi-Scale Analyses of Habitat Use by Elk Following Wildfire. *Northwest Science* **84**:20–32. (accessed 25 Apr. 2022)
- Clatterbuck C. 2022. Personal Communication with Christopher Clatterbuck of Rocky Mountain National Park.
- Colorado Trails with Wildlife in Mind Taskforce. 2021. Colorado's Guide to Planning Trails with Wildlife in Mind. Prepared by Wellstone Collaborative Strategies and Rocky Mountain Innovation Lab. Project supported by Colorado Parks and Wildlife in collaboration with land managers in City, County, State, and Federal government across the State of Colorado. 58pp. (accessed 5 May 2022)
- Department of Local Affairs (DOLA). 2022. County Population Estimates, 2010 to Current Year. State Demography Office, Denver, CO. Accessed from: <https://demography.dola.colorado.gov/assets/html/county.html>. (accessed 25 Apr. 2022)
- Dungan JD, Wright RG. 2005. Summer Diet Composition of Moose in Rocky Mountain National Park, Colorado. *ALCES VOL.* **41**:8. (accessed 25 Apr. 2022)
- Hanophy, W. 2009. Fencing with Wildlife in Mind. Colorado Parks and Wildlife, Denver, CO. 36 pp. (accessed 25 Apr. 2022).
- Harris G, Nielson RM, Rinaldi T, Lohuis T. 2014. Effects of winter recreation on northern ungulates with focus on moose (*Alces alces*) and snowmobiles. *European Journal of Wildlife Research* **60**:45–58. (accessed 25 Apr. 2022).
- Koons DN, Colchero F, Hersey K, Gimenez O. 2015. Disentangling the effects of climate, density dependence, and harvest on an iconic large herbivore's population dynamics. *Ecological Applications: A Publication of the Ecological Society of America* **25**:956–967. (accessed 25 Apr. 2022).
- Lenth BA, Knight RL, Gilgert WC. 2006. Conservation Value of Clustered Housing Developments. *Conservation Biology* **20**:1445–1456. (accessed 5 May 2022).
- Lubow BC, Singer FJ, Johnson TL, Bowden DC. 2002. Dynamics of Interacting Elk Populations within and Adjacent to Rocky Mountain National Park. *The Journal of Wildlife Management* **66**:757–775. [Wiley, Wildlife Society]. (accessed 25 Apr. 2022).
- National Park Service (NPS). 2022. Scope of Services, Contract No. 140P2019D0015. Reconstruct Housing and Infrastructure Destroyed by Fire – Rocky Mountain National Park, National Park Service. Estes Park, Colorado. (accessed 25 Apr. 2022).

- NPS. 2020. Emergency Stabilization and Burned Area Rehabilitation Plan East Troublesome Fire. November 20, 2020. (accessed 25 Apr. 2022).
- NPS. 2008. 68 FR 32084 - Elk and Vegetation Management Plan, Environmental Impact Statement, Rocky Mountain National Park, Colorado. (accessed 25 Apr. 2022).
- Oldham, Kirk. 2010. Troublesome Elk Herd Management Plan Data Analysis Unit E – 8 Game Management Unites 18 and 81. [E-8 - Troublesome \(state.co.us\)](#). (accessed 25 Apr. 2022).
- Polfus J. 2012. Literature Review on the Effects of Residential Development on Ungulates. Pages 647–57. Report prepared for Montana Fish, Wildlife and Parks. Helena, MT. Available from <http://www.jstor.org/stable/wildsocibull2011.36.4.647> (accessed April 25, 2022).
- Species Activity Mapper (SAM) Geospatial Dataset. Colorado Parks and Wildlife. December 2018. <https://data.colorado.gov/Environment/All-Colorado-Parks-and-Wildlife-Species-Activity-M/7iij-d-4q29> . (accessed 25 Apr. 2022).
- Theobald DM, Miller JR, Hobbs NT. 1997. Estimating the cumulative effects of development on wildlife habitat. *Landscape and Urban Planning* **39**:25–36. (accessed 5 May 2022).

Appendix A – Supporting Maps

Figure 1. Project Area Overview Map.

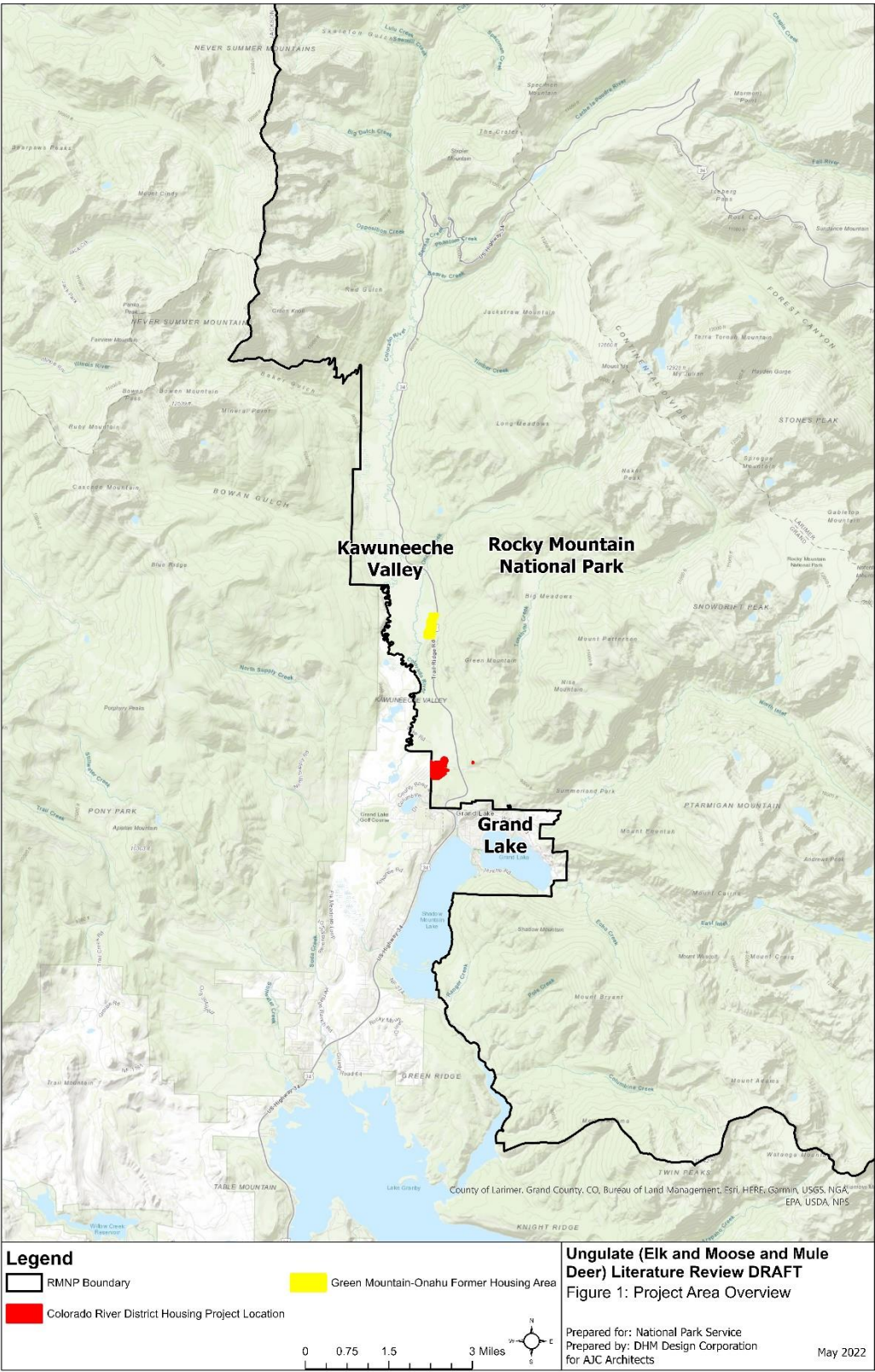


Figure 2. Moose CPW Species Activity Mapping – Colorado River District Housing Area.

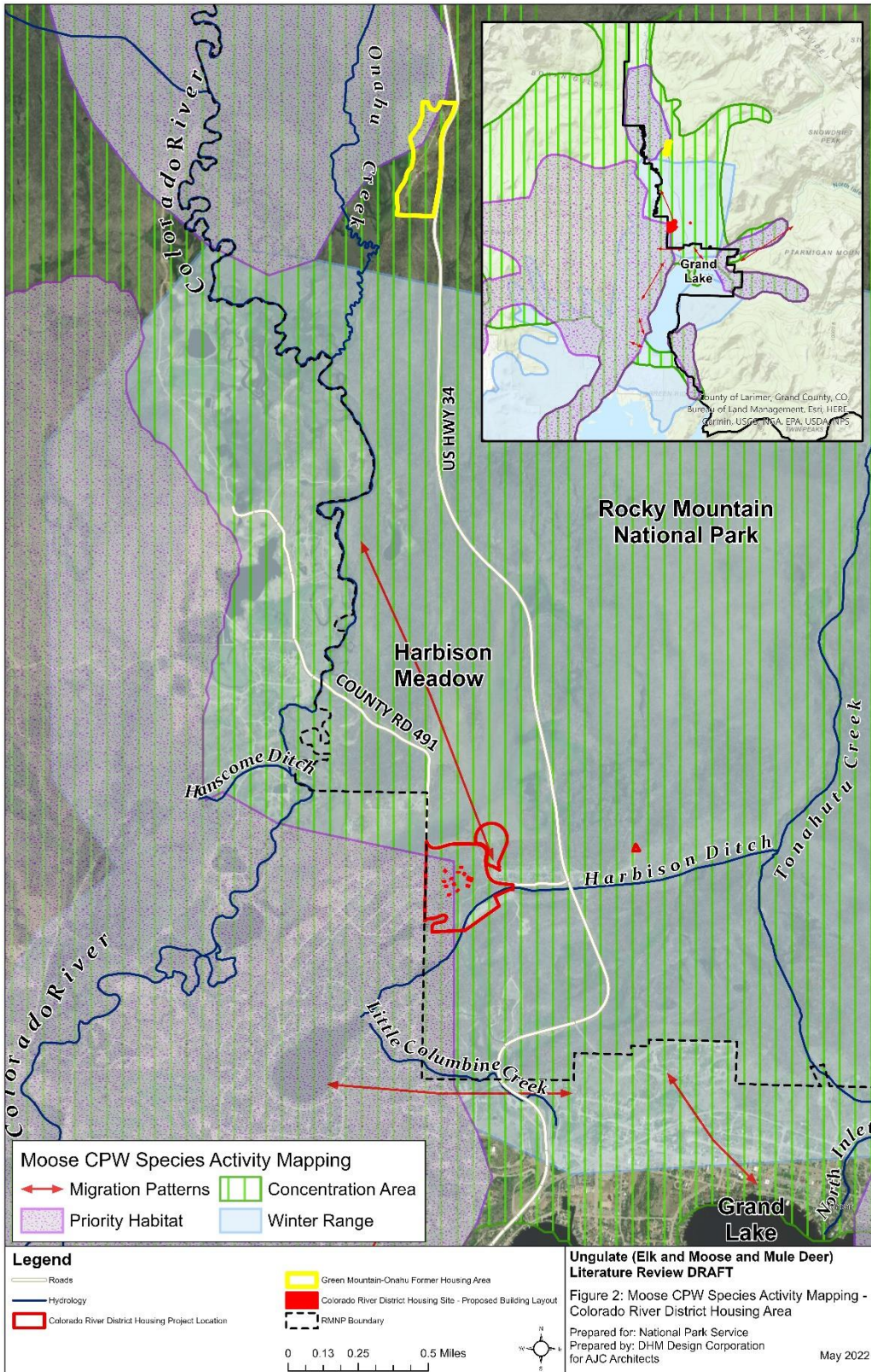


Figure 3. Elk CPW Species Activity Mapping – Colorado River District Housing Area.

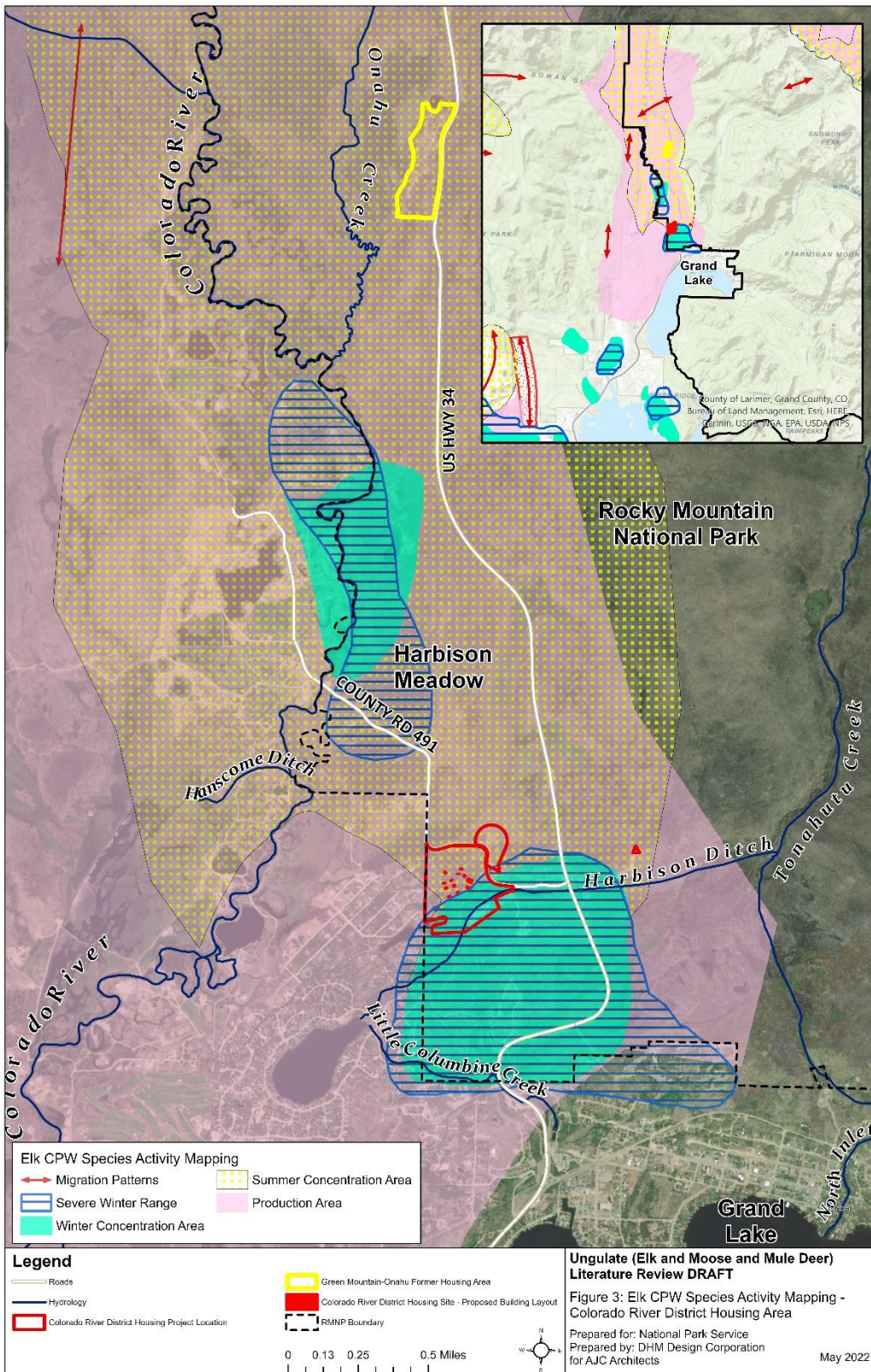


Figure 4. Mule Deer CPW Species Activity Mapping – Colorado River District Housing Area.

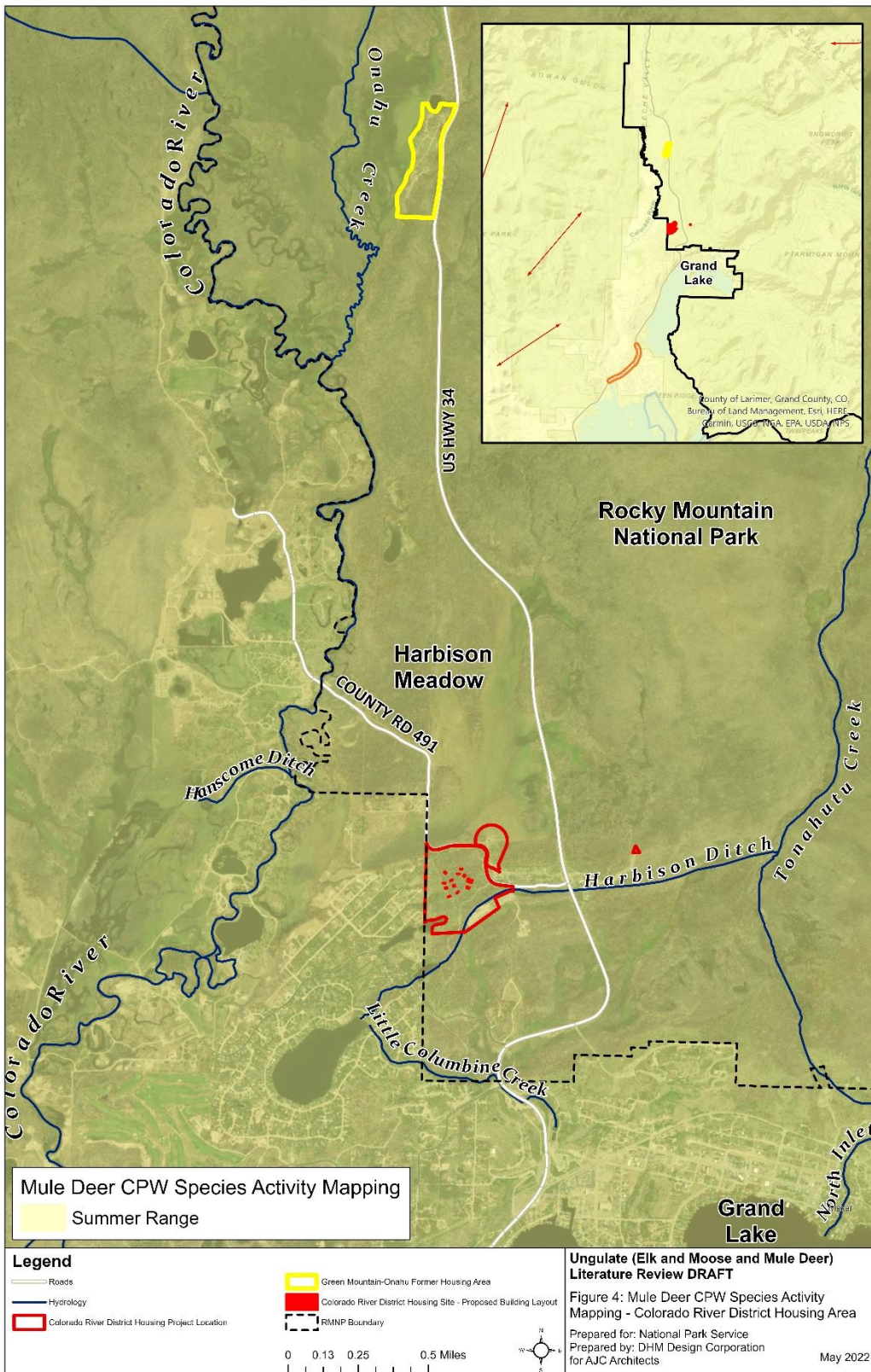


Figure 5. Project Area Vegetation Overview.

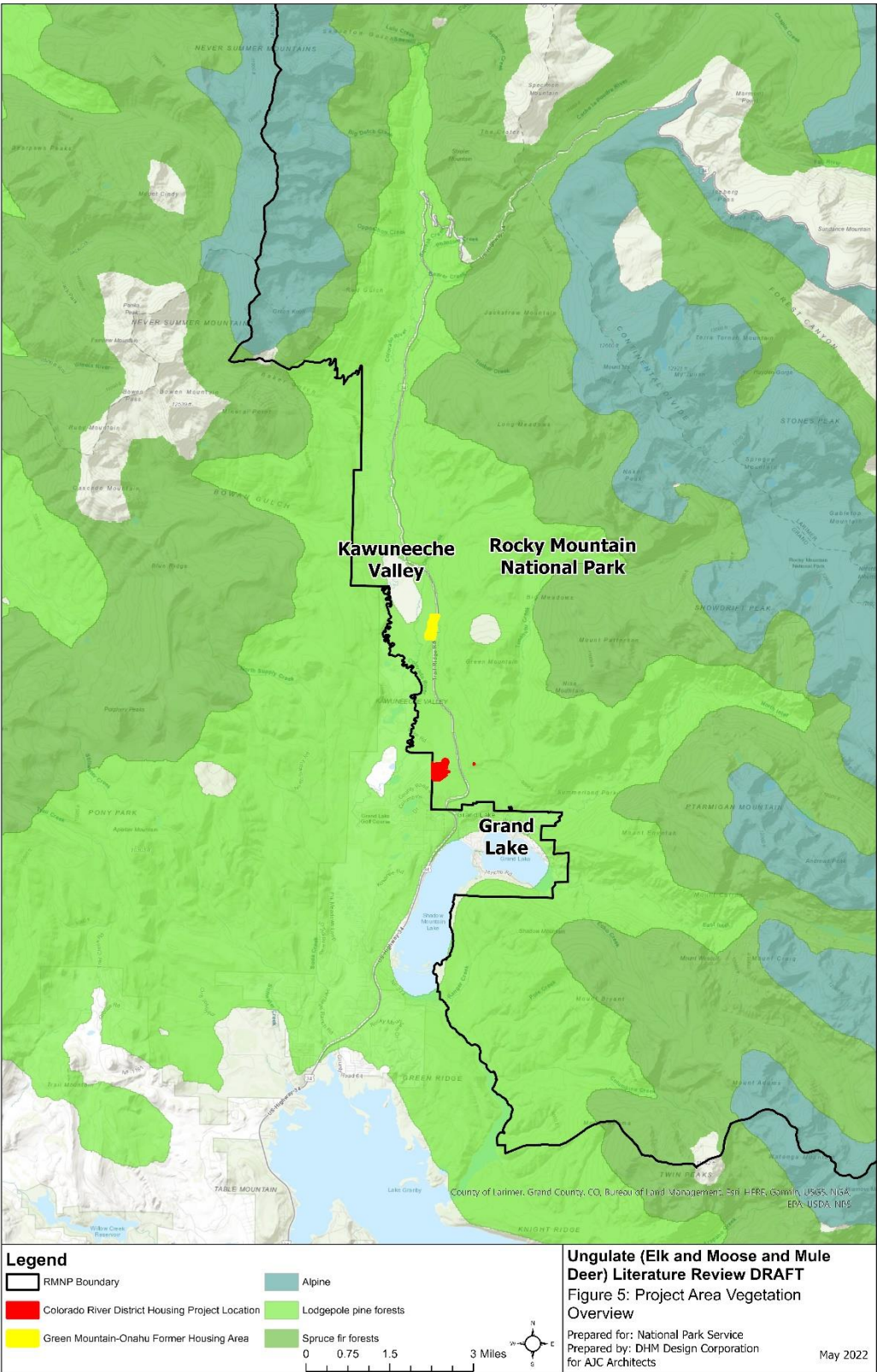


Figure 6. Colorado River District Housing Site Vegetative Communities.

