Inventory of Fens in White River National Forest

Colorado Natural Heritage Program

July 2025

CNHP's mission is to preserve the natural diversity of life by contributing the essential scientific foundation that leads to lasting conservation of Colorado's biological wealth.

Colorado Natural Heritage Program
Warner College of Natural Resources
Colorado State University
1475 Campus Delivery
Fort Collins, CO 80523

Report Prepared for:

White River National Forest
900 Grand Avenue
Glenwood Springs, CO 81601

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Photo title: Fen in Chapman Gulch

Inventory of Fens in White River National Forest

Lauren Laughlin, Joanna Lemly and Gabrielle Smith
Colorado Natural Heritage Program
Warner College of Natural Resources
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EXECUTIVE SUMMARY

The White River National Forest (WRNF) covers 2.4 million acres within central Colorado. Wetlands within the WRNF provide important ecological services to both the forest and lands downstream. Organic soil wetlands known as fens are an irreplaceable resource that the U.S. Forest Service (USFS) has determined should be managed for conservation and restoration. Fens are defined as groundwater-fed wetlands with organic soils that typically support sedges and low stature shrubs. In the arid west, organic soil formation can take thousands of years. Long-term maintenance of fens requires maintenance of both the hydrology and the plant communities that enable fen formation.

In 2012, USFS released a planning rule to guide all National Forests through the process of updating their Land Management Plans (also known as Forest Plans). A component of the planning rule is that each National Forest must conduct an assessment of important biological resources within its boundaries. To support this effort, WRNF contracted the Colorado Natural Heritage Program (CNHP) at Colorado State University to 1) map all potential fens within the WRNF through aerial phot interpretation, and 2) visit potential fens in priority areas within WRNF to confirm organic soil and collect vegetation data.

Potential fens in WRNF were identified from digital aerial photography and topographic maps. Each potential fen polygon was hand-drawn in ArcGIS based on the best estimation of fen boundaries and attributed with a confidence value of 1 (low confidence), 3 (possible fen), 5 (likely fen), 6 (confirmed peat-accumulating wetland) or 7 (confirmed fen). The final map contained 8,946 potential fen locations (all confidence levels), covering 19,166 acres or less than 0.1% of the total land area. This total included 271 ***confirmed fens***, 75 ***confirmed peat-accumulating wetlands***, 1,366 ***likely fens***, 2,664 ***possible fens***, and 4,570 ***low confidence fens.*** The average fen polygon was 2.14 acres, but individual fen polygons ranged from 142 acres to less than an acre.

Fen distribution was analyzed by elevation, geology, and watershed. Nearly all (>95%) mapped potential fens occurred between 10,000 to 12,000 feet. Two watersheds had higher numbers of likely fens: Hunter Creek watershed contains 143 confirmed and likely fens, and the Headwaters Roaring Fork River watershed contains 123 confirmed and likely fens. Thirty-eight confirmed fens were surveyed through this project. All surveyed fens were in good condition and supported diverse communities of vascular and nonvascular plants. The most common characteristic species included *Carex aquatilis, Salix planifolia, Carex scopulorum, Caltha leptosepala,* and *Eleocharis pauciflora.* Eleven populations of four rare plant species were observed.

This report and associated dataset provides the WRNF with a critical tool for conservation planning at both a local and forest-wide scale. These data will be useful for biological assessments and individual management plans, such as for timber sales, grazing allotments, wilderness stewardship, and other management actions. Wherever possible, the forest should avoid direct disturbance to the fens mapped through this project, and should also strive to protect the watersheds surrounding high concentrations of fens, thereby protecting their water sources.

ACKNOWLEDGMENTS

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Thanks to Edward Brett, our always cheerful field technician who was a delight to spend the summer with. We also thank colleagues at CNHP who have worked on previous projects mapping and surveying fen wetlands in the field, specifically Erick Carlson, Denise Culver, Laurie Gilligan, Lexine Long, Peggy Lyon, Dee Malone, Sarah Marshall, and Kristin Schroder. Special thanks David Cooper, Rod Chimner, and Brad Johnson, each of whom has shared with us their great knowledge of fens over the years.

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1.0 INTRODUCTION

Fens are groundwater-fed peat-accumulating wetlands that form an irreplaceable habitat within White River National Forest (WRNF). Fens have deep organic soils and typically support sedges and low stature shrubs (Rydin et al. 2017; Mitsch & Gosselink 2015). Organic soil is defined technically as a soil where more than half of the upper 80 cm (32 in) is organic soil material (also referred to as peat) (Soil Survey Staff 2022). However, wetlands with shallower peat layers may share similar characteristics (Driver 2010). Accumulation of organic material to this depth requires constant soil saturation and cold temperatures, which create anaerobic conditions that slow the decomposition of organic matter. In the Rocky Mountains, peat accumulation occurs very slowly, as little as 20 cm (8 in) per 1,000 years (Chimner 2000; Chimner and Cooper 2002). By storing organic matter in their soils, fens act as carbon sinks. Fens also help to regulate local and regional hydrology by stabilizing base flow through the slow release of groundwater. In addition, fens throughout the Southern Rockies support numerous rare plant species that are often disjunct from their main populations (Cooper 1996; Cooper et al. 2002; Johnson & Stiengraeber 2003; Lemly et al. 2007; Lemly & Cooper 2011). The long-term maintenance of fens requires protection of both the hydrology and the plant communities that enable fen formation.

Human land use activities can have detrimental impacts on fen wetlands, often altering their hydrology to the extent that water levels and associated plant communities are significantly changed or eliminated (Charman 2002). Rocky Mountain fens have been impacted by a variety of land uses, including grazing, recreation, ditching, draining, excavation, flooding, mining activity, and road building (Bocking et al. 2017; Austin & Cooper 2016; Johnston et al. 2012; Chimner et al. 2010; Cooper & McDonald 2000). WRNF is the most visited national forest in the United States. Most visitors visit the forest during the ski season, since the forest is home to eleven ski resorts. Though the forest sees less intense visitor use when it's no longer ski season, it still experiences heavy traffic from hikers, hunters, fishermen, and others seeking the outdoors. While it's undoubtedly a major economic driver for the forest and the state of Colorado, there are major environmental impacts that come with heavy human activity. For the past several years, joint efforts between U.S. Forest Service (USFS) and the Colorado Natural Heritage Program (CNHP) at Colorado State University have helped to better understand the fens of WRNF. With increasing visitation, it's important for these ecosystems to be better understood so that they can in turn be better protected.

In 2012, the USFS released a planning rule to guide all National Forests through the process of updating their Land Management Plans (also known as Forest Plans).[1] A component of the planning rule is that each National Forest must assess important biological resources within its boundaries. To support this effort, WRNF contracted CNHP to 1) map all potential fens within WRNF through aerial photo interpretation, and 2) visit potential fens in priority areas within WRNF to confirm organic soil and collect vegetation data.

[1] For more information on the 2012 Forest Planning Rule, visit the following website: http://www.fs.usda.gov/main/planningrule/home.

This project builds upon CNHP's previous fen mapping for WRNF (Malone et al. 2011), as well as other fen mapping projects for USFS Region 2 and Region 4: Rio Grande National Forest (Smith et al. 2016), Ashley National Forest (Smith & Lemly 2017a), Manti-La Sal National Forest (Smith & Lemly 2017b), Salmon-Challis National Forest (Smith et al. 2017), Bridger-Teton National Forest (Smith & Lemly 2018a), Dixie National Forest (Smith & Lemly 2018b), Humboldt-Toiyabe National Forest (Smith & Lemly 2019a) and Fishlake National Forest (Smith and Lemly 2019b), Caribou-Targhee National Forest (Smith & Lemly 2020), Sawtooth National Forest (Smith & Lemly 2021a), Boise National Forest (Smith & Lemly 2021b), Payette National Forest (Smith & Lemly 2022), and Uinta-Wasatch-Cache (Smith 2023).

2.0 Study Area

2.1 Geography

WRNF covers 2.4 million acres in central Colorado located within portions of Summit, Eagle, Pitkin, Garfield, and Rio Blanco Counties (Figure 1). Elevations range from 7,000 ft to 14,265 ft. The entire forest is located on the western side of the Continental Divide, which forms the eastern boundary in some areas. The forest is divided into two major sections: one north of I-70 and one to the south. Most of the forest, including the headwaters of the Blue, Eagle and Roaring Fork Rivers, drain into the Colorado Headwaters River Basin (HUC: 140100) (Figure 2). The northwest corner of the forest flows north into the White-Yampa River Basin (HUC: 140500).

Historically, the WRNF was home to the Southern Ute tribes, who lived on the land for thousands of years. In the present day, the land is primarily used for recreation. With eleven ski resorts, eight wilderness areas, ten peaks over 14,000 feet, and thousands of miles of maintained trails, WRNF is the most visited national forest in the United States and has something to offer each visitor. With its heavy usage, it's critical that the unique and rare natural features of the forest be identified, studied, and protected. These natural features are diverse and range from high alpine tundra to Douglas fir and aspen forests and various wetland ecosystems. Perhaps one of the most important wetland ecosystems found in WRNF is fens. Though they cover less than 0.1% of the forest, fens provide critical ecosystem services that cannot be replaced.

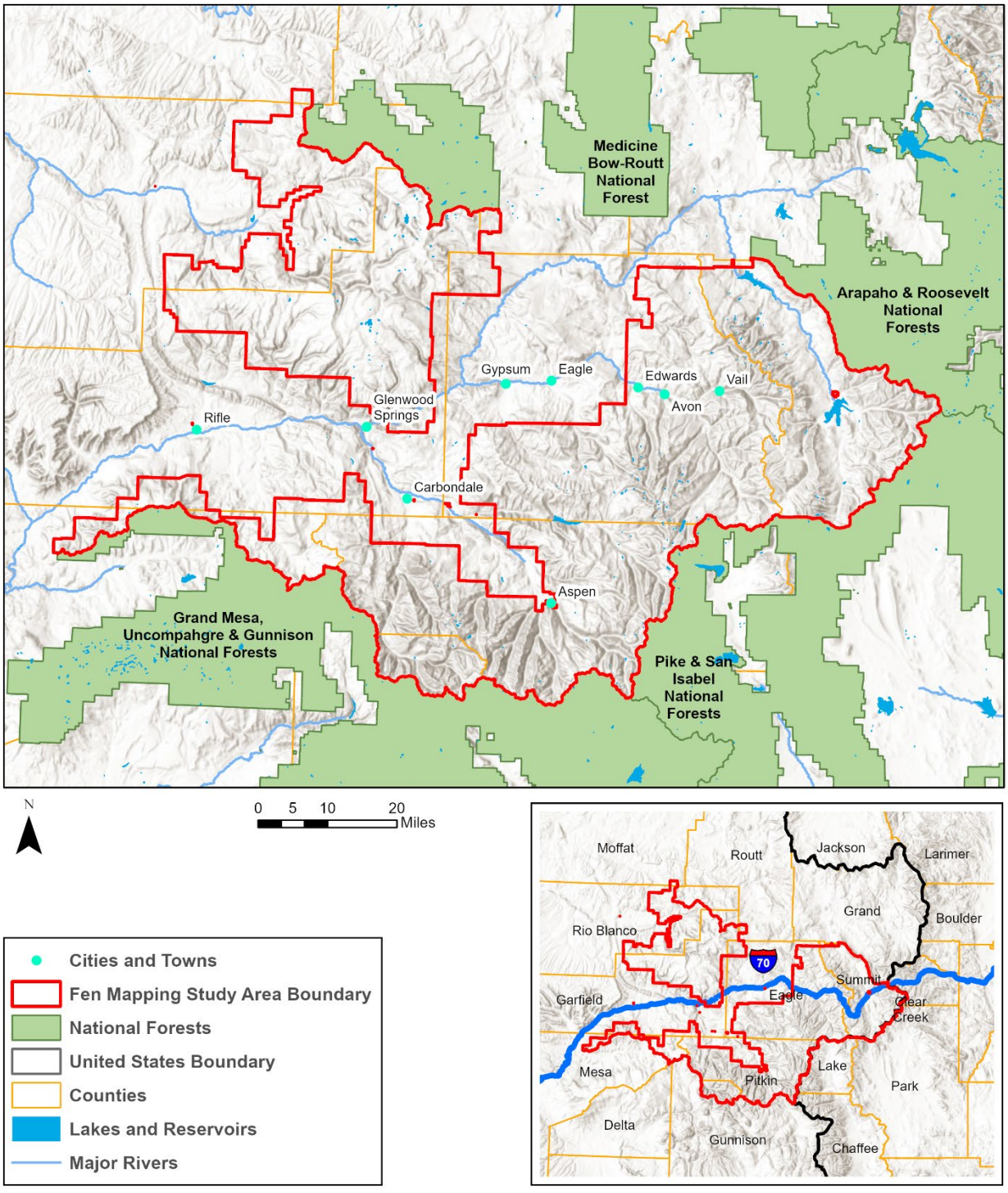

Figure 1. Location of the White River National Forest.

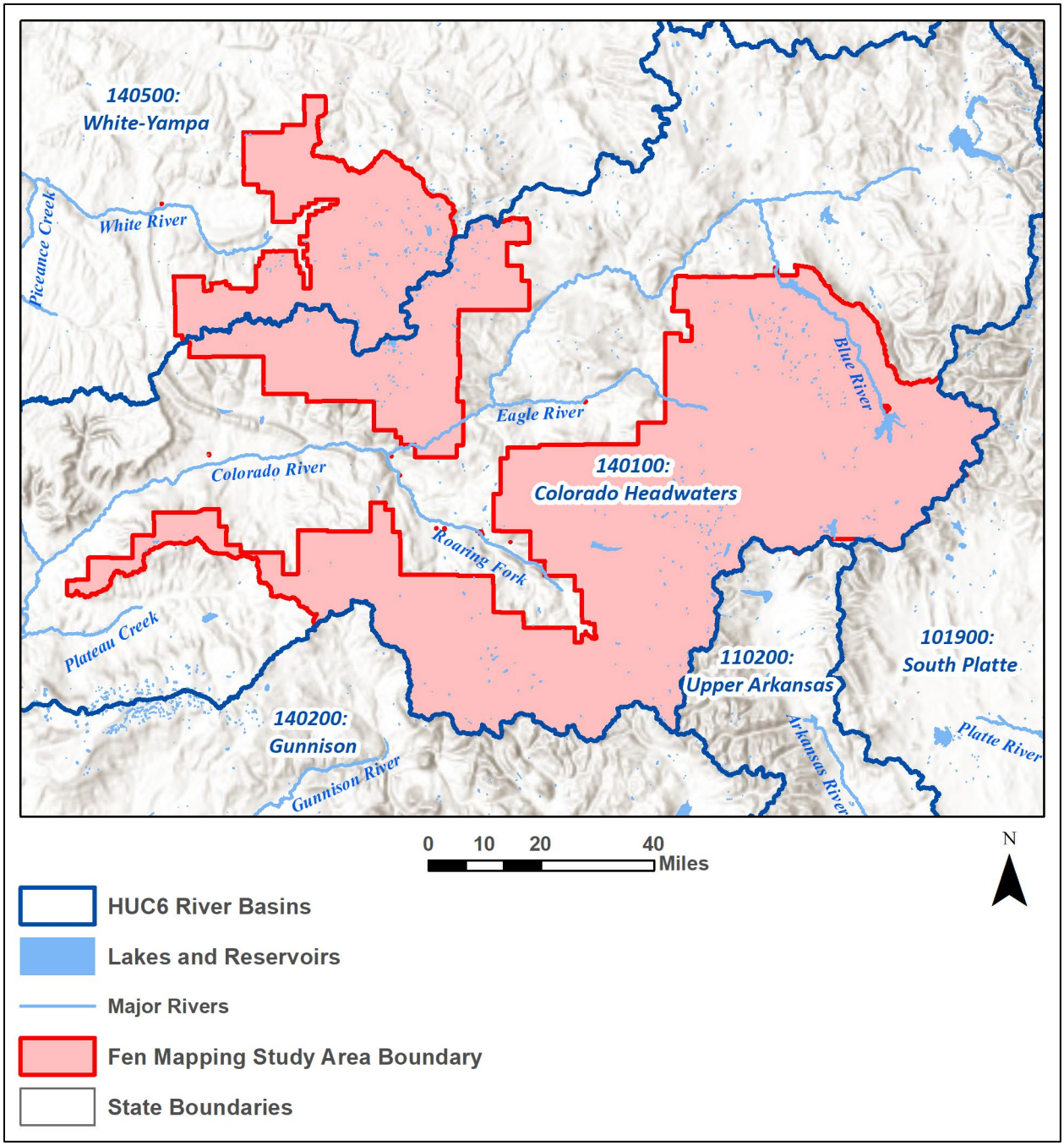

Figure 2. HUC6 river basins and major waterways in the fen mapping study area.

2.2 Geology

The geology of WRNF is incredibly varied and includes metamorphic, sedimentary, and igneous rocks formed over billions of years (Figure 3). The northern section of WRNF is dominated the Flat Tops Wilderness Area, an aptly named plateau of sprawling grasslands and rolling hills at about 10,000 feet in elevation. The Flat Tops and surrounding lands north of I-70 rest on the White River Plateau, which formed over eons of uplift, volcanic activity, and glacial erosion. Thick basalt lava flows of Tertiary age cover the central Flat Tops, but ancient shales, limestone, and other sedimentary layers beneath the basalt are exposed on the edges of the Wilderness Area, especially on the southern edge of the plateau where the bedrock is primarily limestone. Igneous bedrock in the Flat Tops is more mafic composition, meaning higher magnesium and iron content. The limestone and other sedimentary layers have a high calcium and carbonate content, and dissolution of the limestone over millennia have formed numerous karst formations and caves. The Flat Tops are a unique feature in WRNF, since many other areas of the forest contain high rocky peaks and lush valleys with rivers and lakes.

The region of the forest south of I-70 is more typical of the Southern Rocky Mountains that form the central spine of Colorado and mark the landscape with high peaks and deep valleys. The eastern edge of the forest is bound by the iconic mountain ranges of the Continental Divide. These mountains are primarily Precambrian igneous and metamorphic rocks that were push up during mountain building events. Here, the bedrock has a higher silica content than bedrock in the Flat Tops region. Lower elevations surrounding the high peaks are characterized by sedimentary formations deposited before the latest mountain building event when Colorado was covered by a vast inland sea. Both the high igneous peak and the lower sedimentary layers have been eroded through glaciation and streamflow, creating valleys filled with recent Quaternary alluvium and surficial deposits. The margins of the high mountain valleys are perfect for fen formation.

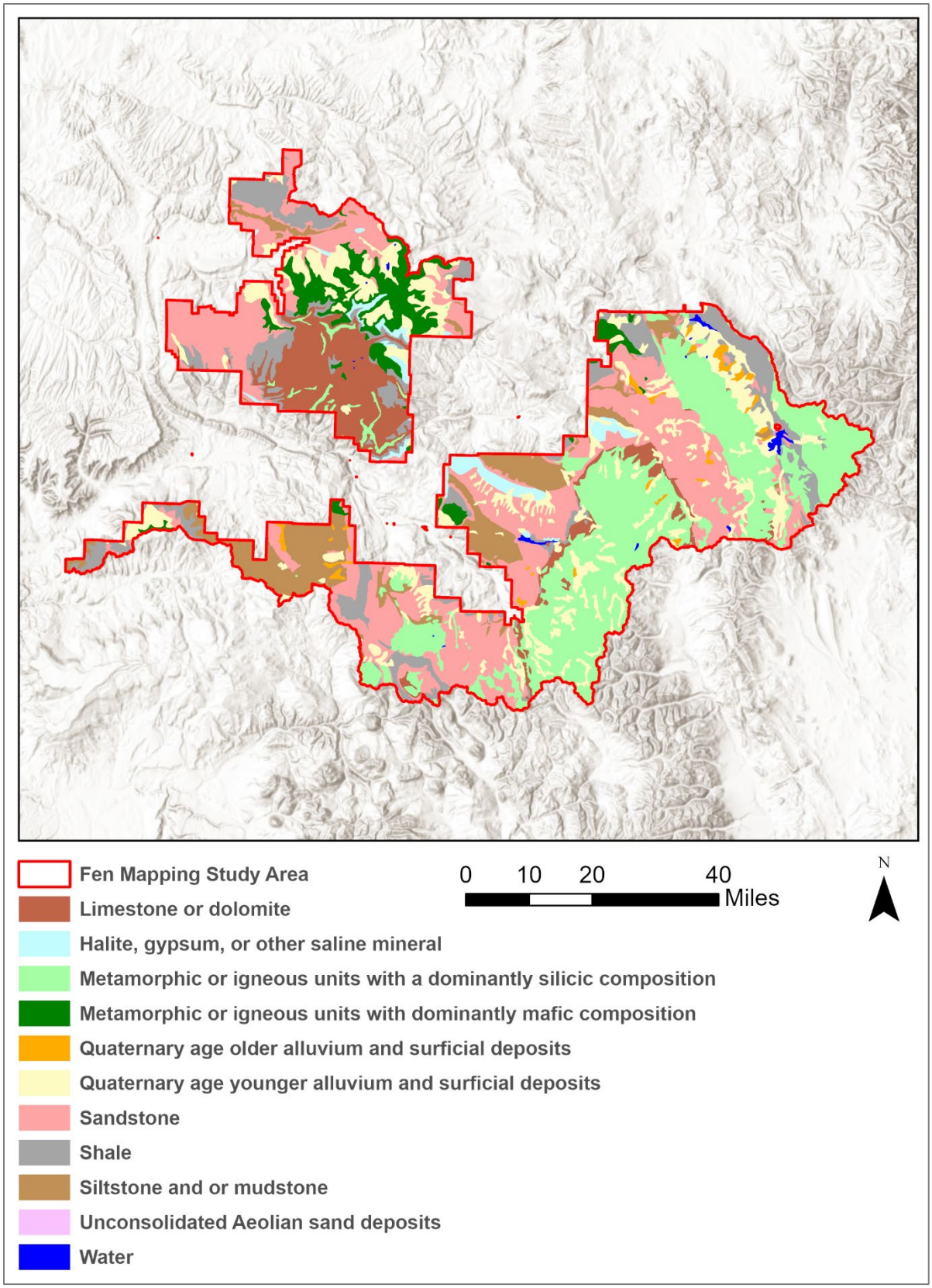

Figure 3. Geology within the fen mapping study area (SWREGAP 2005).

3.0 METHODS

3.1 Fen Mapping Methods

The primary objective of this study was to map fens in the WRNF through aerial photo interpretation. Fens occur most frequently at the base of slopes where groundwater expresses to the surface or in basins where organic material accumulates and gradually fills ponds and small lakes (Wolf & Cooper 2015). In aerial photography, fens can be identified by mottled brownish-green colors, rather than the bright green colors of more productive wetland systems. Fens may contain small pools of water or be located on the margin of ponds or small lakes. They can occur on the edge of mountain stream valleys, but typically not on the floodplains of larger rivers, where the scouring action of periodic flooding would prevent peat accumulation.

In 2011, CNHP completed an initial round of fen mapping and associated field surveys (Malone et. al 2011). The 2011 fen mapping was a review of U.S. Fish and Wildlife Service National Wetland Inventory (NWI) polygons created in the 1980s at 1:40,000 scale. All NWI polygons with a hydrologic regime of "B" (saturated) were reviewed and given a fen confidence rating between 1 (low confidence) and 5 (likely fen). No new fen boundaries were delineated; only existing NWI polygons were rated. While this method provided an approximate estimate of fen distribution in WRNF, many NWI polygons were large and contained both fen and non-fen wetlands. Between 2011 and 2024, CNHP carried out numerous other fen mapping projects and our methodology for mapping fens has changed. Instead of assigning a confidence rating to existing NWI polygons, in subsequent fen mapping projects, CNHP created new polygons drawn specifically around potential fen wetlands. This method has proven to be much more precise and meaningful to land managers.

For the current project, potential fens in WRNF were identified by analyzing digital aerial photography and topographic maps and hand-drawn in ArcGIS 10.8 based on the best estimation of fen boundaries. Every fen polygon in this updated dataset was hand drawn based on aerial photography. True color aerial photography taken by the National Agricultural Imagery Program (NAIP) in 2005, 2009, 2011, 2015, 2019, 2021 and 2023 was used in conjunction with color-infrared imagery from 2015, 2019, 2021 and 2023. High (but variable) resolution World Imagery from Environmental Systems Research Institute (ESRI) was also used. To focus the initial search, where possible, all wetland polygons mapped by NWI in the 1980s with a "B" (seasonally saturated) or "D" (continuously saturated) hydrologic regime were isolated from the full NWI dataset and examined, similar to the 2011 project. Wetlands mapped as Palustrine Emergent Saturated (PEMB/D) and Palustrine Scrub-Shrub Saturated (PSSB/D) were specifically targeted, as they can be the best indication of fen formation, and every PEMB/D and PSSB/D polygon in the study area was checked. However, in contrasts to the 2011 project, the photo-interpreter was not limited to the original NWI polygons and also mapped any fens they observed outside of B or D regime NWI polygons. Each potential fen polygon was attributed with a confidence value of 1, 3, 5, 6 or 7 (Table 1). Each fen location for the purposes of this report is a single potential fen polygon. Potential fen polygons of different confidence levels may be adjacent or nested within each other and together represent a larger fen complex.

Table 1. Description of potential fen confidence levels.

Confidence	*Description*
7	***Confirmed fen.*** Site was visited in the field either through this sampling effort or another highly reputable sampling effort. Site is confirmed to be a fen with > 40 cm of peat soil.
6	***Confirmed peat-accumulating wetland.*** Site was visited in the field. Shallow peat soil < 40 cm was observed. Site is not a fen but confirmed as a peat-accumulating wetland.
5	***Likely fen.*** Strong photo signature of fen vegetation, fen hydrology, and good landscape position. All likely fens should contain peat of 40 cm or more throughout the entire area of the mapped feature.
3	***Possible fen.*** Some fen indicators present (vegetation signature, topographic position, ponding or visibly saturated substrate), but not all indicators present. Some may be weak or missing. Possible fens may or may not have the required peat depth of 40 cm but may have patchy or thin peat throughout.
1	***Low confidence fen.*** At least one fen indicator present, but weak. Low confidence fens are consistently saturated areas that do not show peat signatures in the aerial photography but may contain fen or peat.

In addition to existing NWI mapping, several auxiliary datasets were also used to identify potential and confirmed fens and peat accumulating wetlands. Those included topographic maps from the U.S. Geologic Survey, spring locations from the National Hydrography Dataset (NHD), field data from this project and previous CNHP survey efforts, and fen inventory data from Colorado Mountain College (Table 2). Lastly, all known locations of the rare fen-indicator species in WRNF were obtained from CNHP's BIOTICS database and examined in aerial photography to determine if the site appeared to be a fen. While all species on the target list could occur in fens, they were not all fen-obligates, meaning some species could occur in other habitats as well as fens. The known locations were used to ensure that all known occurrences in what appeared to be fen habitat were included in the potential fen map. Along with the confidence rating, any justifications of the rating or interesting observations were noted, including beaver influence, floating mats, or springs.

Table 22. Data sources used to confirm fen polygons. Polygons could be confirmed by multiple data sources, which occasionally overlapped.

Data Source	*Year(s)*	*Count of Features*
CNHP Element Occurrences	various	38
CNHP Wetland Vegetation Plots	1990s	86
CNHP WRNF Field Sampling	2011	40
Colorado Mountain College Field Sampling	2014-2018	98
CNHP CDOT Fens Field Sampling	2016-2017	35
CNHP WRNF Field Sampling (Dee Malone)	2020-2022	136
CNHP WRNF Field Sampling (this study)	2024	14

3.2 Field Sampling Methods

Field sampling took place over two seven-day sampling periods in September 2024. Field methods were modeled after the USFS Groundwater Dependent Ecosystem (GDE) field guides (USFS 2022; USFS 2012). Field sampling took place while the new fen mapping was being created, meaning the field data informed the mapping and was not verification post-mapping. However, the previous 2011 fen mapping was used to select fen-rich areas for field surveys. Previous field survey locations were also used to identify priority areas with little on-the-ground data. The 2024 field sampling focused on undersurveyed fen-rich areas with well-defined trails for accessibility. Past fen surveys in the area were largely concentrated near roads. In an attempt to sample fens in more remote places while also maintaining efficiency, the crew sampled potential fens near trails the Hunter-Fryingpan Wilderness Area in the southern section and the Flat Tops Wilderness Area in the northern section, as well as front country areas nearby.

At each polygon visited, peat depth was determined in one or more locations with a soil auger. If the site was confirmed as a fen (> 40 cm of organic soil), additional data were collected, including site characteristics, photos, vegetation data, and water chemistry. Methods for each type of data collection are detailed in the following sections.

Peat Depth Estimation

Fens are defined as groundwater-fed wetlands with organic soil. The Natural Resources Conservation Service (NRCS) defines organic soil as follows (Soil Survey Staff 2022):

> *"It is a general rule that a soil is classified as an organic soil (Histosol or Histel) if more than half of the upper 80 cm (32 inches) of the soil is organic or if organic soil material of any thickness rests on rock or on fragmental material having interstices filled with organic materials."*

Figure 5 shows examples of organic soil cores extracted from fens in other studies. Note the presence of roots and fibrous organic material throughout the soil core. The soil color may be dark brown to reddish brown depending on the source material and the soil material holds together.

In at least one representative location within each visited polygon, crews inserted the soil auger to estimate the depth of the organic soil or peat layer. If the polygon was small and homogeneous, one soil core was enough to determine if the polygon contained > 40 cm of organic soil material. If the polygon was large and heterogeneous, the auger was used in multiple locations with different vegetation communities to determine if any portion of the polygon contained organic soil. If the organic soil layer was > 40 cm in at least a portion of the polygon, that portion of the polygon was verified as a fen and additional data were collected. If organic soil material was present but < 40 cm, the site was considered a peat-accumulating wetland, but no other data were collected. If no organic soil material was present, the crew moved on to the next polygon. Peat depth estimations were recorded using a Survey123 form that allowed multiple auger to be recorded per polygon. A GPS waypoint was taken at every soil auger to associate the data with the precise spatial location. In addition to the GPS waypoint, a photo was taken of the location for reference.

Figure 5. Examples of organic soil cores extracted from other studies.

Data Collected for All Confirmed Fens

For each confirmed fen polygon, basic information was recorded using the Survey123 field form based on the USFS GDE Level 1 Inventory Field Guide (USFS 2022). This includes the following data:

- Polygon ID from the 2011 potential fen mapping (if applicable)
- GPS coordinates from the center of the polygon
- Survey date and observers
- Site description (the setting, landform, and landscape context, this information should remain the same over time)
- Site conditions (this is different than the site description and can change between surveys)
- Access directions so that site can be relocated in the future
- Weather and air temperature
- Notes on edits to the polygon boundaries
- Elevation and slope
- Photographs

Vegetation Data Collection

In all confirmed fens, a rapid site evaluation was conducted to characterize the dominant vegetation. In these sites, a list of dominant and readily observable vascular plant species with absolute canopy cover > 10% was recorded. Low cover species were also included if observed, but the site was not exhaustively searched for low cover species. The species search was limited to 30 minutes by one trained botanist to minimize the amount of time spent at each site and maximize the number of polygons the crew was able to visit. When all dominant species were identified within a polygon, or 30 minutes of time was spent searching, the canopy cover of listed species was visually estimated using cover classes (Table 3).

Table 3. Cover classes used for rapid site evaluations.

Cover Class	*Range*
1	Trace (1 or 2 individuals)
2	< 1% absolute canopy cover
3	1 to <2% absolute canopy cover
4	2 to <5% absolute canopy cover
5	5 to <10% absolute canopy cover
6	10 to <25% absolute canopy cover
7	25 to <50% absolute canopy cover
8	50 to <75% absolute canopy cover
9	75 to <95% absolute canopy cover
10	≥95% absolute canopy cover

Nomenclature for all plant species followed USDA PLANTS National Database and all species were recorded in the Survey123 form using the fully spelled out scientific name. Any unknown species were recorded with a unique descriptive name and given a collection number for later identification. Unknown species were collected by the field crew if the species represented > 10% cover over the entire polygon, even if the species appeared to be unidentifiable, in case the same species was encountered in a more developed state at a later site and could be compared with the earlier voucher. Crews also estimated bryophyte abundance in each polygon that was confirmed to be a fen.

Rare Vascular Plant Surveys

In addition to rapid site evaluations, the crew collected additional data on species that are considered rare in the state of Colorado. This list consisted of rare fen-indicator species that are tracked by the CNHP. When searching for rare species, the crew walked the full polygon, focusing on each different habitat that may support rare species. When a targeted species was identified, the crew collected photos and additional information about the population size and phenology. Where possible, the crew also was supplied with the locations of past element occurrence records, and in a few instances, the crew was able to revisit past observations that were accessible and fell within polygons.

Water Chemistry

In one location within confirmed fens, pH, specific conductance, and temperature of groundwater were measured with a handheld YSI Pro1030 pH meter. The meter was calibrated at least every seven days per the manufactured recommendation and more frequently if readings were outside of normal ranges (pH 5.0-8.0; EC >1000). Water chemistry measurements were taken from groundwater within the soil, if possible. Measurements were also taken in standing and/or flowing surface water. GPS coordinates and a description of the location were recorded on the form. Due to late-season sampling, not every site had enough water present to fully submerge the probe for water chemistry.

3.3 Data Analysis

GIS Analysis of Confirmed and Likely Fens

To interpret and provide context to the data, several analyses were conducted in GIS using the confirmed fens, confirmed peat-accumulating wetlands, and likely fens (collectively referred to as "confirmed and likely fens") along with ancillary data sources. We examined the geographic distribution of these fens by watershed, elevation, and geology. Most analyses were carried out as simple intersects in GIS using the centroids of all confirmed and likely fen and ancillary data layers.

Analysis of Field Data

Field collected data were analyzed using several different approaches. 1) Metrics of vegetation composition and cover, including species richness, floristic quality, and cover of various species groups (shrubs, graminoids, forbs, annuals, perennials, native vs. nonnative species, hydrophytic species) were calculated from the rapid site evaluations. Floristic quality was assessed using 'coefficients of conservatism' or C-values, which are numerical ratings (0–10) applied to each species within a state's flora that indicate the species' fidelity to natural habitats and tolerance or intolerance to disturbance (Swink & Wilhelm 1994; Wilhelm & Masters 1996). C-values for Colorado were previously assigned by a group of botanical experts (Smith et al. 2020). 2) Each confirmed fen observed in the field was assigned to a plant community within the U.S. National Vegetation Classification system. 3) Occurrences of rare fen vascular plant species were summarized and will be used to update CNHP's Element Occurrences for rare species. 4) Water quality measurements were summarized and described in context of the poor to rich gradient of peatland water chemistry (Wheeler & Proctor 2000; Malmer 1986).

4.0 RESULTS

4.1 Fen Mapping Results

The final map of potential fens contained 8,946 potential fen locations (all confidence levels), covering 19,166 acres or less than 0.1% of the total land area (Table 4). This total included 271 ***confirmed fens***, 75 ***confirmed peat-accumulating wetlands***, 1,366 ***likely fens***, 2,664 ***possible fens***, and 4,570 ***low confidence fens.*** The fens assigned a confidence level of 7 are fens that have been confirmed on the ground either through this study or previous surveys. Thirty-eight fens were confirmed during the 2024 field season (discussed in Section 4.2 below). Others were compiled from previous CNHP sampling efforts, Colorado Mountain College fen inventories, and previous fen community or rare plant Element Occurrences (EOs) in the national forest.

In addition to confirmed fens and confirmed peat-accumulating wetlands, another 1,366 polygons were considered likely fens (confidence level = 5) due to their landscape position, aerial photo signature, and known plant populations, but were unable to be visited for field confirmation. Together, the fens with a confidence of 5 or higher cover 3,846 acres of the WRNF. In the following analyses, we grouped confirmed fens, confirmed peat-accumulating wetlands, and likely fens as the wetlands of greatest management interest to WRNF management, and we referred to these collectively as "confirmed and likely fens" (Figure 4). Impacts to these 1,712 wetlands should be avoided whenever practicable. Another 7,234 polygons covering 15,321 acres were considered possible or low confidence fens (confidence levels = 3 or 1). These polygons could not be ruled out by remote observation or through aerial image interpretation but are not as likely to be fens as the 1,712 confirmed and likely fens.

The final map produced from this project contained twice as many potential fen polygons as the 2011 dataset, but only ~60% more acres (Table 5). The 2025 mapping was not restricted to existing NWI polygons, which meant more smaller potential fens were captured in the 2025 mapping. In addition, the confirmed and likely fens in the 2025 dataset were smaller than the likely fens in the 2011 dataset because the mapping was more precisely delineated around the fen.

On average, the confirmed fens and confirmed peat-accumulating wetlands in the 2025 mapping were somewhat larger in size than the likely, possible, and low confidence fens (2.47 acres vs. 2.12 acres). The size of individual potential fens ranged from over 142 acres to 0.2 acres. The largest mapped confirmed fen at 44 acres is located in the Smuggler Mountains area, west of No Name Creek (Figure 5). The largest confirmed fen surveyed in 2024 was 16 acres and located in the Fryingpan Wilderness Area near Chapman Gulch (Figure 6). The largest mapped likely fen at 65 acres is located at the headwaters of the South Fork of White River, east of Trappers peak (Figure 7).

The sections that follow break down the fen mapping by elevation range, geology, and HUC12 watershed. The next section summarizes observations made by the fen mappers during the mapping process, including potential floating mat fens.

Table 44. Confirmed and potential fen counts and acreage, by confidence levels, for 2025 mapping.

Confidence	*Count*	*Acres*	*Average size (acres)*
7 – Confirmed Fen	271	669	2.47
6 – Confirmed Peat-Accumulating Wetland	75	199	2.65
5 – Likely Fen	1,366	2,978	2.18
3 – Possible Fen	2,664	5,195	1.95
1 – Low Confidence Fen	4,570	10,126	2.22
TOTAL	**8,946**	**19,166**	**2.14**

Table 55. Potential fen counts and acreage, by confidence levels, for 2011 mapping.

Confidence	*Count*	*Acres*	*Average size (acres)*
5 – Likely Fen	604	2,822	4.67
3 – Possible Fen	1,877	4,898	2.60
1 – Low Confidence Fen	2,273	5,023	2.21
TOTAL	**4,754**	**12,742**	**2.68**

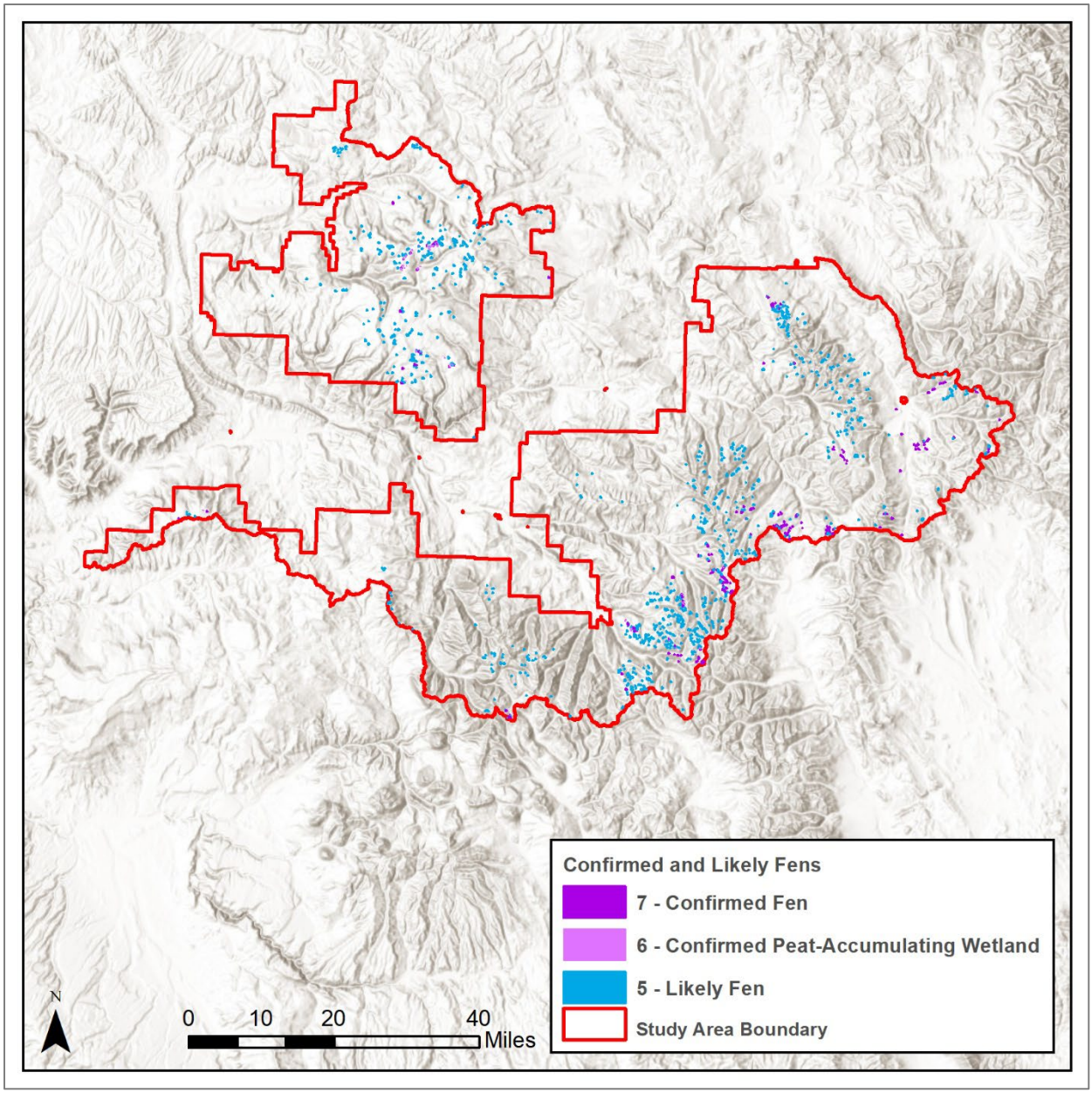

Figure 4. Confirmed and likely fens (confidence rating = 7, 6, or 5) within the fen mapping study area.

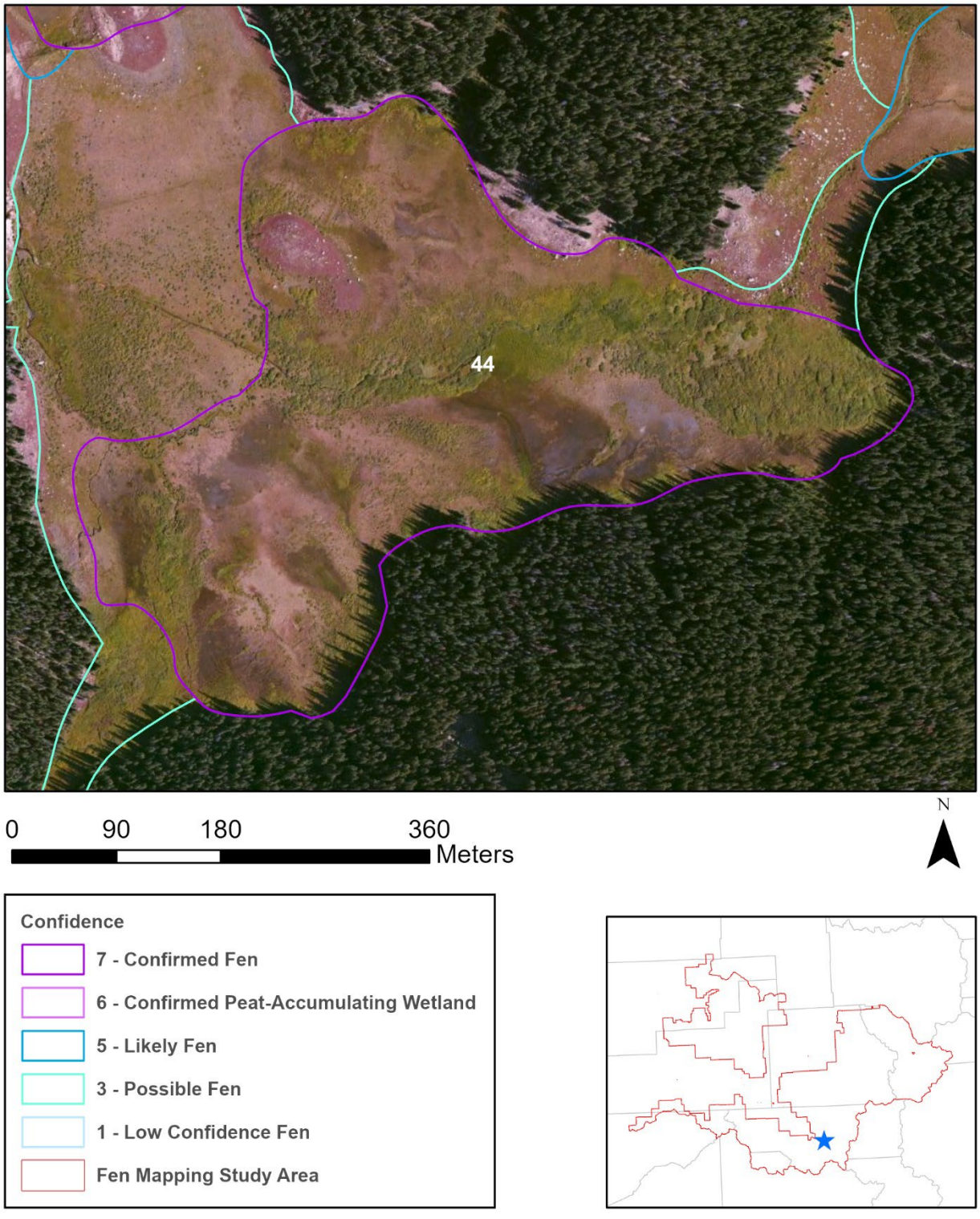

Figure 5. Largest mapped confirmed fen, 44 acres within one polygon. This fen is located in the Smuggler Mountains area, west of No Name Creek in Pitkin County.

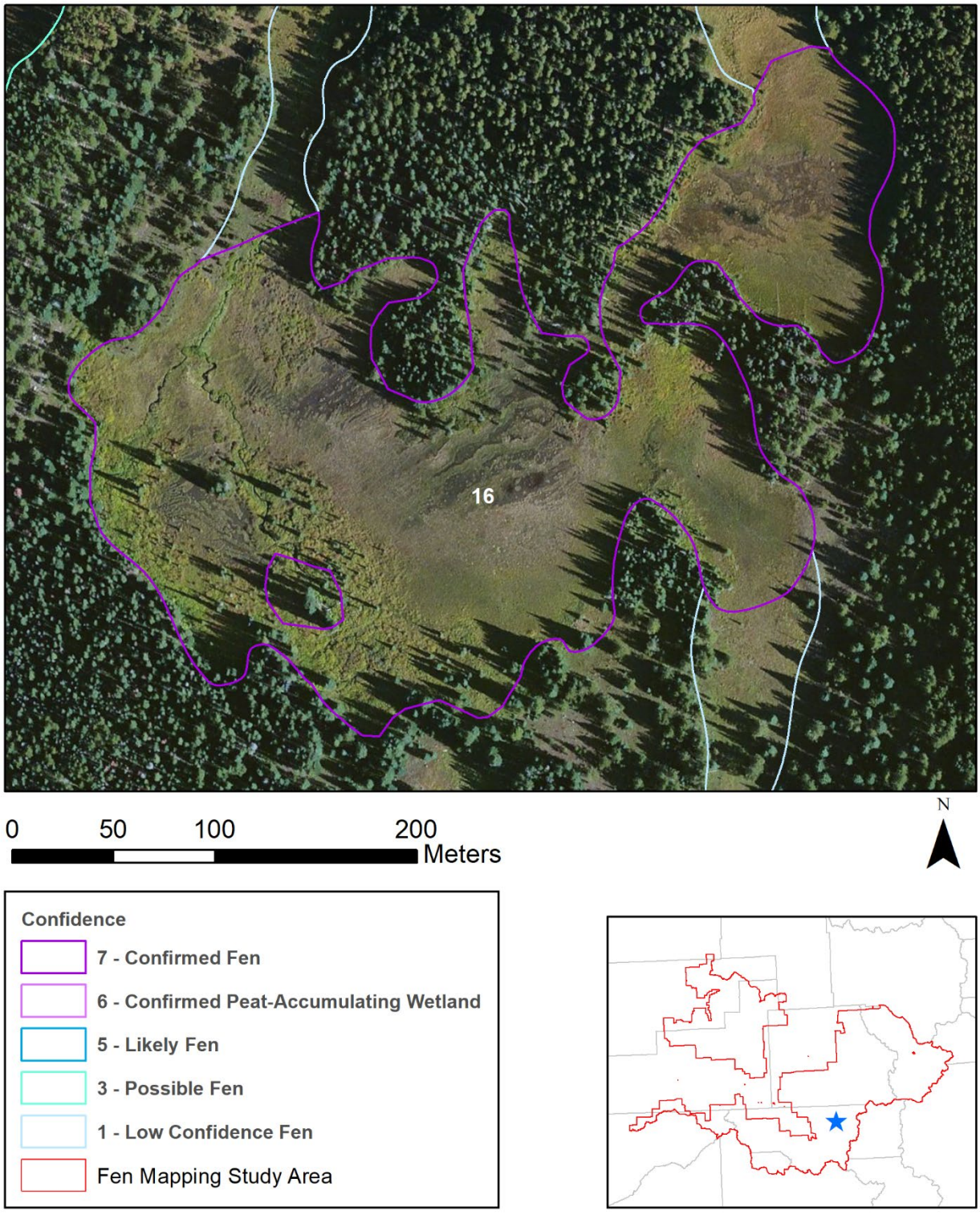

Figure 6. The largest confirmed fen surveyed in 2024 (16 acres). This confirmed fen is located in the Fryingpan Wilderness area, between Chapman and Easter Gulches in Pitkin County.

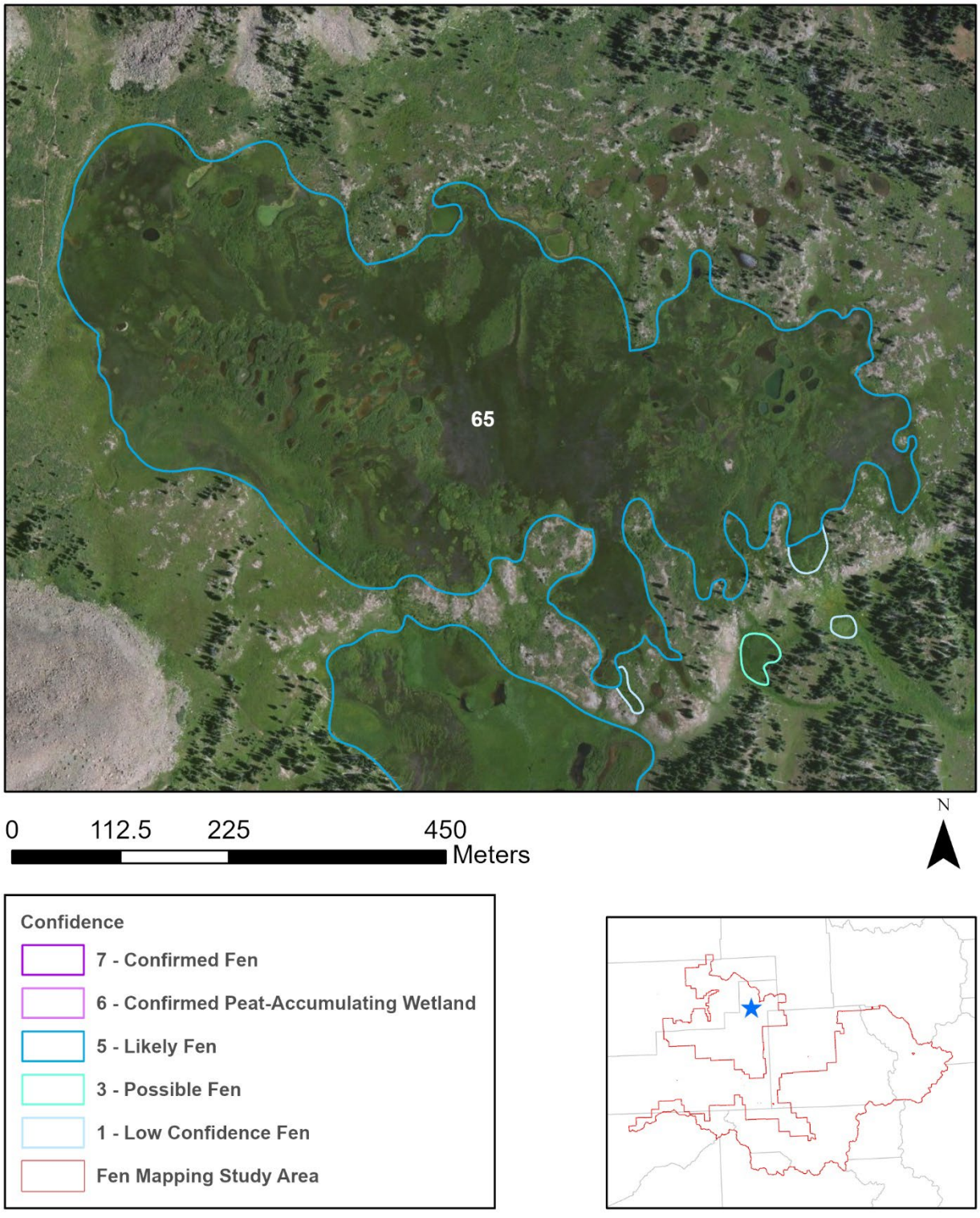

Figure 7. The largest mapped likely fen (65 acres) located at the headwaters of South Fork of the White River, east of Trapper's Peak in Garfield County.

Mapped Potential Fens by Elevation

Elevation is an important factor in the location of fens. Fen formation occurs where there is sufficient groundwater discharge to maintain permanent saturations. This is most often at higher elevations, where slow melting snowpack can percolate into subsurface groundwater. Springs are also an important water source for fens in more arid regions and can occur across a wider elevation range.

Of all potential fens, 3,688 polygons (8,220 acres) were mapped between 10,000 and 11,000 feet, which represents 41% of potential fen locations and 43% of potential fen acres (Table 6; Figure 8). Of the 1,712 total confirmed and likely fens mapped, 724 polygons (42%) and 1,965 acres (51%) were located between 10,000 and 11,000 feet (Figures 9 and 10). The elevation band of 11,000 to 12,000 feet also contain many potential and confirmed and likely fens. Between 11,000 to 12,000 feet, there were 3,038 mapped potential fens (4,852 acres), which represent 34% of potential fen locations and 25% of potential fen acres. In addition, there were 787 confirmed and likely fens (46%) and 1,463 acres (38%) between 11,000 and 12,000 feet. Together, over 95% of confirmed and likely fens occurred between 10,000 and 12,000 feet. This is the zone of maximum fen formation for the WRNF.

Table 66. Potential and likely fens by elevation within the fen mapping study area.

Elevation Range (ft)	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Confirmed and Likely Fens*	*Confirmed and Likely Fen Acres*
< 7,000	5	34	--	--
> 7,000 – 8,000	80	236	--	--
> 8,000 – 9,000	450	1,465	5	11
> 9,000 – 10,000	1,308	3,920	96	246
> 10,000 – 11,000	3,688	8,220	724	1,965
> 11,000 – 12,000	3,038	4,852	787	1,463
> 12,000	377	440	100	161
Total	**8,946**	**19,166**	**1,712**	**3,845**

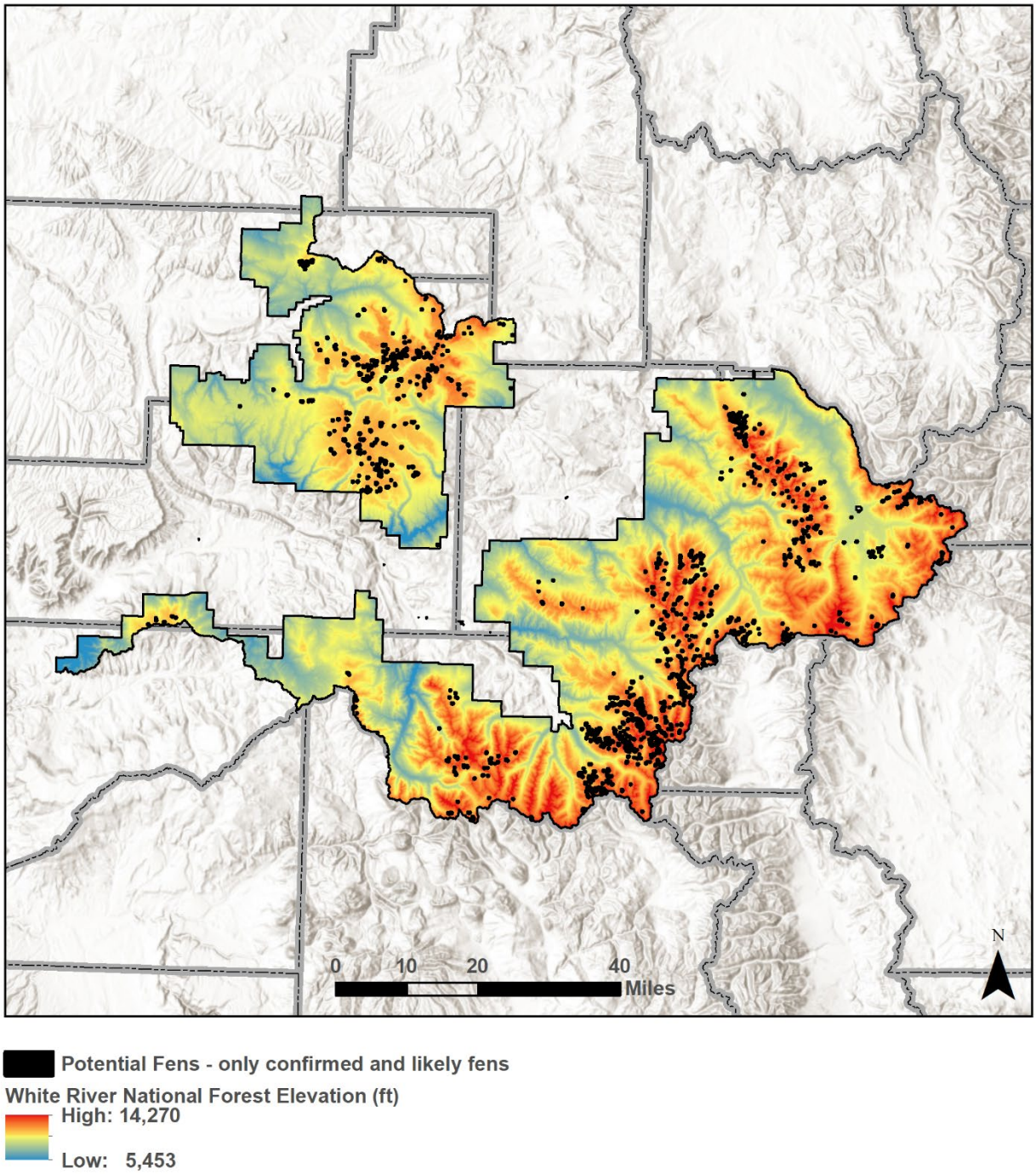

Figure 8. Confirmed and likely fens (confidence rating = 7, 6, or 5) and elevation within the fen mapping study area.

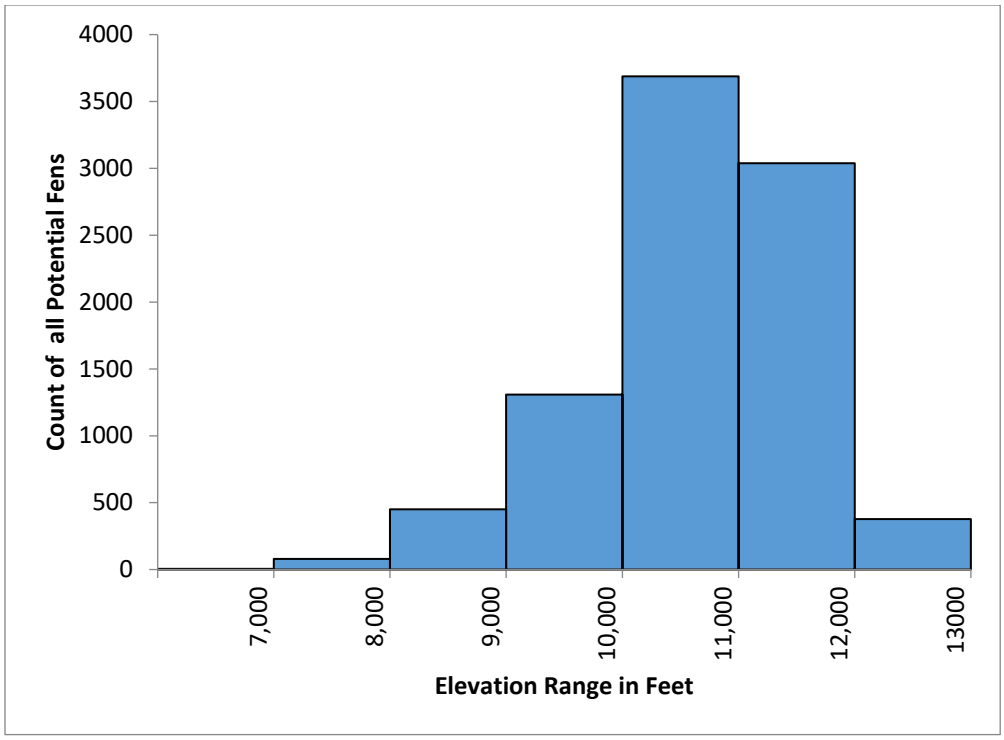

Figure 9. Histogram of all potential fens by elevation within the fen mapping study area.

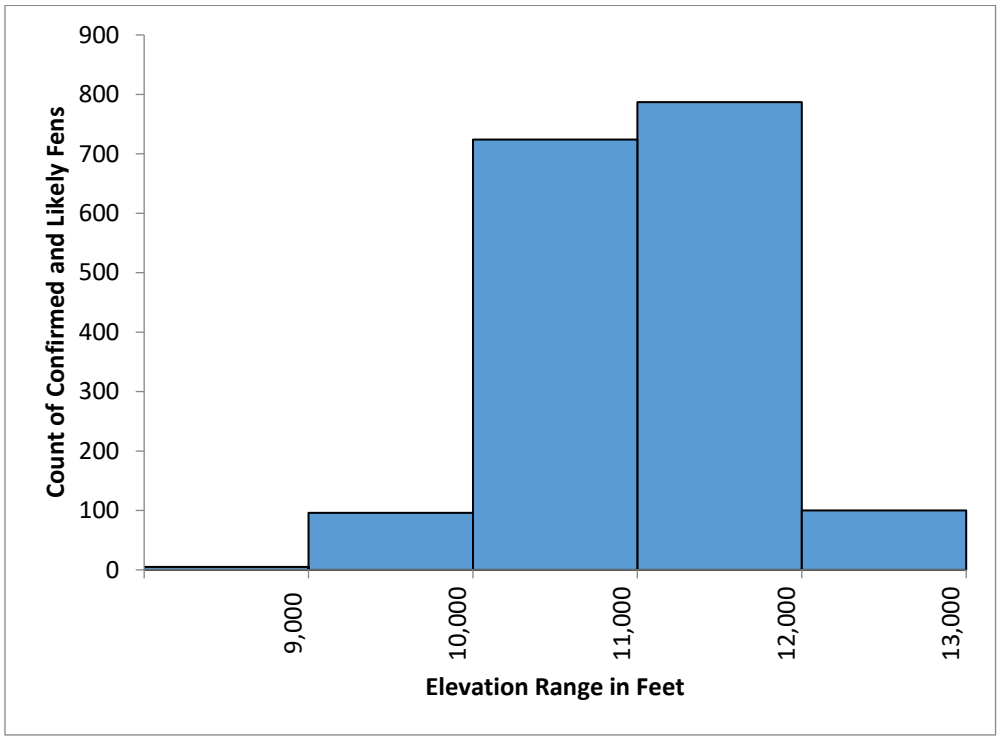

Figure 10. Histogram of confirmed and likely fens by elevation within the fen mapping study area.

Mapped Potential Fens by Geology

The two most common geologic substrates under potential fens in WRNF were metamorphic or igneous units with a dominantly silicic composition, which underlies 3,809 mapped potential fens (6,328 acres) and Quaternary age younger alluvium and surficial deposits, which underlies 1,993 mapped potential fens (4,627 acres) (Table 7). These two substrates also underlie the most confirmed and likely fens. These units were more dominant near the Continental Divide in the southeastern areas of the forest. The third most common geologic substrate for all potential fens was sandstone, while the third most common for confirmed fen acreage was limestones or dolomites. These sedimentary substrate can result in fens with higher pH and ionic concentrations.

Table 77. Potential fens by geologic substrate within the fen mapping study area

Geology	*Acres of Geologic Substrate Within WRNF*[1]	*All Potential Fens*		*Confirmed and Likely Fens*	
		Count	*Acres*	*Count*	*Acres*
Metamorphic or igneous units with a dominantly silicic composition	581,161	3,809	6,328	976	1,833
Quaternary age younger alluvium and surficial deposits	321,543	1,933	4,627	330	804
Sandstone dominated formations	670,695	1,239	2,811	132	304
Metamorphic or igneous units with dominantly mafic composition	131,063	744	1,577	122	368
Carbonate dominated formations either limestone or dolomites	213,389	529	1,794	90	374
Shale dominated formations	265,325	372	1,181	32	136
Siltstone and or mudstone dominated formations	215,050	187	488	13	8
Quaternary age older alluvium and surficial deposits	24,684	74	172	13	14
Evaporite units either halite, gypsum, or other saline mineral dominated formations	50,734	53	177	2	2
Water	8,822	6	11	2	3
		8,946	**19,166**	**1,712**	**3,845**

[1] Acres of geologic substrate shown are only for those substrates where fens were mapped. The total acreage is not shown because it does not equal the total acreage of the White River National Forest.

Mapped Potential Fens by Watershed

Fen distribution with WRNF was not uniform. Confirmed and likely fens were concentrated in specific areas of the forest (Figure 11). Five watersheds stood out for their high number of these features, with more than 70 confirmed or likely fens mapped within the watershed. Hunter Creek (HUC12: 140100040105) had 143 confirmed and likely fens covering 283.3 acres, which represents 1.08% of the landscape in this watershed. Headwaters Roaring Fork River (HUC12:

140100040102) had 123 confirmed and likely fens, covering 0.85% of the landscape. Headwaters Fryingpan River (HUC12: 140100040501) had 103 confirmed and likely fens, representing 0.72% of the landscape. Deeds Creek-Fryingpan River (HUC12: 140100040504) had 90 confirmed or likely fens, representing 0.41% of the landscape. These 4 adjacent watersheds contain 459 of the 1,712 confirmed and likely fens (27%). Headwaters South Fork White River (HUC: 140500050201) also stands out as having the highest fen density in White River National Forest, with 85 confirmed and likely fens representing 1.25% of the watershed area. See Appendix A for the full HUC12 watershed and confirmed and likely fens table.

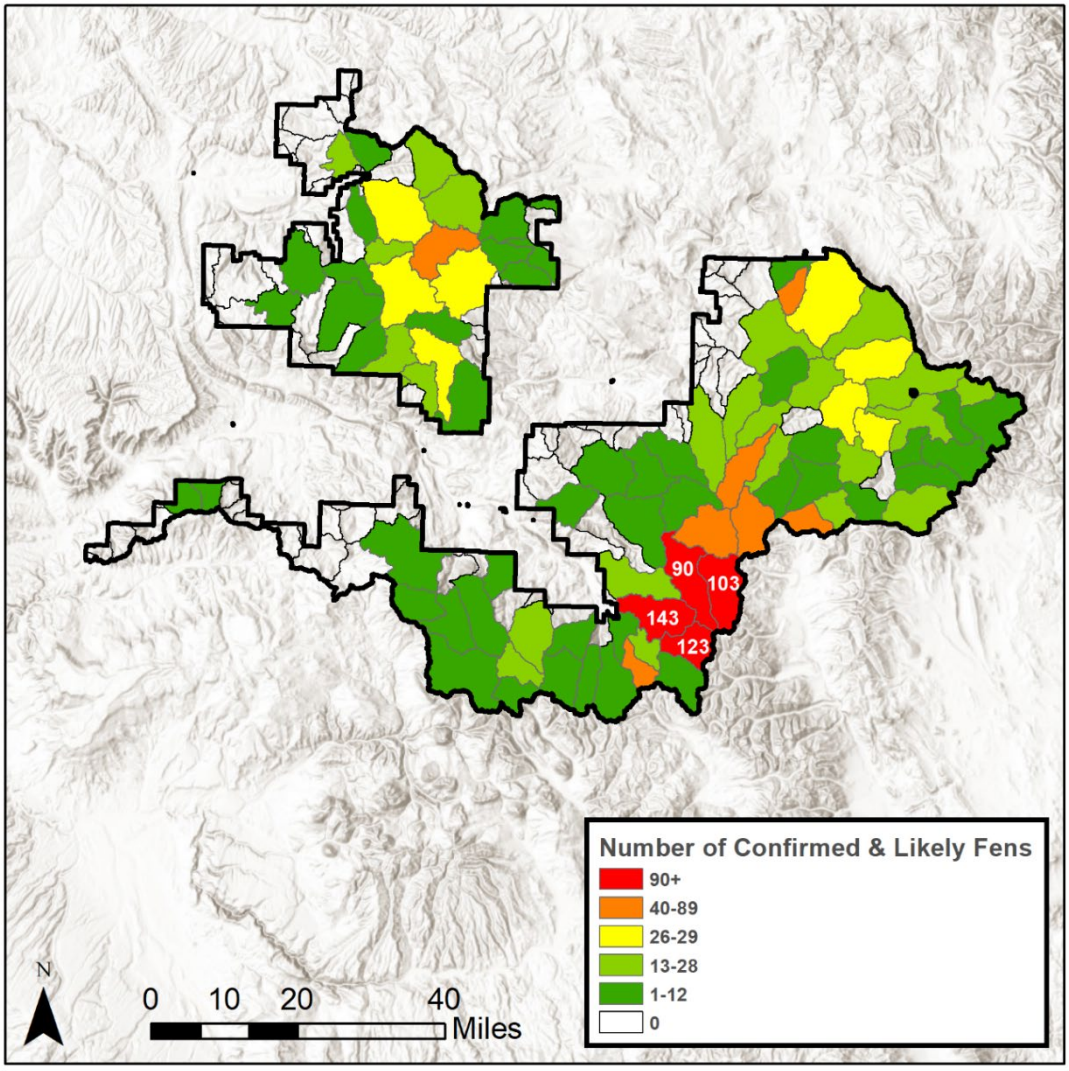

Figure 11. Likely fens by HUC12 watershed within the fen mapping study area.

Mapped Potential Fens with Distinctive Characteristics

Several characteristics related to fens were noted by photo-interpreters when observed throughout the fen mapping process (Table 8), though this was not an original objective of the project and was not consistently applied.

Springs and fens are both important components of groundwater-dependent ecosystems (GDEs) and are of particular interest to the U.S. Forest Service (USFS 2012). Springs were noted when observed on either the topographic map or aerial imagery. However, this was not a comprehensive investigation of springs or even springs within fens. Eighty-three potential fens and three likely fens were observed in proximity to springs. Figure 14 shows one example of a spring influences fen at the headwaters of Wagonwheel Creek. In addition, 34 potential fens (44 acres) and eleven likely fens (18 acres) were identified as potential floating mat fens, which can host rare plant species.

Beaver influence is a potentially confounding variable in fen mapping because longstanding beaver complexes can cause persistent saturation that looks very similar to fen vegetation signatures. Beavers also build dams in fens, so areas influenced by beavers cannot be excluded from the mapping. Five hundred and fifty potential fens (3,763 acres) and twelve confirmed and likely fens (94 acres) showed some evidence of beaver influence. Figure 15 is an example of a beaver influenced fen in Bennett Gulch.

Table 88. Potential and confirmed and likely fens with distinctive characteristics within the fen mapping study area.

Observation	*# of Potential Fens*	*Potential Fen Acres*	*# of Confirmed and Likely Fens*	*Confirmed and Likely Fen Acres*
Spring	83	109	3	13
Possible Floating Mat	34	44	11	18
Beaver Influence	550	3,763	12	94
Total	**667**	**3,916**	**26**	**125**

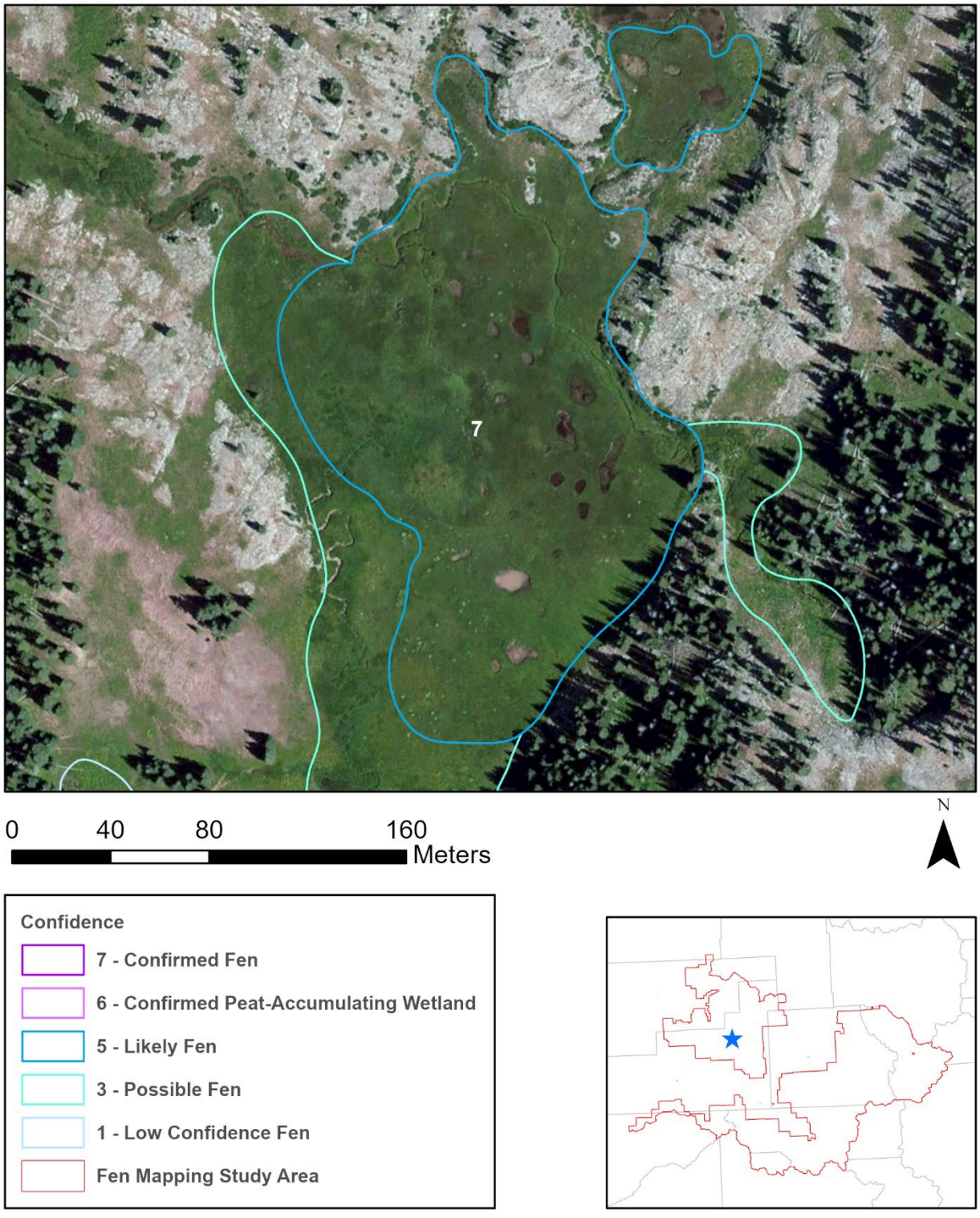

Figure 12. A spring-fed likely fen (7 acres) located at the headwaters of Wagonwheel creek, east of Heart Lake on the White River Plateau in Garfield County.

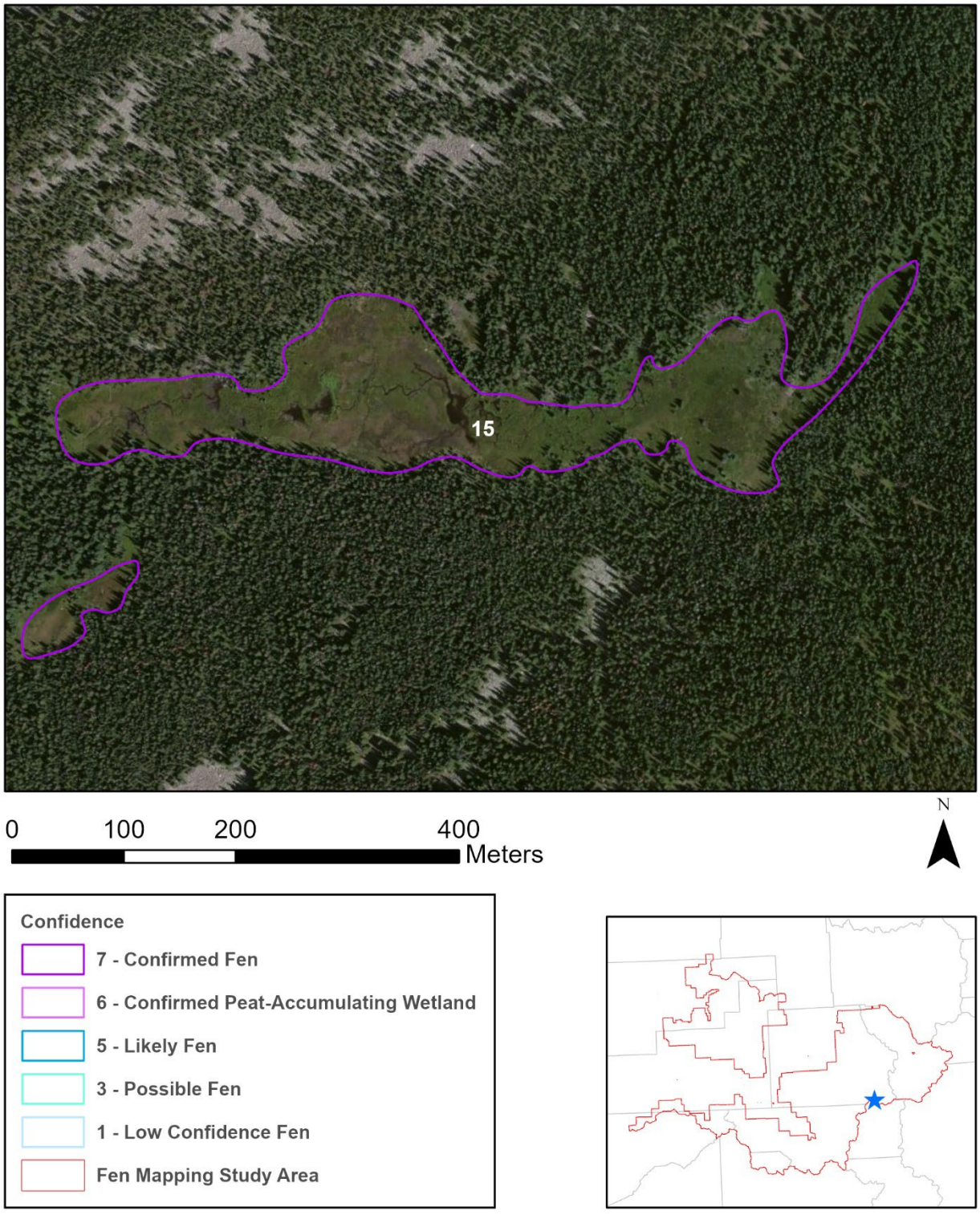

Figure 13. A beaver influenced confirmed fen (15 acres) is located in Bennett Gulch in Eagle County.

4.2 Field Sampling Results

Rapid site evaluations were conducted in 38 confirmed fens across WRNF (Figures 14-16). Most fens observed in the 2024 sampling were considered gently sloping fens, with unidirectional downslope flow of groundwater. Of the 38 fens confirmed in 2024, their average elevation was 3373 m (11,066 ft). Only four of the 38 confirmed fens were situated above 12,000 ft of elevation, and only one fen was observed below 10,000 ft. Bryophytes were observed at all 38 of the sites and their abundance ranged from minor component to common. Appendix B contains detailed data on all confirmed fens sampled in 2024.

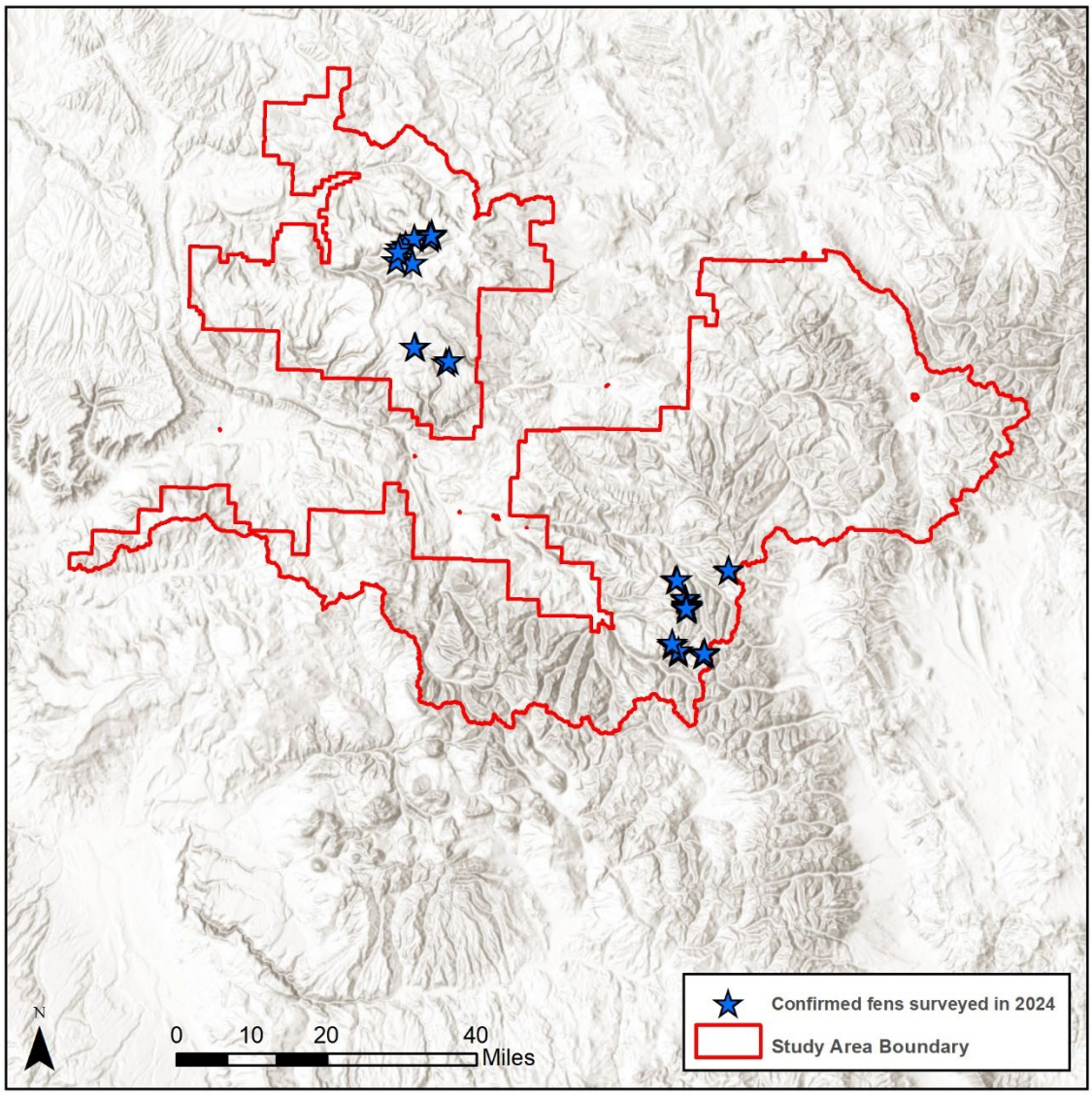

Figure 14. Confirmed fens surveyed with a rapid site evaluation in WRNF. Symbols are overlapping where multiple fens occur in the same vicinity.

Figure 15. Collecting field data in a fen along the Chapman Gulch trail.

Figure 16. Example of a soil core with greater than 40 cm organic soil.

Vegetation Cover and Composition of Confirmed Fens

In each confirmed fen, a list of dominant species and associated cover classes was recorded. These surveys should not be considered exhaustive searches of all species present on the site but were reasonably comprehensive because of the experience and knowledge of the primary botanist. From the site species list, a series of vegetation indicators were calculated for each site (Table 9). Species richness ranged from 5 to 32 species, with a mean of 18.2 species. Floristic quality of samples sites was relatively high, with an average Mean C of 6.87 and a range from 5.08 to 7.6.

Table 99. Mean, minimum, and maximum values for vegetation cover and composition metrics calculated for confirmed fens

Metric Group	Metric	Mean	Minimum	Maximum
Richness	Total Species Richness	18.2	5	32
	Rare Species Richness	0.18	0	2
Floristic Quality	Mean C [A]	6.87	5.08	7.6
Composition (percent of the species list represented by a specific group of species)	Native Species	91.4	80.0	100.0
	Hydrophytic Species [B]	64.7	48.4	100.0
	Graminoids	39.5	18.8	64.3
	Forbs	47.5	28.6	66.5
	Shrubs	7.63	0.0	20.0
	Trees	1.46	0.0	10.5
	Annuals	1.33	0.0	10.0
	Perennials	86.3	68.8	100.0
Relative cover (percent of the total cover represented by a specific group of species)	Native Species	97.5	85.0	100.0
	Hydrophytic Species [B]	88.4	43.7	100.0
	Graminoids	61.1	25.1	91.1
	Forbs	20.7	3.91	51.3
	Shrubs	16.1	0.0	58.1
	Trees	0.7	0.0	6.2
	Annuals	0.3	0.0	3.1
	Perennials	94.7	47.0	100.0

[A] Mean C is calculated as the average C-value for all species observed within a site. C-values numerical ratings (0–10) applied to each species within a state's flora that indicate the species' fidelity to natural habitats and tolerance or intolerance to disturbance. C-values for Colorado are from Smith et al. (2020).

[B] Hydrophytic species are those rated OBL and FACW on the National Wetland Plant List for the Western Mountains region. OBL = obligate wetland species, found in wetlands 99% of the time; FACW = facultative wetland species, found in wetlands 67–99% of the time.

Metrics for both cover and composition were calculated from the rapid species lists (Table 7). Composition metrics refer to the percentage of individual species in the list represented by a specific group of species. Relative cover metrics represent the percentage of total cover represented by a specific group of species. For confirmed fens in WRNF, cover and composition were similar for some metrics and different for others. On average, native species represented 91.4% of each species list and 97.5% of total cover, both very high numbers. Hydrophytic species represented 67.7% of each species list, on average, and 88.4% of total cover. This indicates that vegetation cover was

overwhelmingly dominated by true wetland species and non-wetland species occurred with low cover, which makes sense for permanently saturated wetlands.

Forbs were slightly more common that other life forms, representing 47.5% of species, but provided only 20.7% cover, indicating a fairly high diversity of forbs present in lower covers. Graminoids followed forbs in terms of composition, with 39.5% of species, but provided 61.1% of average cover. While many sites had high forb diversity, forbs often occurred with lower relative cover than the more dominant graminoids species. Shrubs were less common, with 7.63% of species and 16.1% of cover, on average. Some sites were dominated by shrubs, while many others lacked a woody component. Trees were also uncommon, with 1.5% of species and 0.7% of cover. Nearly all species (86.3%) and cover (94.7%) were perennial, with very few annual species observed in sampled sites.

Common and Characteristic Vascular Plant Species of Confirmed Fens

Across all 38 confirmed fens, 117 unique taxa were identified, 86 to the species level. Since sampling took place late in the season, a higher number of species were left at the genus level, as many identifying characteristics were past.

The most common species observed in confirmed fens was *Caltha leptosepala*, which occurred at every confirmed fen except for one. All of the most common species (those recorded in 10 or more confirmed fens) were native (Table 10). Most of the common species were adapted to lower disturbance or relatively unaltered landscapes, as indicated by their coefficients of conservatism (C-values), which ranged from 4 to 8. The common species were also adapted to wetland environments. The list included seven wetland obligates (OBL), seven facultative wetland species (FACW), three facultative species (FAC), and one facultative upland species (FACU).

While no nonnative species were among our most commonly observed, two non-native species were recorded within surveyed fens. Red top (*Agrostis gigantea*) was observed at four sites and common dandelion (*Taraxacum officinale*) was observed at three sites. Neither species are considered noxious weeds in Colorado, and neither species occurred in very high cover. Where *Taraxacum officinale* was recorded, it was recorded as 2% cover or less. *Agrostis gigantea* occurred in slightly higher cover, but only up to 5%.

Table 1010. Vascular plant species observed in ten or more confirmed fens (continued on following page).

Scientific Name	Common Name	# of Obs	Average Cover [A]	Wetland Status [B]	C-Value [C]	Native Status
Caltha leptosepala	White marsh-marigold	37	6.28	OBL	7	Native
Rhodiola rhodantha	Rose crown	34	1.91	FACW	8	Native
Pedicularis groenlandica	Elephanthead lousewort	31	1.89	OBL	8	Native
Salix planifolia	Diamond-leaf willow	31	14.10	OBL	7	Native
Swertia perennis	Felwort	28	1.61	FACW	8	Native
Deschampsia cespitosa	Tufted hairgrass	27	4.02	FACW	4	Native
Carex aquatilis	Water sedge	25	23.70	OBL	6	Native
Ligusticum porteri	Porter's licorice-root	24	1.50	FACU	7	Native
Carex scopulorum	Mountain sedge	23	14.20	OBL	7	Native
Arnica mollis	Hairy arnica	21	0.78	FAC	7	Native

Scientific Name	Common Name	# of Obs	Average Cover [A]	Wetland Status [B]	C-Value [C]	Native Status
Bistorta vivipara	Alpine bistort	20	0.60	FAC	8	Native
Calamagrostis canadensis	Canada bluejoint	20	4.40	FACW	6	Native
Epilobium ciliatum	Fringed willowherb	15	0.90	FACW	4	Native
Carex utriculata	Northwest territory sedge	14	9.79	OBL	5	Native
Eleocharis pauciflora	Fewflower spikerush	13	20.00	OBL	8	Native
Senecio triangularis	Arrowleaf ragwort	13	2.19	FACW	7	Native
Phleum alpinum	Alpine timothy	12	1.58	FAC	6	Native
Juncus drummondii	Drummond's rush	11	0.77	FACW	6	Native

[A] Average cover is derived by averaging the mid-points of each cover class assigned within the rapid vegetation survey and is not a precise measurement.

[B] Wetland Indicator Status is based on the National Wetland Plant List for the Western Mountains region. OBL = obligate wetland species, found in wetlands 99% of the time; FACW = facultative wetland species, found in wetlands 67–99% of the time; FAC = facultative species, found in wetlands 34–66% of the time; FACU = facultative upland species, found in uplands 67–99% of the time; UPL = obligate upland species, found in uplands 99% of the time.

[C] C-value is a numerical rating (0–10) that indicates a species' fidelity to specific habitats and tolerance of disturbance. C-values for Colorado are from P. Smith et al. (2020).

The most common species observed had varying average cover. Of the species that were recorded in 10 or more confirmed fens, *Carex aquatilis* and *Eleocharis pauciflora* had the highest average cover, 23.7% and 20.0% respectively. Where these species were found, they were most often found in abundance. Other species, like *Arnica mollis* and *Bistorta vivipara* were found in several sites but often with only a few individuals. Four of the top five most common species found were forbs, though only one of the four forbs had an average cover of over 2%, so while they were common across sites, they were not often found in high abundance.

To focus on the species that best characterize the sites surveyed, a unitless 'importance value' was calculated by adding relative frequency and relative abundance of each species.[2] The resulting twenty most important species best characterize the species composition of the confirmed fens within WRNF (Table 11). The five species with the highest importance value were water sedge (*Carex aquatilis*), diamond-leaf willow (*Salix planifolia*), mountain sedge (*Carex scopulorum*), marsh marigold (*Caltha leptosepala*), and fewflower spikerush (*Eleocharis pauciflora*). This list differed from the four most common species, with more graminoids rising in importance. This change is expected, as the graminoids were generally found in higher cover than forbs like elephanthead lousewort (*Pedicularis groenlandica*), which was found in 31 of the 38 sites, but only had an average cover of 1.89. Of the top ten most important species in confirmed fens, seven were sedges and two were wetland shrubs. These are considered the most characteristic wetland species groups. The list also includes non-sedge graminoids, such as tufted hairgrass (*Deschampsia cespitosa*) and bluejoint (*Calamagrostis* canadensis). Mud sedge (*Carex limosa*) and boreal bog sedge (*Carex magellanica* spp. *irrigua*) also made the important list. While these two sedges occurred in only four sites, they

[2] Relative frequency for each species = number of times the species was observed / total number of species observations across all sites. Relative abundance for each species = sum of cover for that species wherever it occurred / sum of cover of all species across all sites.

often occurred with higher cover. Nine common fen forbs were also in the top twenty most important species.

Table 1111. Twenty most characteristic vascular plant species in confirmed fens, as measured by the importance value.

Scientific Name	Common Name	Import Value [A]	# of Obs	Average Cover	Wetland Status	C-Value	Native Status
Carex aquatilis	Water sedge	21.27	25	23.7	OBL	6	Native
Salix planifolia	Diamond-leaf willow	17.51	31	14.1	OBL	7	Native
Carex scopulorum	Mountain sedge	13.05	23	14.2	OBL	7	Native
Caltha leptosepala	Marsh marigold	12.26	37	6.28	OBL	7	Native
Eleocharis pauciflora	Fewflower spikerush	9.61	13	20.0	OBL	8	Native
Deschampsia cespitosa	Tufted hairgrass	7.12	27	4.02	FACW	4	Native
Rhodiola rhodantha	Rose crown	6.83	34	1.91	FACW	8	Native
Pedicularis groenlandica	Elephanthead lousewort	6.21	31	1.89	OBL	8	Native
Carex utriculata	Northwest territory sedge	6.10	14	9.79	OBL	5	Native
Calamagrostis canadensis	Canada bluejoint	5.50	20	4.4	FACW	6	Native
Swertia perennis	Felwort	5.37	28	1.61	FACW	8	Native
Ligusticum porteri	Porter's licorice-root	4.53	24	1.5	FACU	7	Native
Carex limosa	Mud sedge	4.19	4	30.2	OBL	9	Native
Arnica mollis	Hairy arnica	3.51	21	0.786	FAC	7	Native
Salix wolfii var. *wolfii*	Wolf's willow	3.26	4	22.5	OBL	8	Native
Bistorta vivipara	Alpine bistort	3.24	20	0.6	FAC	8	Native
Carex neurophora	Alpine nerve sedge	2.98	6	11.8	FACW	7	Native
Senecio triangularis	Arrowleaf ragwort	2.72	13	2.19	FACW	7	Native
Epilobium ciliatum	Fringed willowherb	2.56	15	0.9	FACW	4	Native
Carex magellanica spp. *irrigua*	Boreal bog sedge	2.46	4	15.8	OBL	9	Native

[A] Importance value is a unitless number derived as the sum of relative frequency and relative cover across all species and all sites.

Vegetation Communities Observed in Confirmed Fens

Vegetation within the 38 confirmed fens surveyed in 2024 was classified into 12 different vegetation communities in the U.S. National Vegetation Classification (USNVC) (Table 12). Eleven of the 12 vegetation communities were classified to the Association level, the most specific level of the USNVC. One was left at the Alliance level, which is one level above Association. The two fens classified as *Carex limosa - Carex buxbaumii - Triglochin maritima* Alkaline Graminoid Fen Alliance (A3435) were left at the Alliance level because they had a higher cover of *Carex magellanica*, which was not represented in any specific association.

The most common observed vegetation type in the 2024 sampling was *Eleocharis quinqueflora* Fen (CEGL001836), which represented 18% of confirmed fens. The next most common vegetation type observed was *Carex aquatilis* Wet Meadow (CEGL001802), which represented 16% of confirmed fens. The third most common vegetation type observed was *Salix planifolia / Carex aquatilis* Wet

Shrubland (CEGL001227), which represented 13% of confirmed fens. These common vegetation types are some of the most common vegetation communities within Southern Rocky Mountain fens. In addition to *Salix planifolia, Carex aquatilis, and Eleocharis quinqueflora,* other vegetation communities included those dominated by *Carex scopulorum, Carex limosa, Salix wolfii*, and other ubiquitous fen forbs such as *Caltha leptosepala.*

The middle levels of the USNVC are currently being revised, which has implications for Alliances and Associations. Vegetation data collected through this sampling effort will help improve the classification. For example, one of the most common vegetation communities in Southern Rocky Mountain fens is *Salix planifolia* over *Carex aquatilis.* However, middle level revisions to the USNVC now restrict this community to riparian shrublands with mineral soil and does not include fen wetlands. In order to classify the vegetation observed, Association names and codes of wet meadows and riparian shrublands were used. Ecologists at CNHP are advocating for similar association types to be developed for fens in order to accurately classify the different vegetation communities present in Colorado.

Table 1212. Confirmed fens classified by USNVC Association or Alliance

Vegetation Type		Fens sampled in 2024	
Association / Alliance Code	**Vegetation Common Name**	**Count**	**Acres**
CEGL001836	*Eleocharis quinqueflora* Fen	13	9
CEGL001802	*Carex aquatilis* Wet Meadow	10	8
CEGL001822	*Carex scopulorum* Wet Meadow	7	5
CEGL001229	*Salix planifolia* / *Carex scopulorum* Shrub Fen	7	26
CEGL001227	*Salix planifolia* / *Carex aquatilis* Wet Shrubland	6	30
CEGL001234	*Salix wolfii* / *Carex aquatilis* Wet Shrubland	6	27
CEGL001811	*Carex limosa* Fen	5	25
A3435	*Carex limosa - Carex buxbaumii - Triglochin maritima* Alkaline Graminoid Fen Alliance	5	3
CEGL001803	*Carex aquatilis - Carex utriculata* Wet Meadow	4	9
CEGL002665	*Salix planifolia* / *Caltha leptosepala* Wet Shrubland	2	2
CEGL001823	*Carex scopulorum - Caltha leptosepala* Wet Meadow	2	1
CEGL001240	*Salix wolfii* / Mesic Forbs Wet Shrubland	1	1
WRNF Total		68	146

Rare Vascular Plant Species Observed in Confirmed Fens

Eleven populations of four rare vascular plant species were observed either within or near confirmed fens or confirmed peat-accumulating wetlands (Table 13; Figure 17). Species considered "rare" are species that are tracked by CNHP. The species observed were all considered globally secure (G5) but rare within the state of Colorado (S1, S2, or S3). Many fen-indicator plant species considered rare in the Rocky Mountains are common in northern latitudes but found in their far southern extent in Wyoming or Colorado. Fens in the southern Rocky Mountains serve as refuges for rare plants like these, which may be more common elsewhere, due to the unique environmental factors of these locations. There are additional previously documented Element Occurrences (EOs)

within fens of WRNF, as well. Some of the rare plants observed in 2024 were previously known populations. The new populations observed will be submitted to CNHP's Biotics database.

Table 1313. Rare vascular plant species observed in confirmed fens.

Scientific Name	Common Name	# of Obs	Wetland Status	C-Value	G Rank [A]	S Rank [A]
Eriophorum gracile	Slender cottongrass	2	OBL	10	G5	S1S2
Carex limosa	Mud sedge	4	OBL	9	G5	S2S3
Carex diandra	Lesser panicled sedge	3	OBL	9	G5	S2
Carex microglochin	Few-seeded bog sedge	2	FACW	9	G5	S2

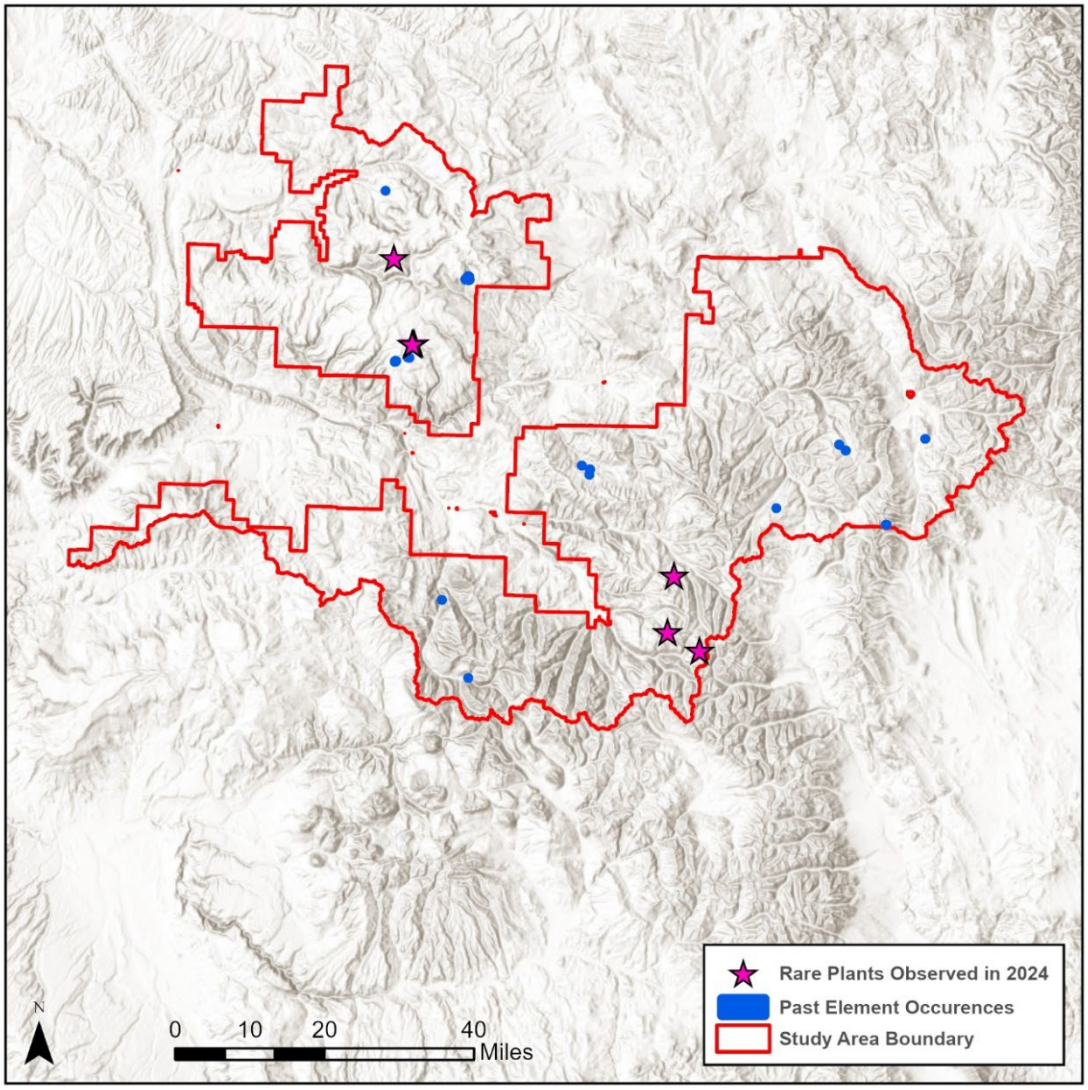

Figure 17. Locations of rare fen-indicator plant species observed in WRNF and past Element Occurrences. Symbols overlap where multiple species occur in the same vicinity.

Water Chemistry of Confirmed Fens

Basic water chemistry measurements were taken in several confirmed fens. In some sites, multiple measurements were taken, for a total of 11 measurements of pH, specific conductance, and temperature (Table 14). Mean pH was 6.47 and values ranged from 5.32 to 8.33. Mean specific conductance was 71.9 µS/cm and ranged from 22.2 to 230. Water chemistry was not taken at every site due to late season sampling. Enough water to fully submerge the probe was not present at every site. Most pH values were just below neutral and specific conductance values were below 100 µS/cm, both of which are common for intermediate rich fens of the Southern Rocky Mountains. One set of values from site WRNF-4639 along Grizzly Creek south of the Flat Top Wilderness, was higher than the rest (Figure 18). This site was the only on sedimentary bedrock where water chemistry was measured, and it contained a variety of fen species, including the rare *Cares diandra*.

Table 1414. Mean, minimum, and maximum values for water chemistry parameters (pH, specific conductance, and temperature) measured in confirmed fens.

Parameter (n = 11)	Mean	Median	Minimum	Maximum
pH	6.47	6.48	5.32	8.33
Specific conductance (µS/cm)	71.9	66.7	22.2	230
Temperature (°C)	11.9	10.8	3.3	19.3

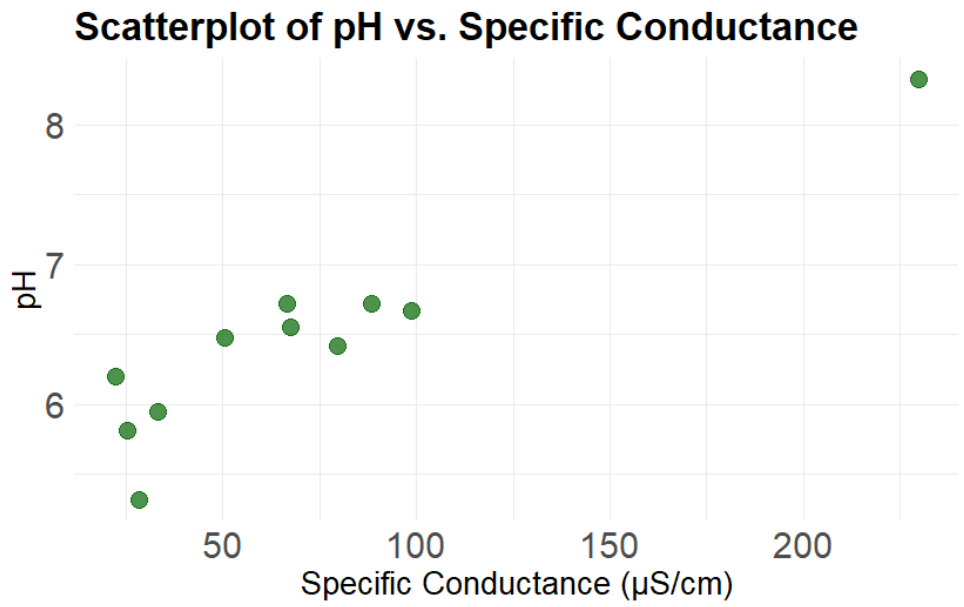

Figure 18. Scatter plot of pH vs. specific conductance measured in confirmed fens and confirmed peat-accumulating wetlands.

5.0 Discussion

White River National Forest contains an abundance of fen wetlands, covering up to 19,166 acres. While the acreage is small compared to the full 2.4 million acres of WRNF, fen wetlands are an irreplaceable resource that should be protected. Fens in the Southern Rocky Mountains support numerous rare plants and plant associations and WRNF is no exception. Fens in the forest support 38 Element Occurrence (EO) records of rare plants and plant associations. Along with habitat for rare plant species, fens also play a pivotal role in regional hydrologic processes. By slowly releasing groundwater, they help maintain stream flows throughout the growing season. With a predicted warmer future climate, in which snowpack may be less and spring melt may occur sooner, maintaining groundwater storage high in the mountains is imperative. Intact fens also sequester carbon in their deep organic soils, however, disturbing fen hydrology can lead to rapid decomposition of peat and associated carbon emissions (Chimner 2000).

Generally, higher elevation wetlands are in excellent or good condition, and that appears to be the case for fens in WRNF (Figures 19 & 20. This matches the finding of high elevation wetlands in the Rio Grande National Forest (Lemly 2012), but not for fens in former mining areas of the Sam Juan Mountains (Chimner et al. 2010). Only 74 of the 1,692 confirmed and likely fens (fens with a confidence of 5, 6, or 7) were mapped below 9,853 ft in elevation. In other words, 96% of mapped confirmed and likely fens are at 9,853 ft or higher. Most fens that were confirmed on the ground in 2024 were observed with low or minimal human disturbance. While the fens of WRNF are largely still intact and undisturbed, it's important to better understand their locations, the rare plants and plant associations they may house, and their ecological importance. WRNF is the most visited national forest in the United States, with many visitors looking to recreate at higher elevations. This high visitor usage increases potential pressures put on fen ecosystems in the national forest.

This report and its associated dataset provide the WRNF with a critical tool for conservation planning at a local and forest-wide scale. Wherever possible, the forest should avoid direct disturbance to the fens mapped through this project, especially the confirmed and likely fens. The forest should also strive to protect the watersheds surrounding the high concentrations of fens, thereby protecting their water resources and conserving these invaluable ecosystems.

Figure 19. Fens in the Flat Top Wilderness, White River National Forest.

Figure 20. Fens along the Lost Man Loop, White River National Forest.

6.0 LITERATURE CITED

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APPENDIX A: CONFIRMED AND LIKELY FENS BY HUC12 WATERSHED

HUC12 Code	HUC12 Name	Watershed Acres	Confirmed and Likely Fen Count	Confirmed and Likely Acres	Fen Density (Fen Acres/Watershed Acres)
140500050201	Headwaters South Fork White River	25,211	85	316	1.25%
140100040103	Difficult Creek	10,464	52	124	1.18%
140100040105	Hunter Creek	27,583	143	298	1.08%
140100020601	Elliott Creek	9,615	63	92	0.96%
140100040102	Headwaters Roaring Fork River	18,418	123	156	0.85%
140100011602	Grizzly Creek	24,796	33	192	0.77%
140100040501	Headwaters Fryingpan River	29,010	103	209	0.72%
140100040104	Weller Lake-Roaring Fork River	9,172	23	62	0.67%
140100030201	South Fork Eagle River	12,167	41	72	0.59%
140100040106	McFarlane Creek-Roaring Fork River	10,672	10	63	0.59%
140100020201	North Fork Snake River	10,239	22	52	0.50%
140100011603	No Name Creek	13,173	16	59	0.45%
140100040502	North Fork Fryingpan River	27,025	50	119	0.44%
140100030208	Cross Creek	21,946	42	90	0.41%
140500050202	Lost Solar Creek	10,415	19	43	0.41%
140100040504	Deeds Creek-Fryingpan River	30,558	90	124	0.41%
140100030204	French Creek-Homestake Creek	23,977	56	86	0.36%
140100030202	East Fork Eagle River	12,231	19	43	0.35%
140100020304	Lower Tenmile Creek	15,664	26	52	0.33%
140500050203	Patterson Creek-South Fork White River	36,365	38	116	0.32%
140100011301	Upper Sweetwater Creek	36,188	28	105	0.29%
140100030205	Whitney Creek-Homestake Creek	16,959	9	45	0.27%
140500050106	Ute Creek	13,311	11	34	0.26%
140100040601	Woody Creek	31,130	17	77	0.25%
140500050104	Marvine Creek	38,336	26	91	0.24%
140500050107	Fawn Creek	12,058	16	28	0.23%
140100040702	North Fork Crystal River	13,080	16	30	0.23%
140100020502	Rock Creek-Blue River	30,014	27	64	0.21%

140500050204	Cave Creek-South Fork White River	13,205	3	27	0.21%
140100030209	West Grouse Creek-Eagle River	29,456	25	60	0.20%
140100011401	Headwaters Deep Creek	16,188	7	30	0.19%
140100020202	Peru Creek-Snake River	26,685	8	48	0.18%
140100020101	Headwaters Blue River	27,051	16	45	0.17%
140100030101	Upper Gore Creek	22,145	30	35	0.16%
140100040202	Express Creek-Castle Creek	26,540	6	41	0.16%
140100050101	Canyon Creek	35,635	20	55	0.15%
140100020302	West Tenmile Creek	17,548	16	27	0.15%
140100030103	Lower Gore Creek	22,462	11	33	0.15%
140100040701	South Fork Crystal River	12,197	10	17	0.14%
140100020504	Green Mountain Reservoir-Blue River	54,433	31	67	0.12%
140100040704	Coal Creek	17,085	9	20	0.12%
140100040401	Headwaters Snowmass Creek	25,101	13	27	0.11%
140100011202	South Fork Derby Creek	11,526	6	12	0.10%
140100030102	Middle Gore Creek	20,633	13	21	0.10%
140500050102	Snell Creek-North Fork White River	25,869	14	25	0.10%
140100020401	Dillon Reservoir-Blue River	25,639	16	25	0.10%
140100030303	Lake Creek	31,400	19	27	0.09%
140100020203	Keystone Gulch-Snake River	12,849	4	11	0.08%
140100030402	East Brush Creek	20,775	9	17	0.08%
140100020501	Straight Creek-Blue River	35,562	18	29	0.08%
140100050205	East Elk Creek	25,348	3	20	0.08%
140100011201	North Fork Derby Creek	19,614	12	16	0.08%
140500050101	Headwaters North Fork White River	32,633	17	24	0.07%
140100020104	Gold Hill-Blue River	10,430	2	7	0.07%
140100040503	Lime Creek	22,287	9	14	0.06%
140100020503	Slate Creek-Blue River	39,020	25	24	0.06%
140100020102	French Gulch-Blue River	17,351	1	10	0.06%
140100040302	Willow Creek-Maroon Creek	17,004	5	9	0.05%
140100030301	Beaver Creek-Eagle River	21,453	14	11	0.05%
140100010801	Upper Piney River	35,477	15	18	0.05%
140500050302	North Elk Creek	28,363	2	14	0.05%
140100040706	Avalanche Creek	27,445	7	12	0.05%
140100040101	Lincoln Creek	21,317	5	9	0.04%

140100030501	Upper Gypsum Creek	28,409	6	12	0.04%
140100020103	Swan River	24,074	11	10	0.04%
140100030206	Resolution Creek-Eagle River	20,781	3	8	0.04%
140100011101	Sunnyside Creek	19,048	3	7	0.04%
140100040507	Taylor Creek-Fryingpan River	22,542	2	8	0.03%
140100040703	Yule Creek-Crystal River	43,340	8	14	0.03%
140100050202	Upper Elk Creek	32,314	5	10	0.03%
140500050103	Lost Creek	13,830	3	4	0.03%
140100040801	Sopris Creek	29,383	9	7	0.02%
140100040201	Conundrum Creek	14,160	2	3	0.02%
140100011203	Deer Creek-Derby Creek	15,015	2	3	0.02%
140100011504	Red Dirt Creek	13,831	2	3	0.02%
140100030203	Turkey Creek	18,902	3	4	0.02%
140100020301	Upper Tenmile Creek	15,813	1	2	0.01%
140100040708	Thompson Creek	49,453	8	6	0.01%
140100050701	Beaver Creek-Colorado River	38,066	2	5	0.01%
140100040301	West Maroon Creek-East Maroon Creek	20,532	1	2	0.01%
140100050702	Cache Creek-Colorado River	45,680	6	3	0.01%
140100020602	Deep Creek-Blue River	28,092	5	2	0.01%
140100030401	West Brush Creek	20,849	1	1	0.01%
140100011604	Glenwood Canyon	43,642	1	2	0.01%
140100040705	Big Kline Creek-Crystal River	21,376	1	1	0.00%
140100050503	East Rifle Creek	33,421	1	1	0.00%
140100040505	Ruedi Reservoir-Fryingpan River	34,438	1	1	0.00%