Fen Mapping for the Caribou-Targhee National Forest

May 2020

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.

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EXECUTIVE SUMMARY

The Caribou-Targhee National Forest covers over 3 million acres spread across ten units in south-east Idaho with portions in Wyoming and Utah. Wetlands within the Caribou-Targhee National Forest 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 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, the U.S. Forest Service released a new 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 new planning rule is that each National Forest must conduct an assessment of important biological resources within its boundaries. To support this effort, U.S. Forest Service contracted Colorado State University and the Colorado Natural Heritage Program (CNHP) to map all potential fens within the Caribou-Targhee National Forest.

Potential fens in the Caribou-Targhee National Forest 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) or 5 (likely fen). The final map contained 1,779 potential fen locations (all confidence levels), covering 6,494 acres or less than 1% of the total land area. This total included 130 ***likely fens***, 369 ***possible fens***, and 1,280 ***low confidence fens.*** The average fen polygon was 3.65 acres, but individual fen polygons ranged from 64 acres to less than an acre.

Fen distribution was analyzed by elevation, geology, Ecological Subsection, and watershed. The majority of mapped potential fens occurred between 6,000 to 7,000 feet. This elevation range contained 56% of all potential fen locations and 65% of likely fen locations. Two watersheds in particular have higher numbers of likely fens: Boone Creek watershed contains 35 likely fens, and Winegar Creek-Fall River watershed contains 29 likely fens.

This report and associated dataset provides the Caribou-Targhee National Forest with a critical tool for conservation planning at both a local and Forest-wide scale. These data will be useful for the Caribou-Targhee National Forest biological assessment required by the 2012 Forest Planning Rule, but can also be used for individual management actions, such as planning 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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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.

Finally, we would like to thank Tracey Trujillo and Carmen Morales with Colorado State University for logistical support and grant administration.

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1.0 INTRODUCTION

The Caribou-Targhee National Forest covers over 3 million acres, mostly in Idaho, and spans a broad elevation range from 4,483 to 12,165 ft. Several types of wetlands occur within the Caribou-Targhee National Forest. Snowfall in the mountains percolates through shallow mountain soils and creates wet meadows, riparian shrublands, and organic soil wetlands known as fens. These wetland habitats provide important ecological services to both Caribou-Targhee National Forest and lands downstream (Mitsch & Gosselink 2007; Millennium Ecosystem Assessment 2005). Wetlands act as natural filters, helping to protect water quality by retaining sediments and removing excess nutrients. Wetlands help to regulate local and regional hydrology by stabilizing base flow, attenuating floods, and replenishing belowground aquifers. Wetlands also support habitat for numerous plant and animals species that depend on aquatic habitats for some portion of their life cycle (Redelfs 1980 as cited in McKinstry et al. 2004).

Organic soil wetlands known as fens are an irreplaceable resource. Fens are defined as groundwater-fed wetlands with organic soils that typically support sedges and low stature shrubs (Mitch & Gosselink 2007). The strict definition of an organic soil (peat) is one with 40 cm (16 in) or more of organic soil material in the upper 80 cm (31 in) of the soil profile (Soil Survey Staff 2014). 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. By storing organic matter deep in their soils, fens act as a carbon sink. In the arid west, peat accumulation occurs very slowly; estimates are 20 cm (8 in) per 1,000 years in Colorado (Chimner 2000; Chimner and Cooper 2002). Long-term maintenance of fens requires maintenance of both the hydrology and the plant communities that enable fen formation.

In 2012, the U.S Forest Service released a new planning rule that will guide all National Forests through the process of updating their Land Management Plans (also known as Forest Plans).[1] A component of the new planning rule is that each National Forest must conduct an assessment of important biological resources within its boundaries. To support this effort, U.S. Forest Service contracted Colorado State University and the Colorado Natural Heritage Program (CNHP) to map all potential fens within the Caribou-Targhee National Forest. This project builds upon CNHP's previous projects mapping fens on the White River National Forest (Malone et al. 2011), 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 2019) and Fishlake National Forest (Smith and Lemly 2019b).

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

2.0 STUDY AREA

2.1 Geography

The fen mapping study area was the entire Caribou-Targhee National Forest, which is administered as ten discontinuous units located in southeastern Idaho and extending into Wyoming and Utah (Figure 1). The Caribou-Targhee National Forest manages the Curlew National Grassland which was included in the project area. Caribou-Targhee National Forest borders Yellowstone National Park, Grand Teton National Park, and Bridger-Teton National Forest to the east. The Forest also shares boarders with Uinta-Wasatch-Cache National Forest to the south, Custer-Gallatin and Beaverhead-Deerlodge National Forests to the north, and the Salmon-Challis National Forest to the northwest. Caribou-Targhee National Forest includes portions of fourteen counties in Idaho, two in Wyoming and three in Utah. The counties with the largest share of National Forest land are Caribou, Clark, Bonneville, and Fremont Counties in Idaho, and Teton County in Wyoming. The largest municipalities near the study area are Idaho Falls, ID, Pocatello, ID, and Logan, UT. Elevation in the study area ranges from 4,483 ft. (1,366 m) to 12,165 ft. (3,708 m) and the mean elevation is 7,136 ft. (2,175 m).

Caribou-Targhee National Forest spans five different HUC6 river basins (Figure 2). The majority of Forest land occurs in either the Snake River Headwaters (HUC6:170401) or the Upper Snake River (HUC6: 170402) basins. The Snake River originates outside the Forest in Teton National Park, Wyoming, and bisects the Caribou-Targhee National Forest near the Idaho/Wyoming border at Palisades Reservoir. Only a short stretch of the Snake River flows through the Forest, but most of the Forest's watersheds eventually drain into the Snake River across the large open Snake River Plain. Smaller portions of Caribou-Targhee National Forest to the south occur in the Upper Bear River (HUC6:160101), Lower Bear River (HUC6:160102), and Great Salt Lake (HUC6:160203) basins.

2.2 Ecological Subsections

The U.S. Forest Service has developed Land Type Associations for each National Forest to describe the major geomorphic landforms within the Forest (USDA 2019). EcoMap Ecological subsections are a component of Land Type Associations.

There are 22 unique Ecological Subsections in Caribou-Targhee National Forest. The most common Ecological subsection in the Caribou-Targhee National Forest is the Caribou-Snake River Range (25% of study area) (Figure 3). The next most common Land Type Association subsections are the Southern Beaverhead Mountains (15%), Island Park (10%) and Southwestern Overthrust Belt Mountains (14%) (USFS 2017 Ecological Subregions) .

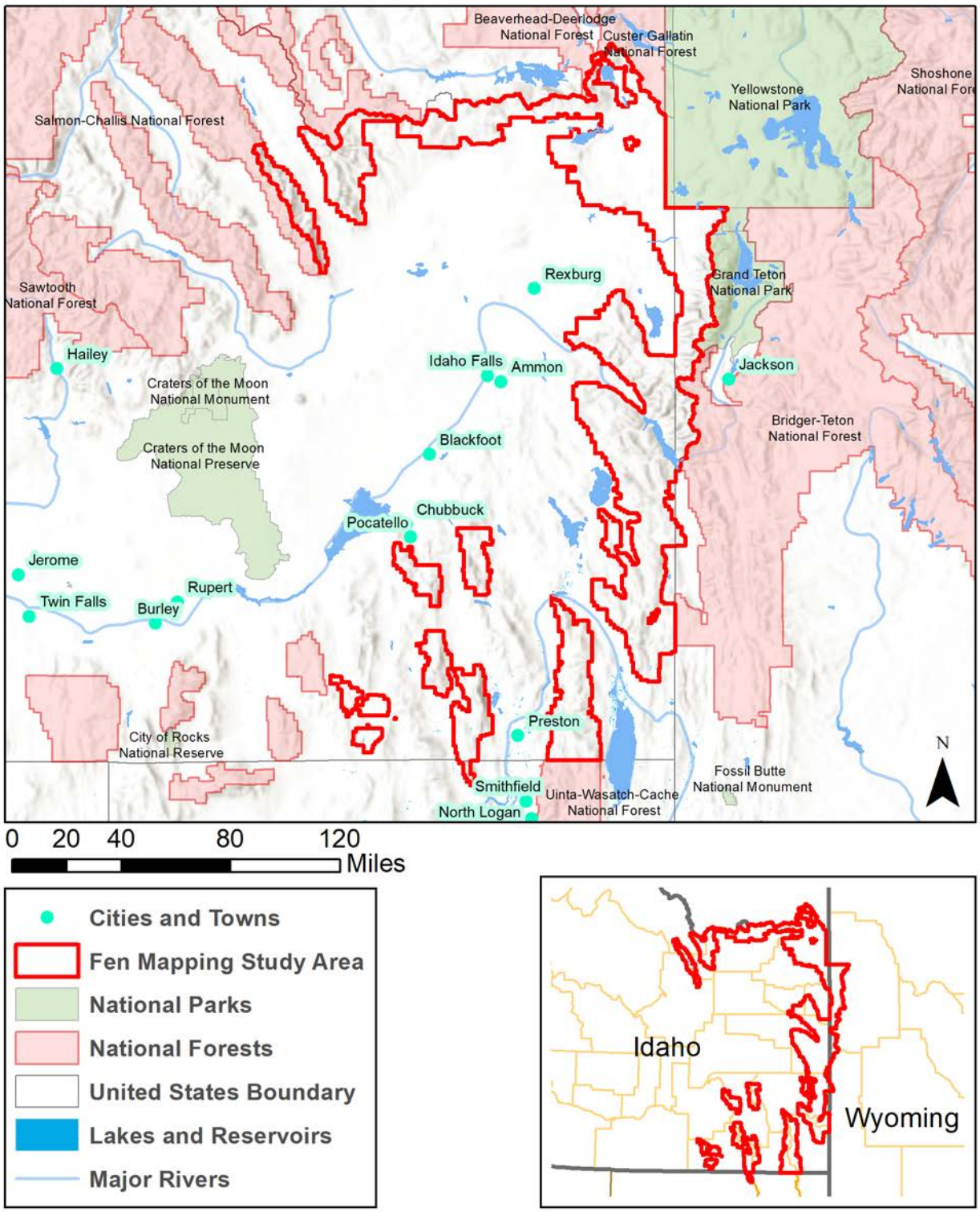

Figure 1. Location of the Caribou-Targhee National Forest (fen mapping study area).

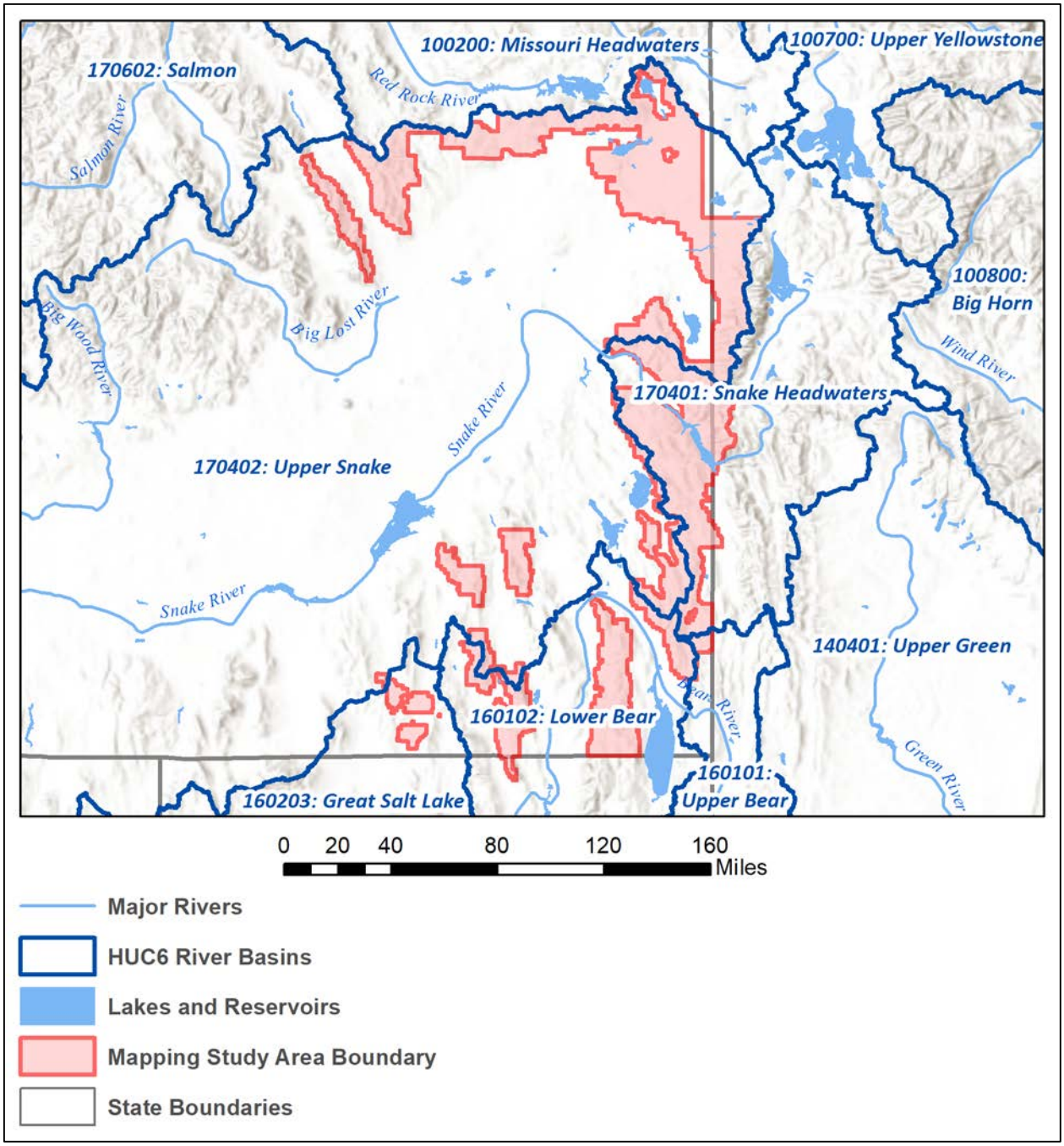

Figure 2. HUC6 river basins and major waterways in the fen mapping study area.

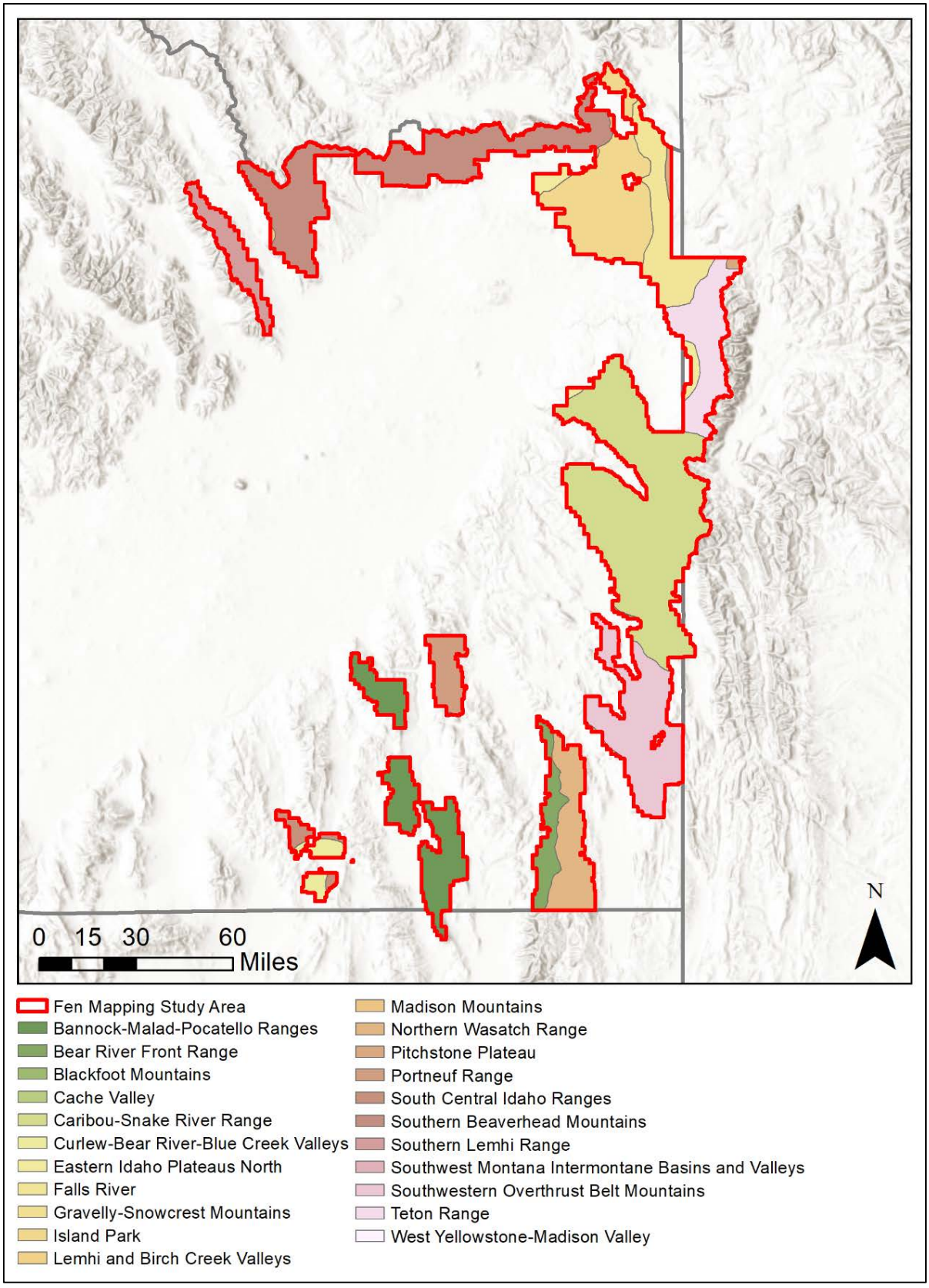

Figure 3. EcoMap Ecological Subsections of the fen mapping study area.

2.3 Geology

The Forest crosses several major geologic provinces in Idaho. The northeast corner of the Forest is located at the eastern end of the Snake River Plain or Yellowstone Volcanic Province, a broad depression that arches across the entire width of southern Idaho. The Snake River Plain formed over millions of years as the North American continental plate slowly passes over a stationary magma plume known as the Yellowstone hot spot. The hot spot is currently located beneath Yellowstone National Park and is responsible for the numerous geysers that characterize the National Park. Bedrock geology within the Snake River Plain is primarily basalts, tufts, and other volcanic rocks extruded from various iterations of Yellowstone volcanism.

Mountain ranges within the Caribou-Targhee National Forest to the south and west of the Snake River Plain are primarily sedimentary rocks uplifted by faulting in the Basin and Range Province. Across the entire Forest, limestone is the most common bedrock geology unit (25% of the land area). Sandstone (15%) and rhyolite (14%) are also common.

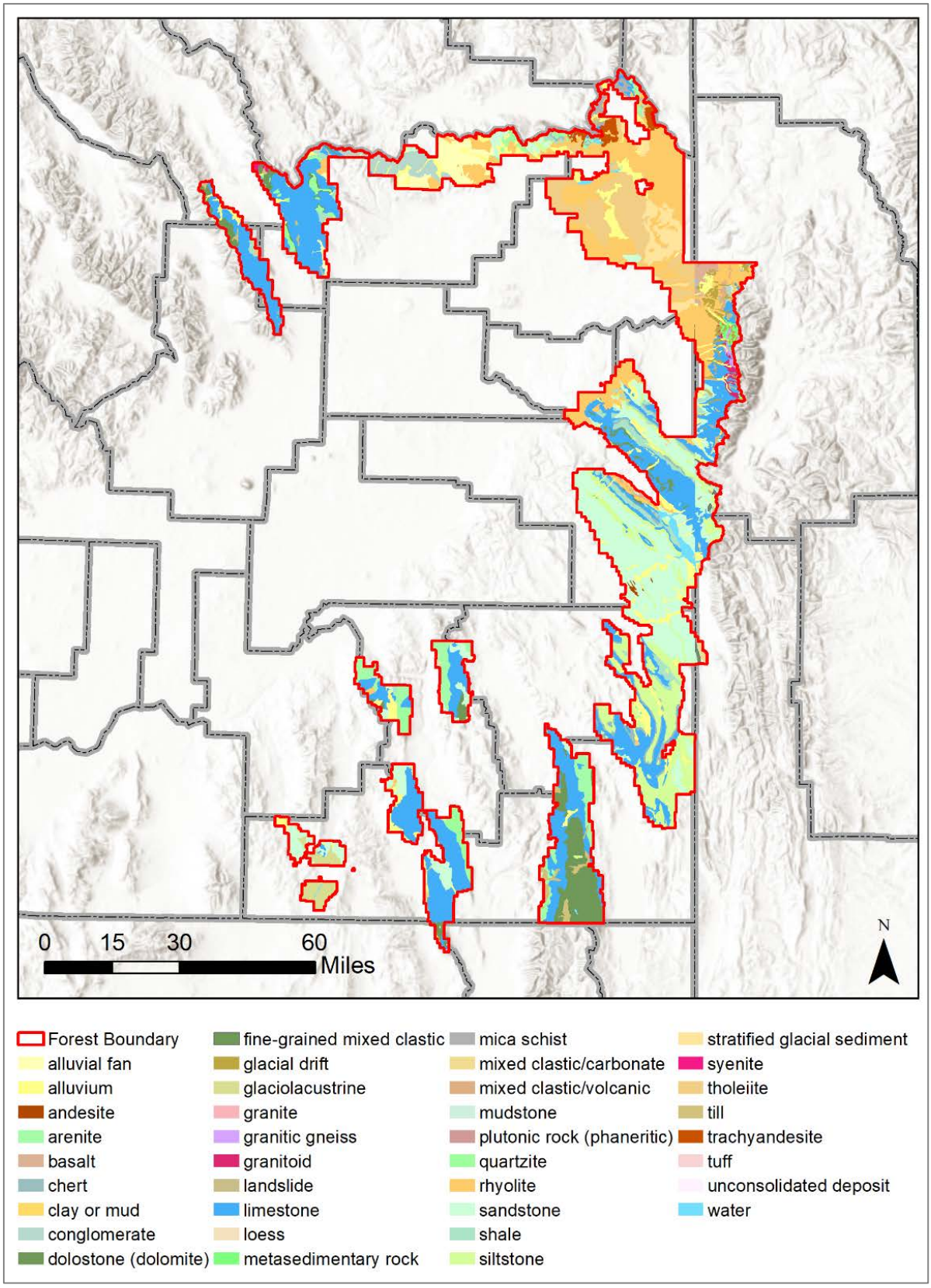

Figure 4. Geology within the fen mapping study area (USGS 2004).

3.0 Fen Mapping Methods

Potential fens in the Caribou-Targhee National Forest were identified by analyzing digital aerial photography and topographic maps. True color aerial photography taken by the National Agricultural Imagery Program (NAIP) in 2013, 2012 and 2009 were used in conjunction with color-infrared imagery from 2013. 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 the U.S. Fish and Wildlife Service's National Wetland Inventory (NWI) program in the 1970s and early 80s with a "B" (seasonally saturated) hydrologic regime were isolated from the full NWI dataset and examined.[2] Wetlands mapped as Palustrine Emergent Saturated (PEMB) and Palustrine Scrub-Shrub Saturated (PSSB) were specifically targeted, as they can be the best indication of fen formation, and every PEMB and PSSB polygon in the study area was checked. However, photo-interpreters were not limited to the original NWI polygons and also mapped any fens they observed outside of B regime NWI polygons.

Potential fen polygons were hand-drawn in ArcGIS 10.4 based on the best estimation of fen boundaries. In most cases, this did not match the exact boundaries of the original NWI polygons because the resolution of current imagery is far higher than was available in the 1980s. The fen polygons were often a portion of the NWI polygon or were drawn with different, but overlapping boundaries. This will provide Caribou-Targhee National Forest the most accurate and precise representation of fens in the Forest, as opposed to estimates based on the NWI polygons themselves. Each potential fen polygon was attributed with a confidence value of 1, 3 or 5 (Table 1). In addition to the confidence rating, any justifications of the rating or interesting observations were noted, including beaver influence, floating mats and springs.

Table 1. Description of potential fen confidence levels.

Confidence	*Description*
5	***Likely fen.*** Strong photo signature of fen vegetation, fen hydrology, and good landscape position. All likely fens should contain peat of 40cm 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 40cm, 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.

[2] For more information about the National Wetland Inventory and the coding system, please visit: http://www.fws.gov/wetlands/

4.0 RESULTS

4.1 Potential Fen Mapping Acreage

The final map of potential fens contained 1,779 potential fen locations (all confidence levels), covering 6,494 acres or 0.2% of the total land area (Table 2; Figures 5 and 6). This total included 130 likely ***fens*** (confidence level = 5), 369 ***possible fens***, and 1,280 ***low confidence fens.*** On average the likely fens much were larger in size than the possible and low confidence fens (6.04 acres vs. 3.21 or 3.54 acres), resulting in 785 acres of likely fens, 1,184 acres of possible fens, and 4,525 acres of low confidence fens. The size of individual potential fens ranged from over 63 acres to 0.2 acres. The largest mapped likely fen at 64 acres is located along Winegar Creek, west of Rock Lake (Figure 7). The four largest mapped likely fens are in the Winegar Hole area (Figures 8 and 9), near the border with Yellowstone National Park. This area contains many fens, including fens along the lakeshores of Moose Lake, Loon Lake, Rock Lake, Junco Lake, and Tillery Lake, which are described in the Wyoming Natural Diversity Database's recent report Botany Inventories in Select Fens of the Caribou-Targhee and Bridger-Teton National Forests (Heidel 2019).

Table 2. Potential fen counts and acreage, by confidence levels.

Confidence	*Count*	*Acres*	*Average size (acres)*
5 – Likely Fen	130	785	6.04
3 – Possible Fen	369	1,184	3.21
1 – Low Confidence Fen	1,280	4,525	3.54
TOTAL	**1,779**	**6,494**	**3.65**

The sections that follow (4.2 through 4.5) break down the fen mapping by elevation range, geology, Land Type Association, and HUC12 watershed. The last section summarizes observations made by the fen mappers during the mapping process, including potential floating mat fens.

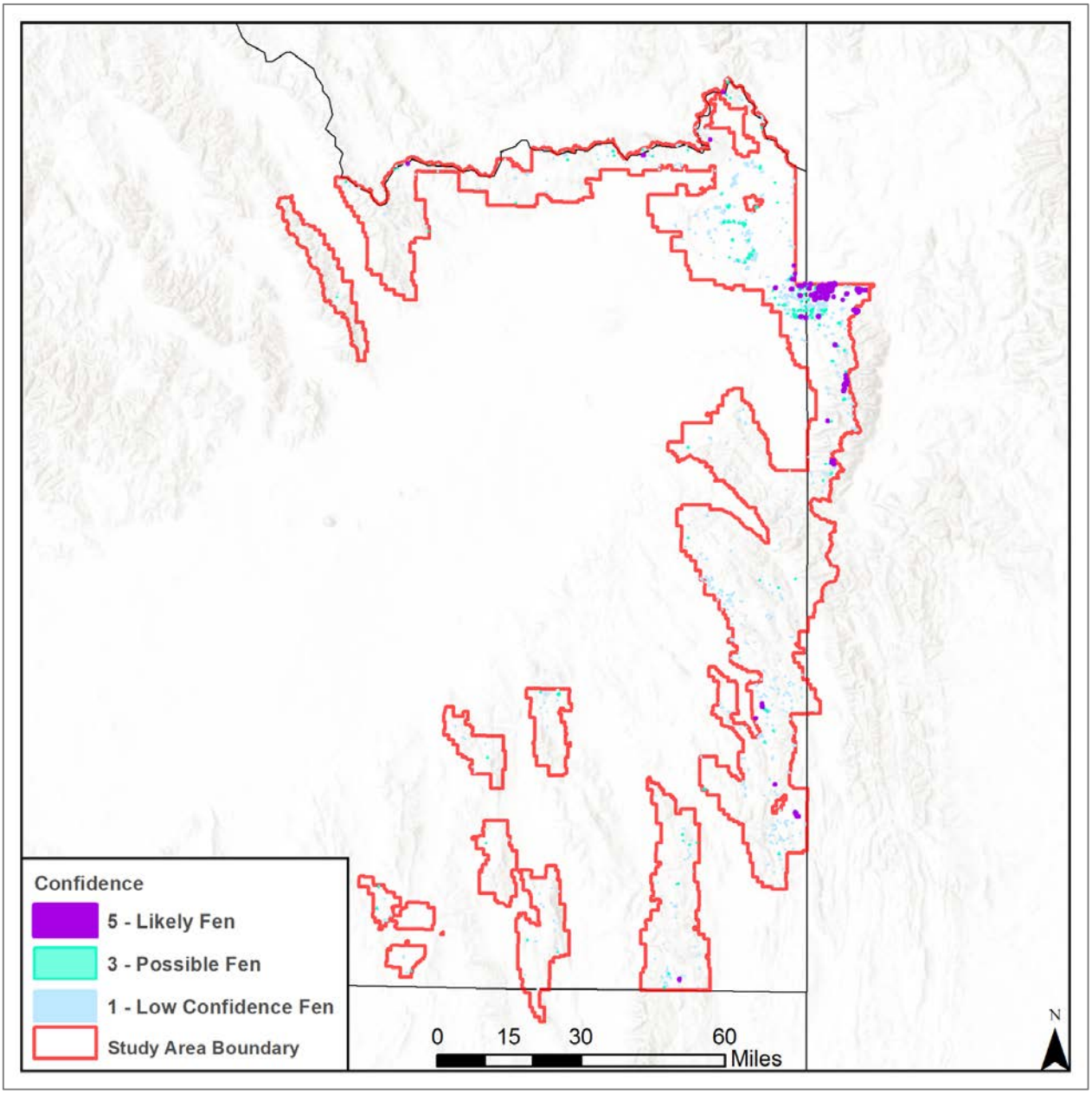

Figure 5. All potential fens within the fen mapping study area.

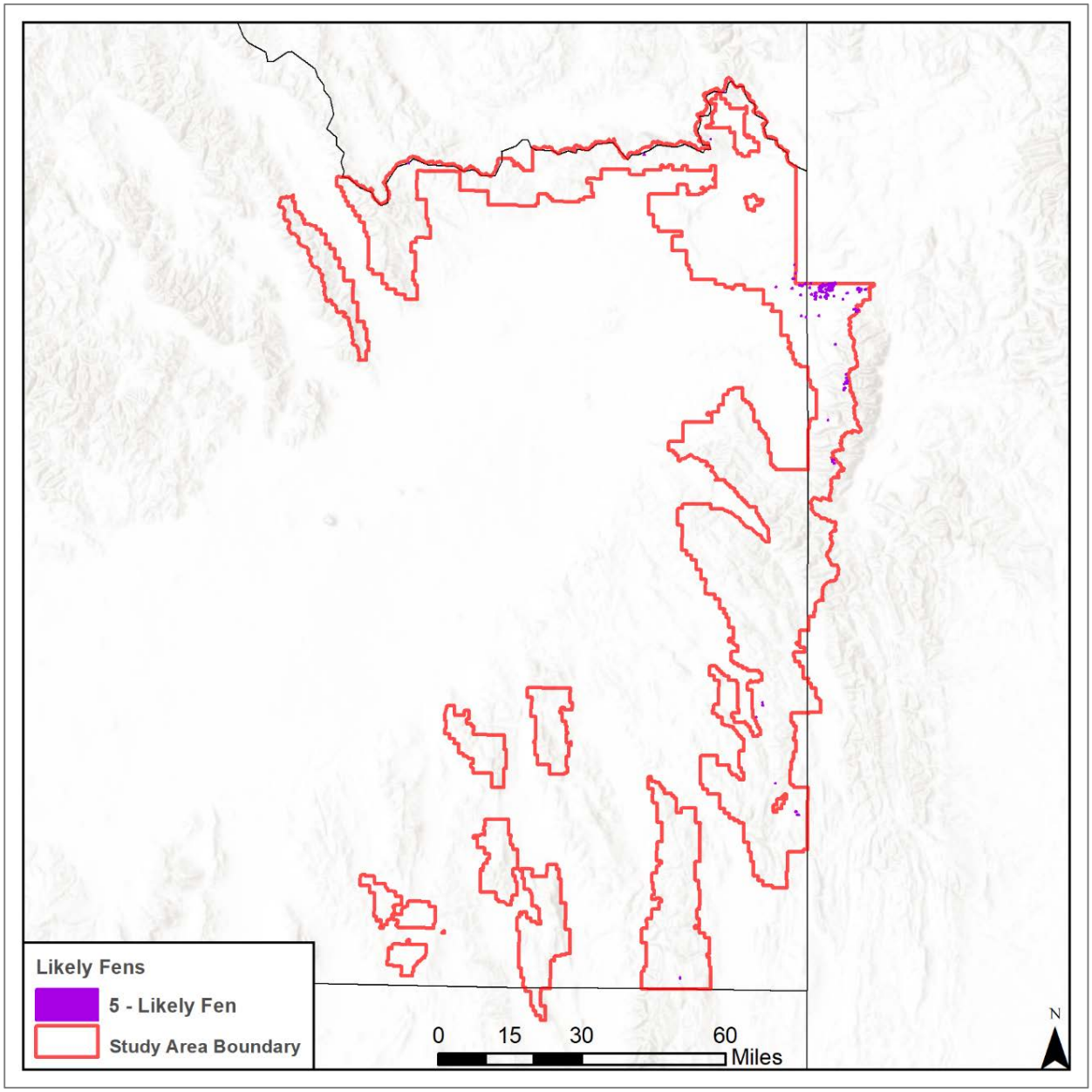

Figure 6. Likely fens (confidence rating = 5) within the fen mapping study area.

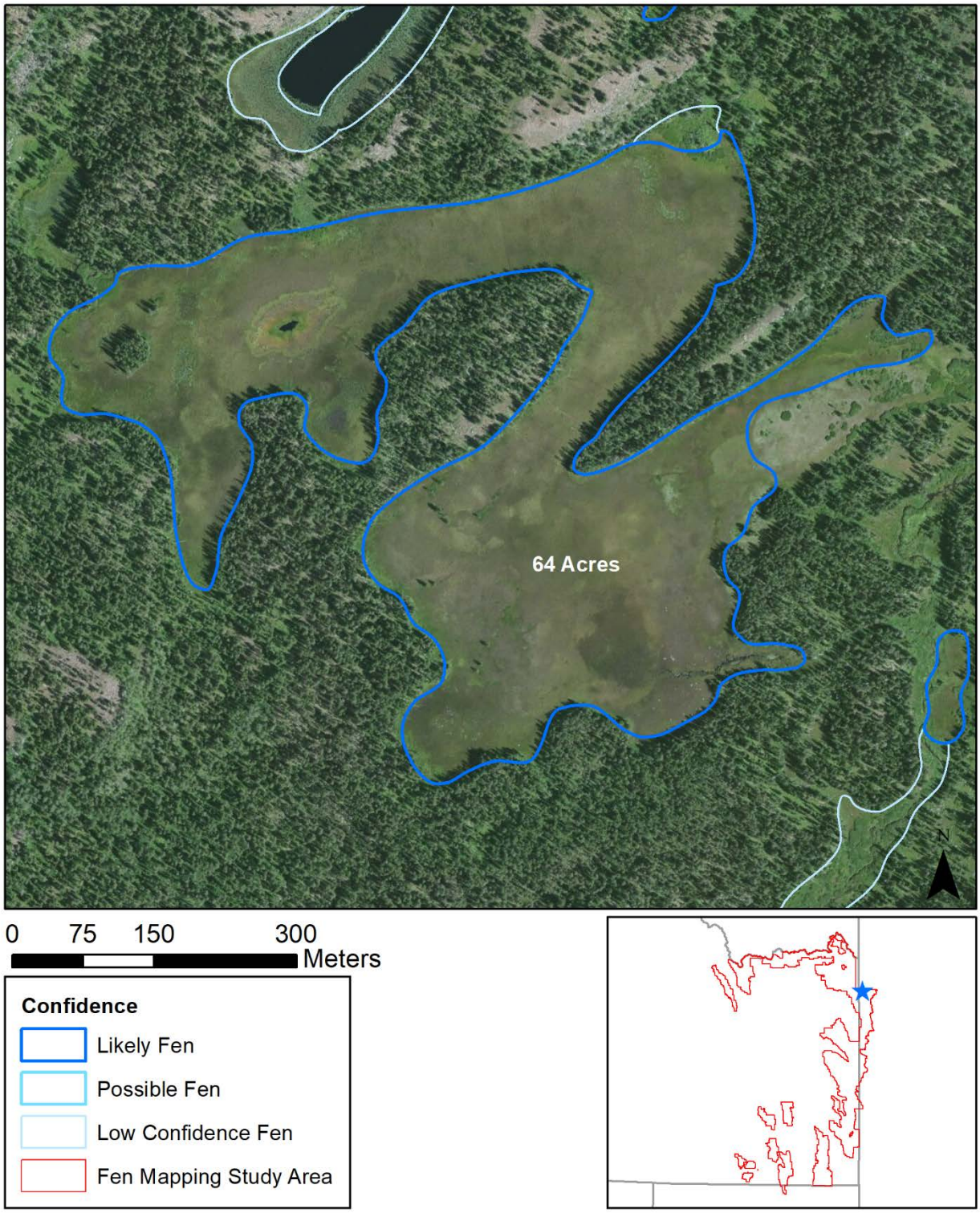

Figure 7. Largest mapped likely fen, 64 acres within one polygon. This fen is located in the Winegar Hole area, west of Winegar Creek.

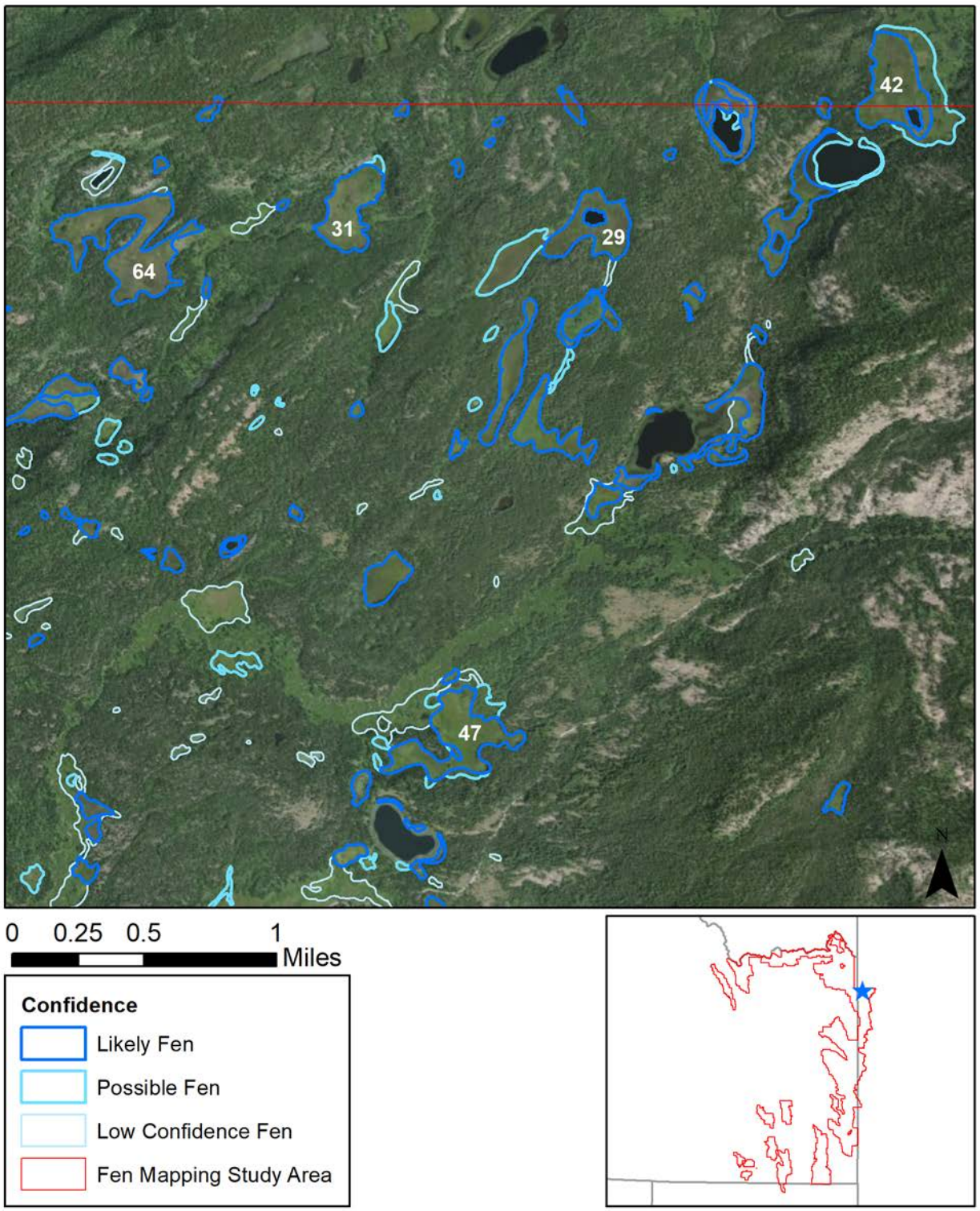

Figure 8. The five largest mapped likely fens, ranging from 64 to 29 acres. These likely fens are located in the Winegar Hole area.

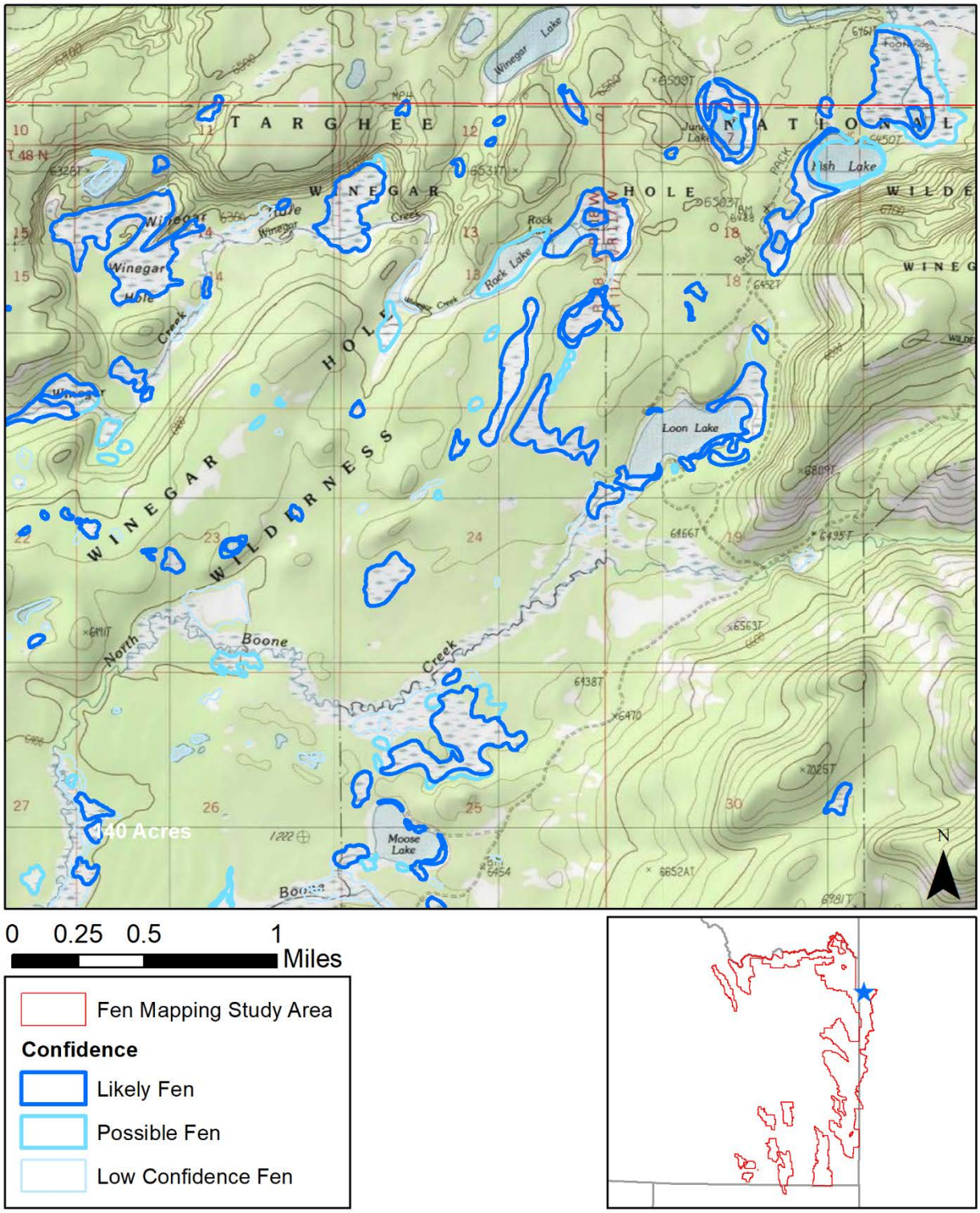

Figure 9: The five largest mapped likely fens in the Winegar Hole Area. Likely fens form the lakeshores of Moose, Loon, Fish and Rock Lakes.

4.2 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, closer to the zone of 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, 993 polygons (4,228 acres) were mapped between 6,000 and 7,000 feet, which represents 56% of potential fen locations and 65% of potential fen acres (Table 3; Figure 10). Of the 130 total likely fens mapped, 78 polygons (60%) and 597 acres (76%) were located between 6,000 and 7,000 feet (Table 3; Figures 11 and 12). This is clearly the zone of maximum fen formation for the CTNF.

The elevation bands of 7,000 to 8,000 feet and 8,000 to 9,000 also contain many potential and likely fens. Between 7,000 to 8,000 feet, there were 455 mapped potential fens (1,156 acres), which represent 25% of potential fen locations and 18% of potential fen acres. In addition, there were 18 likely fens (100 acres), which represent 14% of likely fen locations and 13% of likely fen acres. Between 8,000 to 9,000 feet, there were 136 mapped potential fens (309 acres), which represent 8% of potential fen locations and 5% of potential fen acres. In addition, there were 15 likely fens (43 acres), which represent 12% of likely fen locations and 5% of likely fen acres.

Table 3. Potential and likely fens by elevation within the fen mapping study area.

Elevation Range (ft)	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
< 6,000	115	685	1	7
> 6,000 – 7,000	993	4,228	78	597
> 7,000 – 8,000	455	1,156	18	100
> 8,000 – 9,000	136	309	15	43
> 9,000	80	118	18	38
Total	**1,779**	**6,494**	**130**	**785**

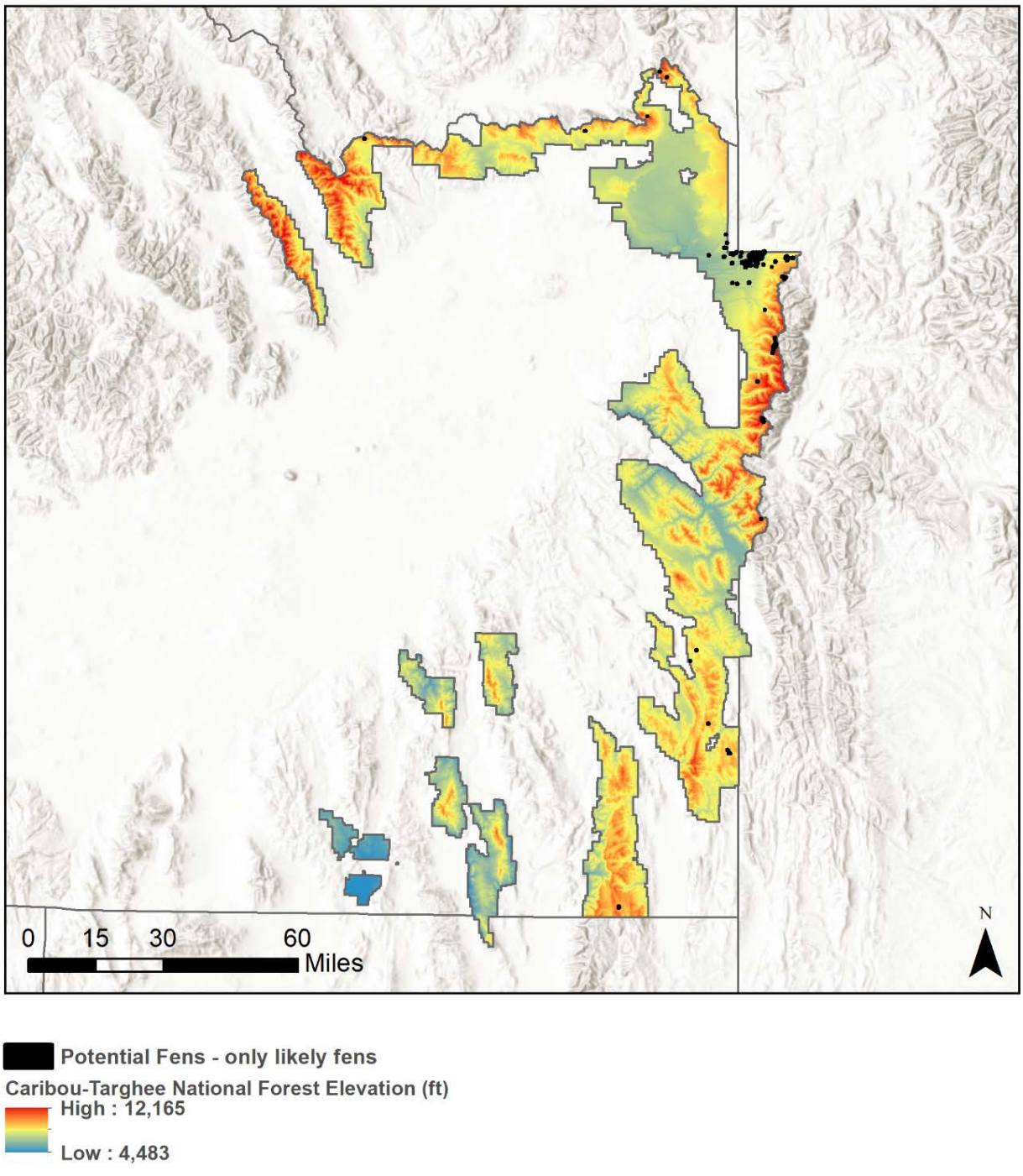

Figure 10: Likely fens (confidence rating = 5) and elevation within the fen mapping study area.

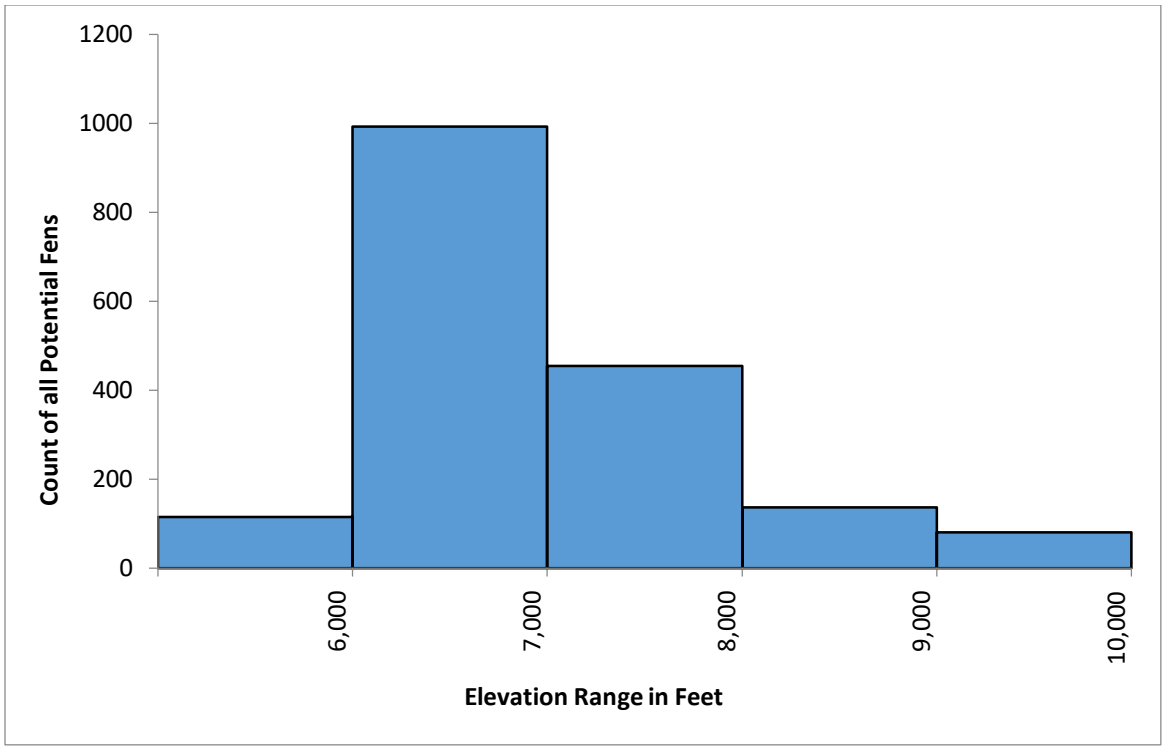

Figure 11. Histogram of all potential fens by elevation within the fen mapping study area.

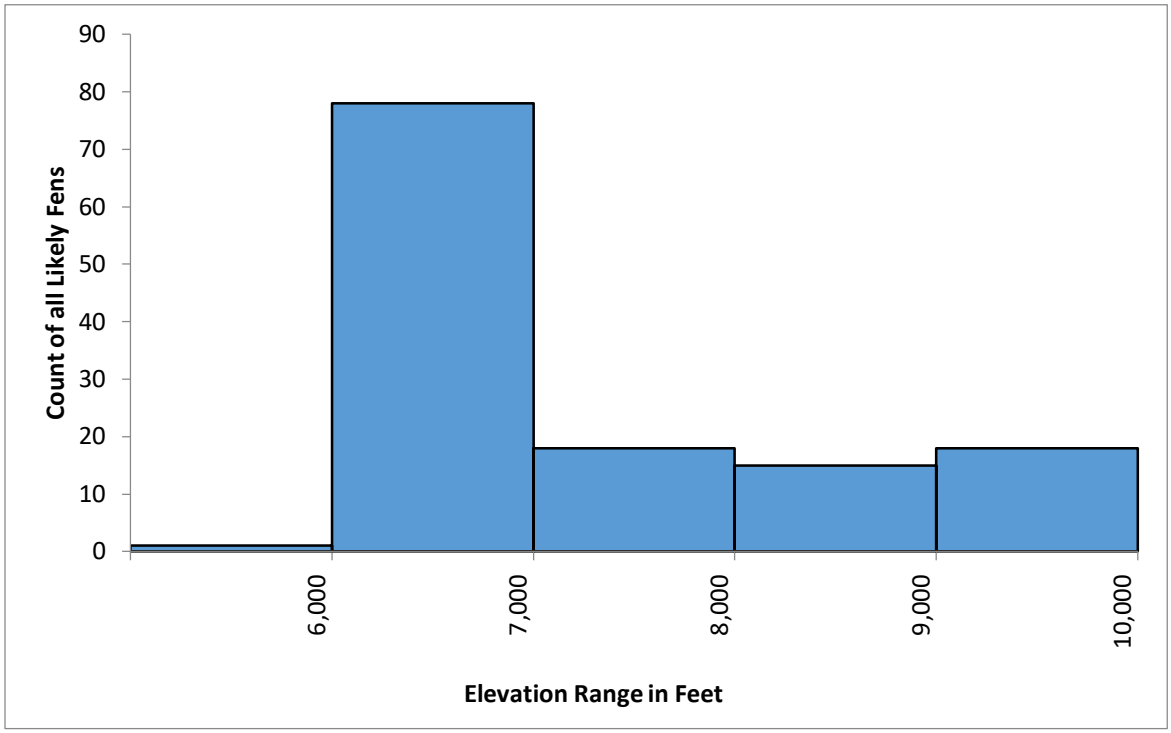

Figure 12. Histogram of the most likely fens by elevation within the fen mapping study area.

4.3 Mapped Potential Fens by Geology

The most common geologic substrate under potential fens in Caribou-Targhee National Forest was the volcanic formation tholeiite, which underlies 332 mapped potential fens (1,645 acres). The most common geologic substrates under likely fens was basalt, which underlies 49 mapped likely fens (375 acres) (Table 4). While basalt underlies only 1% of the Forest, 9% of all potential fens and 38% of likely fens occurred in these areas. Like tholeiite, basalt is also a volcanic rock formation. These two volcanic formations are common in the northeastern Snake River Plain section of the Forest, where most likely fens were mapped.

Alluvium underlies the second highest number of likely fens and likely fen acres, 13 likely fens and 104 likely fen acres. Alluvium typically occurs at the toe of slopes as alluvial fans or within the floodplains of rivers and other low-lying areas that can accumulate alluvial material over time. Similarly, fens often form at the toe of slopes or the edges of floodplain valleys where there is a distinct break in slope, locations that are likely to contain alluvium.

Table 4. Potential and likely fens by geologic substrate within the fen mapping study area

Geology	*Acres of Geologic Substrate Within HTNF[1]*	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
tholeiite	165,536	332	1645	9	69
alluvium	215,865	255	1222	13	104
sandstone	473,578	212	480	1	6
limestone	755,946	170	277	13	42
basalt	16,787	166	746	49	375
rhyolite	419,640	137	493	10	74
siltstone	234,330	116	284	3	2
glacial drift	24,940	89	345	11	59
arenite	96,890	36	77	--	--
dolostone (dolomite)	150,216	33	136	1	12
shale	77,916	33	56	1	1
stratified glacial sediment	64,794	32	196	1	3
granitoid	8,371	28	43	7	9
till	23,828	16	125	--	--
trachyandesite	21,840	16	51	1	1
alluvial fan	68,333	15	40	--	--
mica schist	15,311	15	17	2	4
conglomerate	49,133	14	88	--	--
granitic gneiss	4,205	11	19	4	10
landslide	8,734	9	17	--	--
glaciolacustrine	38,769	8	32	--	--

metasedimentary rock	7,865	7	8	2	2
quartzite	43,884	7	1	--	--
chert	36,448	6	28	--	--
mixed clastic/volcanic	4,823	5	23	2	12
water	21,389	5	28	--	--
syenite	2,693	3	6	--	--
andesite	1,943	1	1	--	--
loess	6,362	1	9	--	--
unconsolidated deposit	209	1	3	--	--
		1,779	**6,494**	**130**	**785**

[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 Caribou-Targhee National Forest.

4.4 Mapped Potential Fens by Ecological Subsection

Land Type Associations (LTA) combine location, geology, and dominant vegetation and are defined by each Forest. Ecological Subsections are a component of LTAs. The Falls River Ecological Subsection covers only 6% of the Caribou-Targhee National Forest, but this Subsection contains 29% of potential fens (512) and 60% likely fen locations (78). The Island Park Subsection covers 10% of the Forest and contains 15% of potential fens (272) and 42% of likely fen acres (1,633). The Teton Range Subsection covers only 6% of the Forest yet it contains 200 mapped potential fens (658 acres) and 30 likely fens (74 acres) (Table 5).

Table 5. Potential and likely fens by ecological subsection within the fen mapping study area.

EcoMap Ecological Subsection Name	*Acres within Caribou-Targhee National Forest*[1]	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
Falls River	174,374	512	2,193	78	600
Island Park	319,842	272	1,633	2	4
Southwestern Overthrust Belt Mountains	318,147	234	596	7	31
Caribou-Snake River Range	783,757	227	470	2	1
Teton Range	188,435	200	658	30	74
Southern Beaverhead Mountains	453,103	128	329	3	7
Northern Wasatch Range	174,984	66	320	1	12
Bannock-Malad-Pocatello Ranges	258,325	48	48		
Pitchstone Plateau	14,193	26	93	7	56

Portneuf Range	75,181	18	71		
Southern Lemhi Range	91,464	17	13		
Curlew-Bear River-Blue Creek Valleys	48,673	11	45		
South Central Idaho Ranges	32,506	9	11		
Bear River Front Range	92,861	8	10		
Eastern Idaho Plateaus North	41,535	2	2		
Southwest Montana Intermontane Basins and Valleys	47	1	<1		
Blackfoot Mountains	2,764	0	-		
Cache Valley	1,514	0	-		
Gravelly-Snowcrest Mountains	29	0	-		
Lemhi and Birch Creek Valleys	4,841	0	-		
		2,323	**4,982**	**199**	**1,161**

[1] Acres of Land Type Associations shown are only for those ecoregions where fens were mapped. The total acreage is not shown because it does not equal the total acreage of the Caribou-Targhee National Forest.

4.5 Mapped Potential Fens by Watershed

An analysis of likely fens in HUC12 watersheds revealed interesting patterns. Three watersheds in particular had significant numbers of likely fens (Figure 13). Boone Creek (HUC12: 170402030203) had 35 likely fens, which covered 1.56% of the landscape in this watershed. Winegar Creek-Falls River (HUC12: 170402030204) had 29 likely fens, covering 0.69% of the landscape. Calf Creek-Falls River (HUC12: 170402030202) also had 13 likely fens, representing 0.41% of the landscape. These three adjacent watersheds contain 72 of the 130 likely fens (55%).

See Appendix A for the full HUC12 watershed and likely fens table.

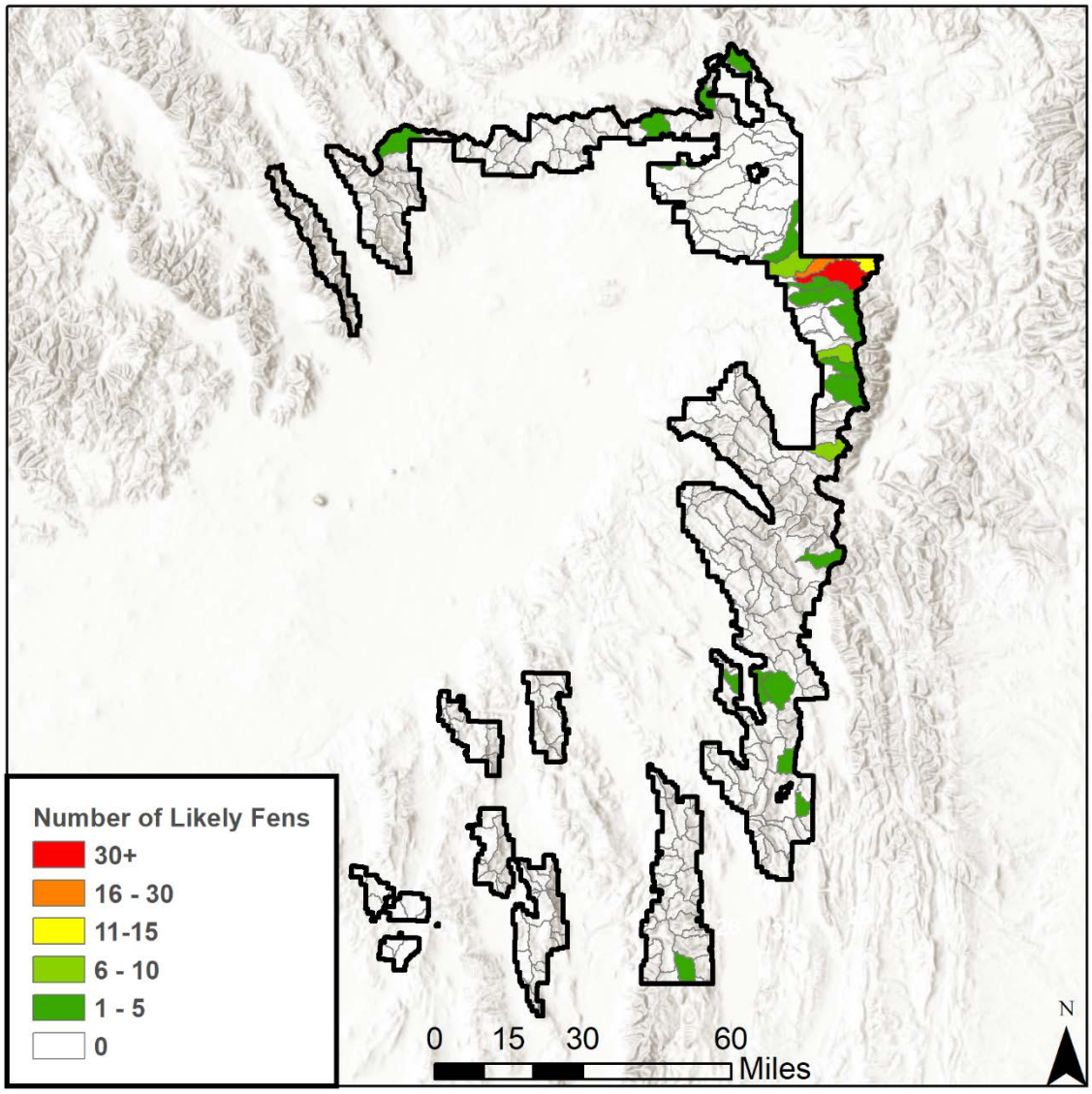

Figure 13. Likely fens by HUC12 watershed within the fen mapping study area.

4.6 Mapped Potential Fens with Distinctive Characteristics

Several characteristics related to fens were noted by photo-interpreters when observed throughout the fen mapping process (Table 6), though this was not an original objective of the project and was not consistently applied.

Of particular interest was identifying markers for potential floating mat fens, a rare type of fen that may occur in Caribou-Targhee National Forest (Kate Dwire, *personal communications*). Ninety potential fens (677 acres) and eleven likely fens (212 acres) were identified as potential floating mat fens. See Figure 14 for a likely fen that shows floating mat characteristics located north of Fish Lake in Teton County, Wyoming.

Springs and fens are both important components of groundwater-dependent ecosystems (GDEs) and are of particular interest to the U.S. Forest Service (USDA 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. Two hundred thirty-three potential fens and three likely fens were observed in proximity to springs.

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. Two hundred and thirty-nine potential fens (1,550 acres) and one likely fen (5 acres) showed some evidence of beaver influence.

Table 6. Potential and likely fens with distinctive characteristics within the fen mapping study area.

Observation	*# of Potential Fens*	*Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
Spring	233	427	3	10
Possible Floating Mat	90	677	11	212
Beaver Influence	239	1,550	1	5
Total	**562**	**2,654**	**15**	**227**

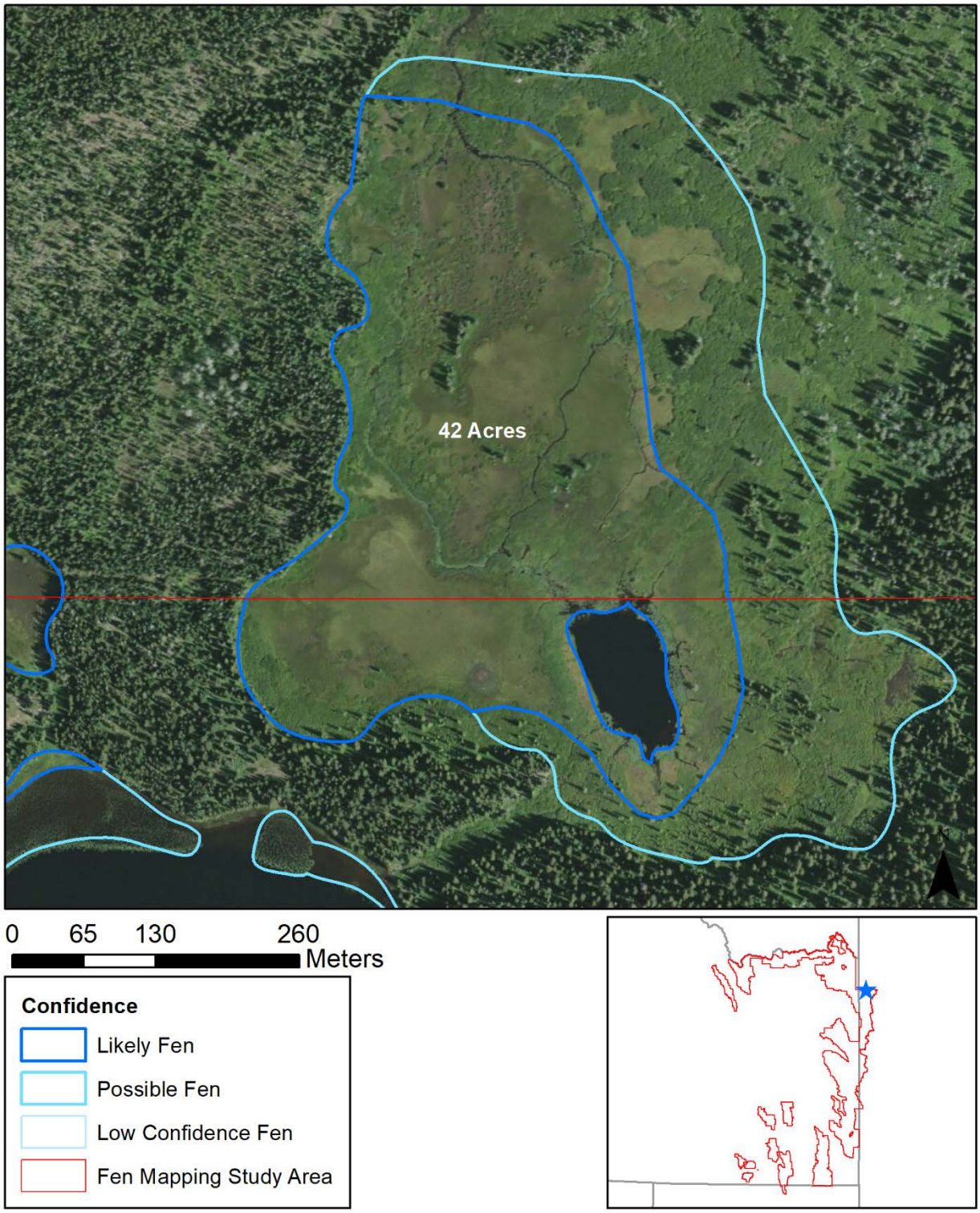

Figure 14: Possible floating mat fen (the area around the pond) located north of Fish Lake in Teton county, Wyoming. Also note beaver ponds in the southeast portion of the mapped potential fen.

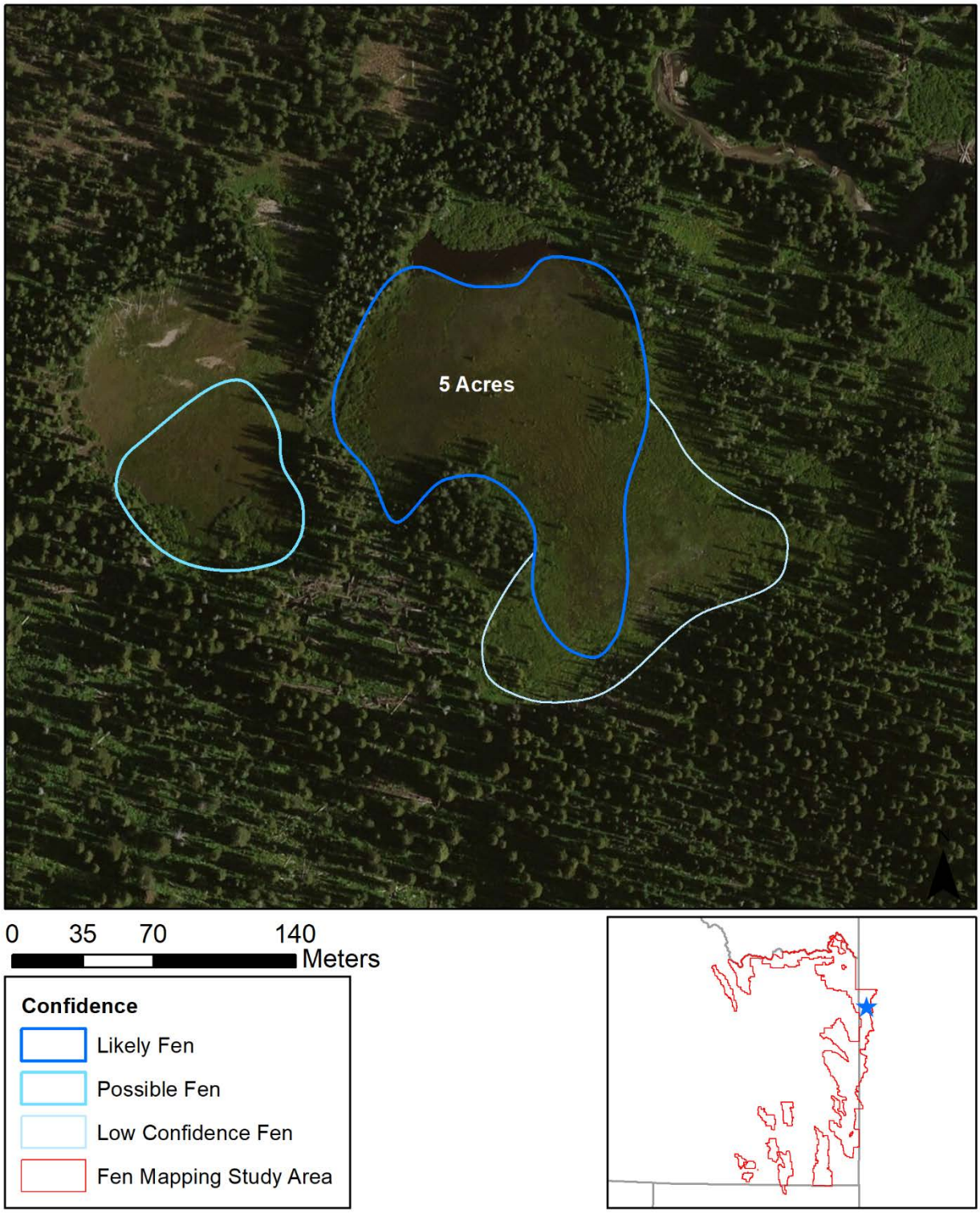

Figure 15: A beaver influenced likely fen in Teton County, Wyoming.

5.0 DISCUSSION

The Caribou-Targhee National Forest contains a relatively small number of potential fen wetlands, covering up to 6,494 acres across its jurisdiction. While the potential fen resource represents only a very small portion of the entire landscape, these fen wetlands are an irreplaceable resource for the Forest and the citizens of Idaho, Wyoming and Utah. Fens throughout the West 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). 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 snow pack 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).

In total, 1,779 potential fens were mapped throughout the Caribou-Targhee National Forest, of which only 130 were most likely to be fens. Analysis of the potential fen data showed clear hotspots for fens in the Caribou-Targhee National Forest, particularly the Boone Creek and Winegar Creek-Falls River watersheds at the edge of the Snake River Plain bordering Yellowstone National Park. The abundance of moisture and relatively flat volcanic bedrock of this area provide a natural template for fen formation, particularly expansive basin fens and floating mats. A study of fens in neighboring Yellowstone National Park found a similar concentration of basin fens within the Falls River / Bechler Meadows area of the Park (Figure 16) (Lemly 2007). These Yellowstone fens supported several rare or uncommon plant species, including *Carex lasiocarpa, Carex limosa, Carex livida, Carex buxbaumii, Carex diandra, Eriophorum gracile, Drosera anglica, Menyanthes trifoliata, Potentilla palustris, Dulichium arundinaceum, Lycopodiella inundata, Lysimachia thyrsiflora, Scheuchzeria palustris,* along with numerous *Sphagnum* moss species. A 2018 survey of fens in the Winegar Hole area documented the following rare and uncommon plant species in Caribou-Targhee National Forest: *Carex lasiocarpa, Carex limosa, Carex buxbaumii, Cicuta bulbifera*, *Drosera anglica*, *Eriophorum gracile*, *Lycopodiella inundatum*, *Lycopus uniflorus*, *Menyanthes trifoliata,Scheuchzeria palustris* and *Utriculalaria minor* (Heidel, 2019). The strong elevation pattern found within the mapping, with 65% of likely fens falling between 6,000 and 7,000 feet, is much lower than typical fen formation in western mountain ranges and is strongly tied to the abundance of fens in the Snake River Plain. The southern and western ranges of the Forest, which reach higher elevations, support far fewer fens.

Previous studies of wetland condition in other high elevation forests have found that high elevation wetlands were generally in excellent to good condition (Lemly 2012). Human stressors were observed in some fen wetlands while mapping fens on the Caribou-Targhee National Forest, such as impoundments or excavated ponds, and those observations were captured in the “Notes” field of the GIS dataset accompanying this report. However most potential fens in Caribou-Targhee National Forest showed little sign of human disturbance, particularly at higher elevations.

This report and associated dataset provide the Caribou-Targhee National Forest with a critical tool for conservation planning at both a local and Forest-wide scale. These data will be useful for the Caribou-Targhee National Forest biological assessment required by the 2012 Forest Planning Rule, but can also be used to establish buffers around potential fens for individual management actions, such as timber sales, grazing allotments, 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.

Figure 16: Examples of floating mat fens in Yellowstone National Park adjacent to the Caribou-Targhee National Forest (photos by J. Lemly taken in 2005).

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APPENDIX A: LIKELY FENS BY HUC12 WATERSHED, SORTED BY FEN DENSITY

HUC12 Code	HUC12 Name	Watershed Acres	Likely Fen Count	Likely Acres	Fen Density (Fen Acres/Watershed Acres
170402030204	Winegar Creek-Fall River	15,232	29	239	1.57%
170402030203	Boone Creek	28,752	35	199	0.69%
170402030202	Calf Creek-Fall River	34,574	13	142	0.41%
170402020402	Rock Creek	28,377	10	75	0.26%
170402040403	North Leigh Creek-Spring Creek	22,877	9	28	0.12%
170401050108	Spring Creek	27,567	2	18	0.07%
170402040102	Moose Creek	13,939	6	8	0.06%
170402020403	Middle Robinson Creek	22,816	3	12	0.05%
170402030301	Upper Conant Creek	22,854	2	12	0.05%
170402040402	South Leigh Creek	16,679	5	8	0.05%
160102030301	Beaver Creek	27,087	1	12	0.04%
170401050201	Upper Stump Creek	22,022	3	8	0.04%
170402020101	Targhee Creek	13,796	2	4	0.03%
170401050107	Sage Creek	15,149	1	4	0.03%
170402040301	South Bitch Creek	22,293	1	5	0.02%
170402020202	Howard Creek-Sheridan Creek	38,451	1	6	0.01%
170401040402	South Fork Indian Creek	14,240	2	1	0.01%
170402030302	Squirrel Creek	23,165	1	2	0.01%
170402020102	Duck Creek	11,104	1	1	0.01%
170402040202	Teton Creek	32,932	1	2	0.00%
170402070102	Lower Lanes Creek	26,886	1	1	0.00%
170402150101	Divide Creek-Warm Creek	24,491	1	1	0.00%