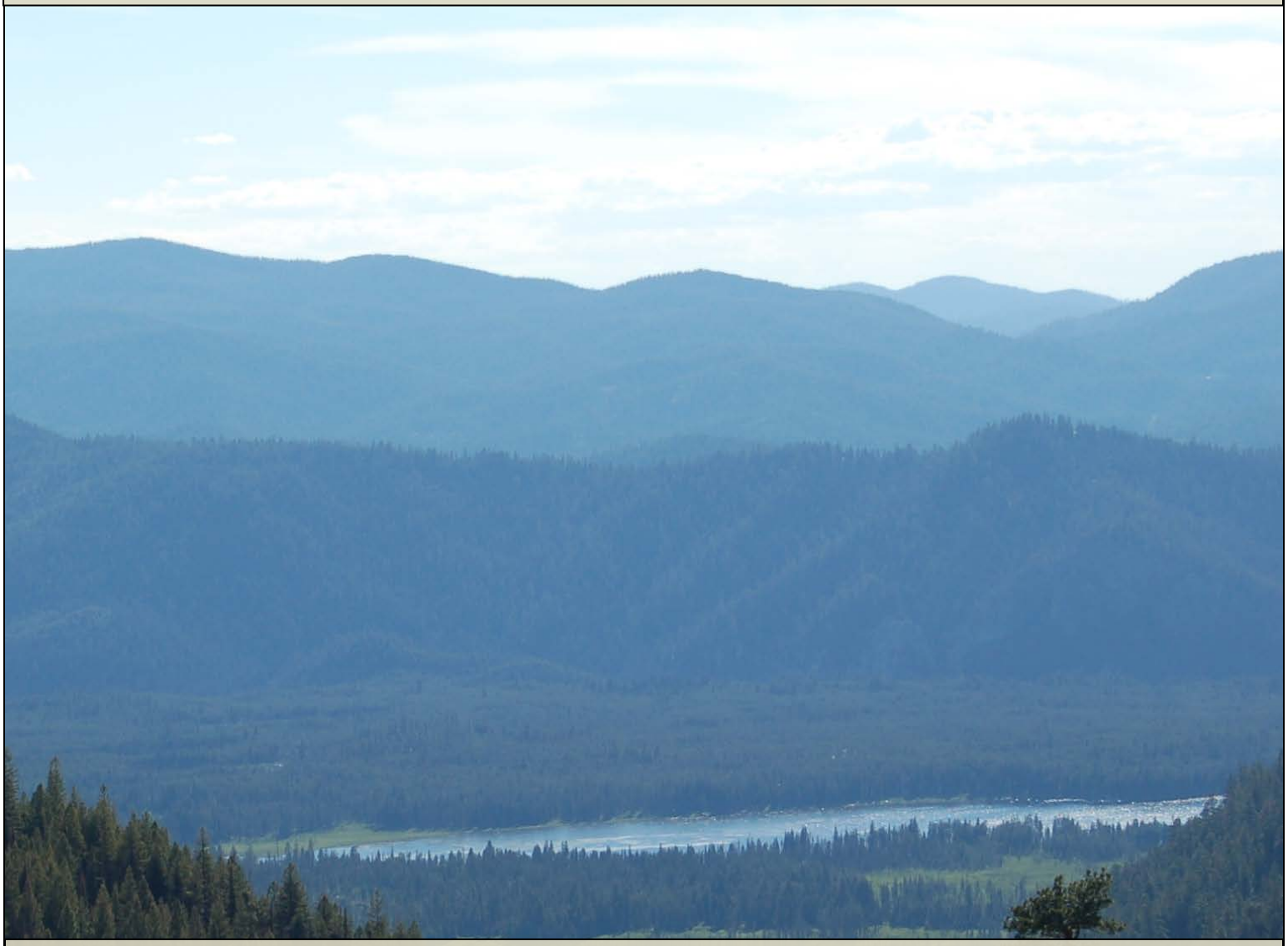
Fen Mapping for the Boise National Forest



COLORADO NATURAL HERITAGE PROGRAM

September 2021

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Recommended Citation:
Smith, G. and J. Lemly. 2021. Fen Mapping for the Boise National Forest.
Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Front Cover Photo:

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EXECUTIVE SUMMARY

The Boise National Forest covers over 2.5 million acres spread across three units in western central Idaho. Wetlands within the Boise 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 Boise National Forest.

Potential fens in the Boise 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 2,291 potential fen locations (all confidence levels), covering 8,091 acres or less than 1% of the total land area. This total included 218 ***likely fens***, 500 ***possible fens***, and 1,573 ***low confidence fens.*** The average fen polygon was 3.53 acres, but individual fen polygons ranged from 268 acres to less than an acre.

Fen distribution was analyzed by elevation, geology, Ecological Subsection, and watershed. The majority of mapped likely fens occurred between 7,000 to 8,000 feet. This elevation range contained 40% of all potential fen locations and 60% of likely fen locations. Three watersheds in particular have higher numbers of likely fens: Ditch Creek – Johnson Creek and Cache Creek – Bear Valley Creek both had 17 likely fens and Upper Warm Spring Creek watershed contains 16 likely fens.

This report and associated dataset provide the Boise National Forest with a critical tool for conservation planning at both a local and Forest-wide scale. These data will be useful for the Boise 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

The authors at Colorado Natural Heritage Program (CNHP) would like to acknowledge the U.S. Forest Service for their financial support of this project. Special thanks to John Proctor, Regional Botanist for U.S. Forest Service Region 4, and Jeff Bruggink , Regional Soils and BAER Program Manager for US Forest Service Region 4 for supporting this project.

We also thank colleagues at CNHP who have worked on previous projects mapping and surveying fen wetlands in the field, specifically Denise Culver, Laurie Gilligan, Peggy Lyon, Dee Malone, and Sarah Marshall. 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 Boise National Forest covers over 2.5 million acres in Idaho, and spans a broad elevation range from 2,800 to nearly 10,000 ft at the top of Steel Mountain. Several types of wetlands occur within the Boise 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 higher-elevation headwaters 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 Boise 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 2019a), Fishlake National Forest (Smith and Lemly 2019b), Caribou-Targhee National Forest (Smith & Lemly 2020a) and Sawtooth National Forest (Smith & Lemly 2020b).

[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 Boise National Forest, which is administered as three discontinuous units located in central to southwestern Idaho (Figure 1). Boise National Forest is located on the western border of Salmon-Challis and Sawtooth National Forests with Payette National Forest forming the northern border. Boise National Forest includes portions of five Idaho counties. The counties with the largest share of National Forest land are Valley, Boise, and Elmore counties Idaho. The largest municipalities near the study area are Boise, Eagle, Garden City, McCall and Mountain Home Idaho. Elevation in the study area ranges from 2,800 ft. (850 m) to 9,730 ft. (2,970 m) and the mean elevation is 5,889 ft. (1,795 m).

Boise National Forest spans three different HUC6 river basins (synonymous with 3rd-field HU's) (Figure 2). The majority of the Forest land occurs in the Middle Snake-Boise River Basin (HUC6:170501), with smaller amounts in the Salmon River (HUC6:170602) or the Upper Snake River (HUC6: 170402) basins. The southern portion of the Forest is drained by the Boise River while the northern/central portions are drained by the Payette River, a tributary to the Boise. Headwater tributaries of the Salmon River originate in the northeastern-most portion of the Forest and drain north.

2.2 Ecological Subsections

The U.S. Forest Service has developed a National Hierarchy of Ecological Units (Cleland et. al. 1997). Ecological Subsections of the hierarchy were used for this project to help describe geologic and geomorphic correlations of fen locations. A Subsection is a unit of land with similar surficial geology, lithology, geomorphic process, soil groups, subregional climate, and potential natural communities. They are generally mapped at 1:250K to 1:3.5M scale and represent land areas of 10s to 1,000s of square miles. Subsection boundaries usually correspond with discrete changes in geomorphology.

There are 18 unique Ecological Subsections in Boise National Forest. The most common Ecological Subsection in the Boise National Forest is the Middle and South Forks Boise River (15% of study area) (Figure 3). The next most common Subsections are the Middle Fork Payette Canyon and Stream Cut Lands (14%), Bear Valley – Landmark Basin and Uplands (13%) and Upper Middle Fork Boise River (10%) (USFS 2017 Ecological Subregions).

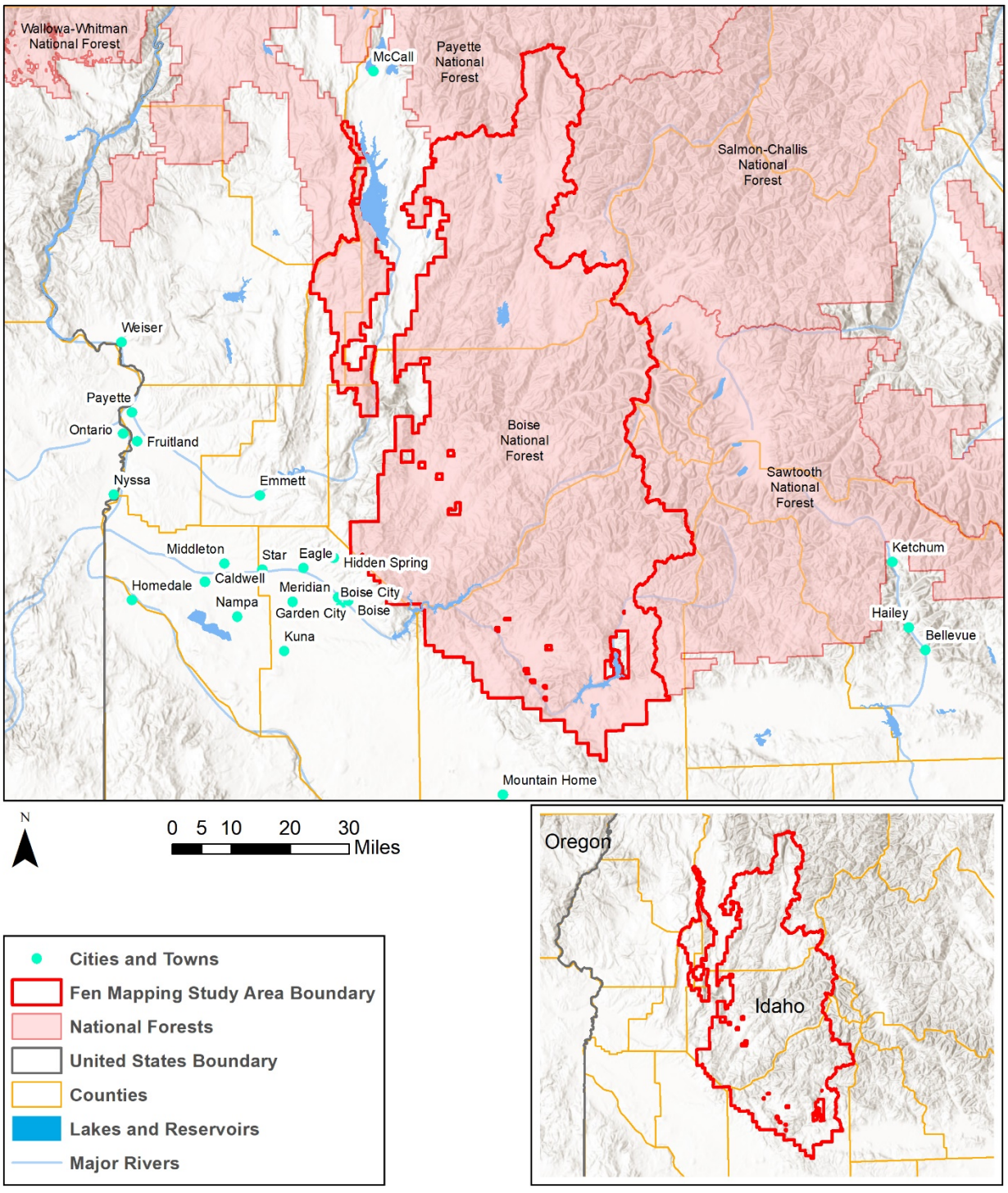

Figure 1. Location of the Boise National Forest (fen mapping study area).

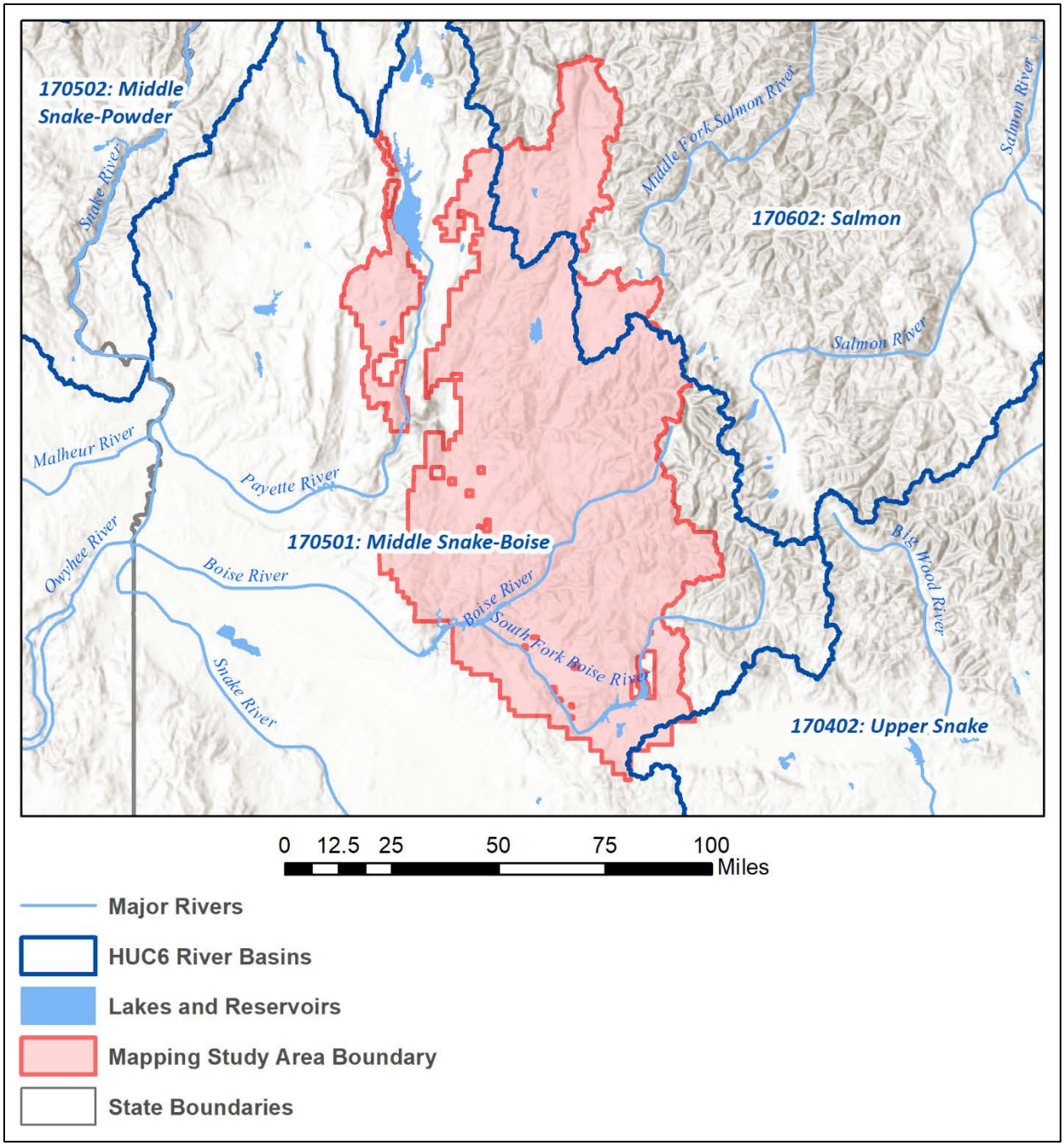

Figure 2. HUC6 river basins and major waterways in the fen mapping study area.

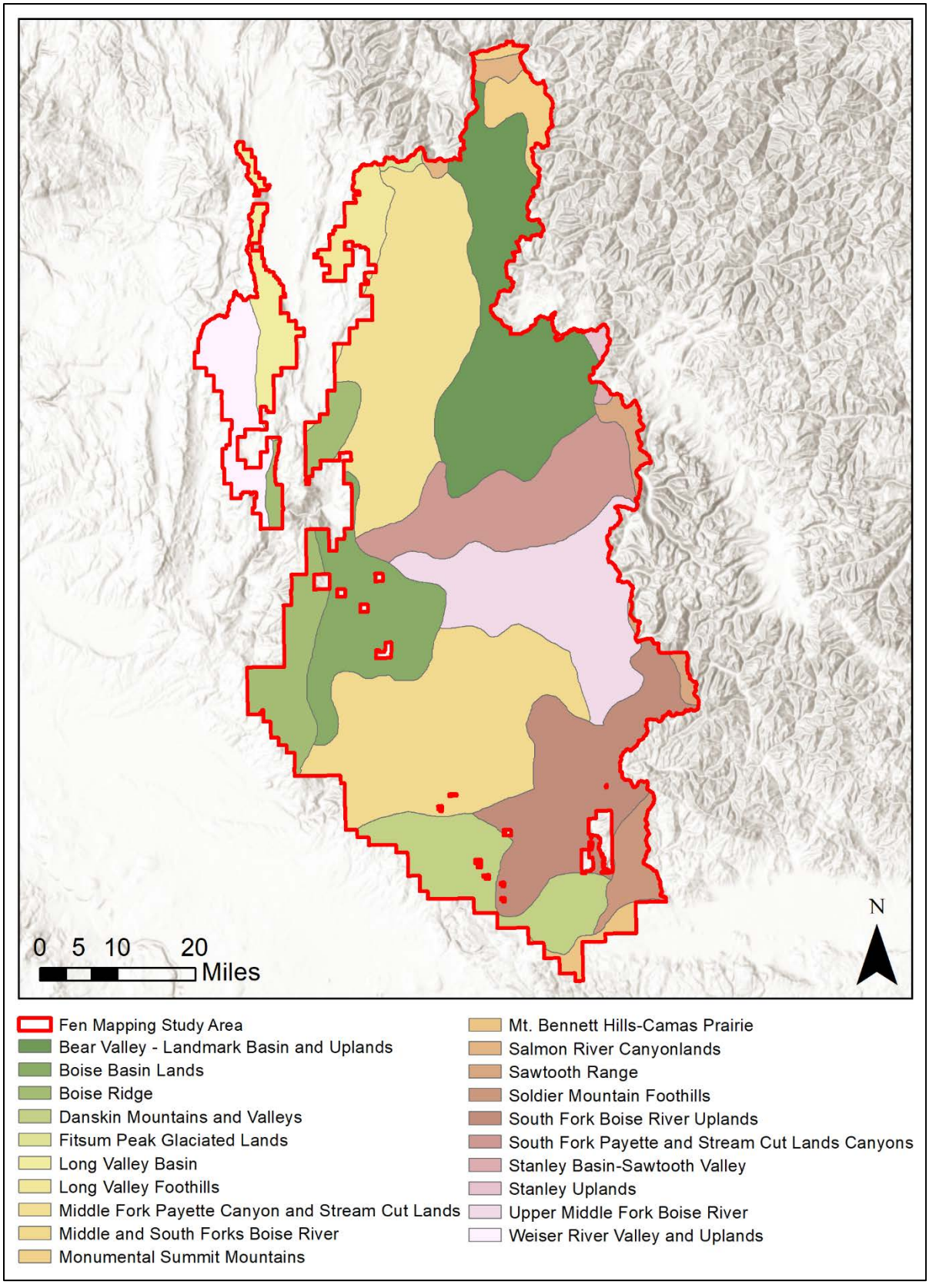

Figure 3. EcoMap Ecological Subsections of the fen mapping study area.

2.3 Geology

Boise National Forests is comprised of the Atlanta lobe of the Idaho Batholith, a granitic and granodioritic formation that covers nearly 10,000 square miles of central Idaho and western Montana. Across the entire Forest, granodiorite is by far the most common bedrock geology unit (86% of the land area). Granite (3%), tholeiite (2%), till (2%) and alluvium (2%) are also common. Intrusions of basalt (1%) are present along the western edge of the Forest, and volcanic tholeiite and rhyolite are present in the southern portions of the Forest. Till is more common at higher elevations in the northeast portion of the Forest.

In the northern portion of the Forest (between the North and South Forks of the Payette River) the Salmon River Mountain range extends north and east outside of the Forest border. The southern portion of the Forest is covered by the Boise Mountains, which includes Steel Mountain, the highest mountaintop in the Forest. The southwest border of the Forest falls within the Danskin Mountain Range, and the northwest portion of the Forest (south and west of Lake Cascade) are part of the West Mountain Range.

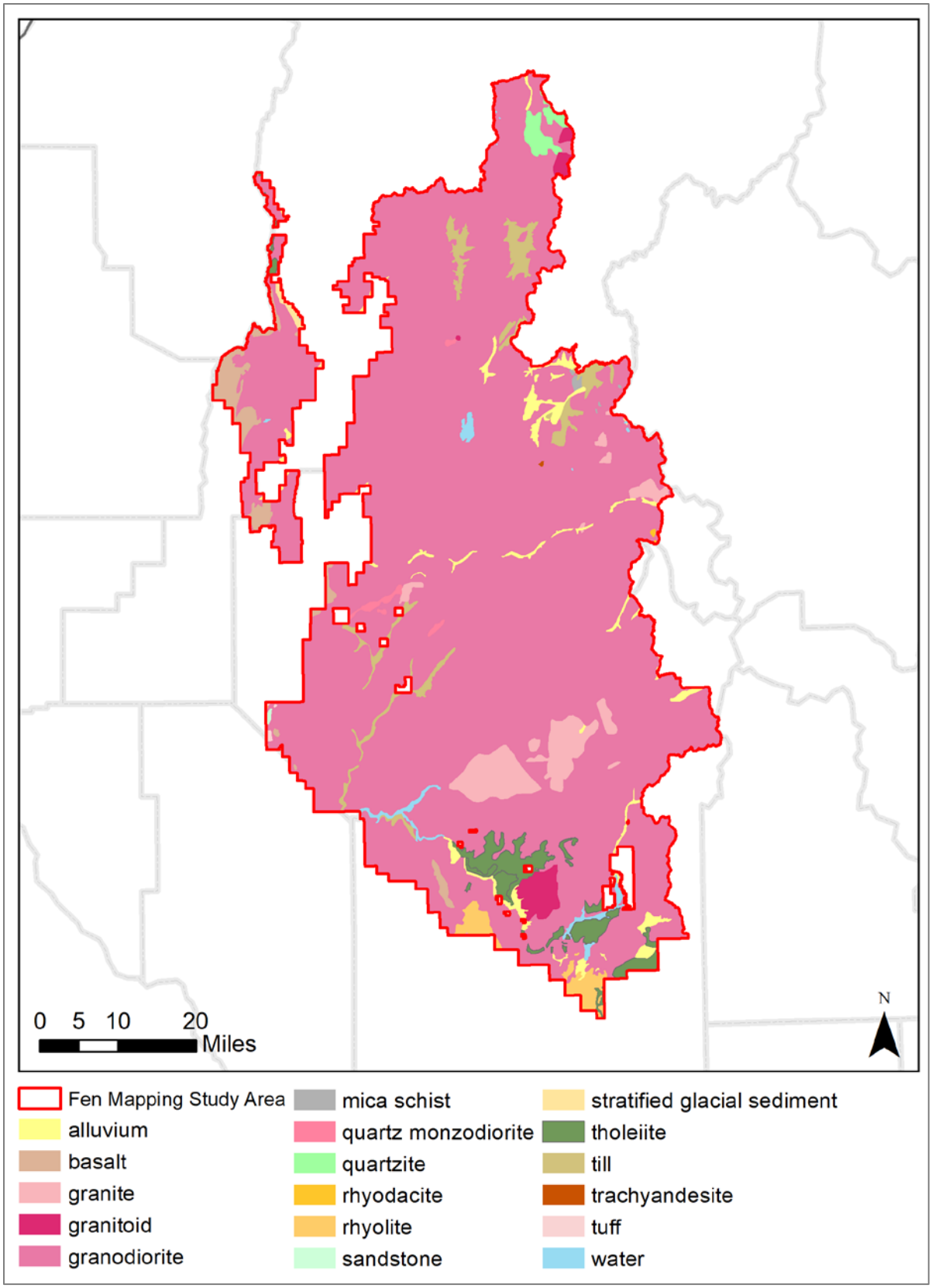

Figure 4. Geology within the fen mapping study area (USGS 2004).

3.0 Fen Mapping Methods

Potential fens in the Boise 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 2004, 2009, 2011, 2013, and 2019 were used in conjunction with color-infrared imagery from 2011, 2013, 2015 and 2019. 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 10.6 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 Boise 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, springs or human stressors.

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*
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 2,291 potential fen locations (all confidence levels), covering 8,091 acres or 0.3% of the total land area (Table 2; Figures 5 and 6). This total included 218 likely ***fens*** (confidence level = 5), 500 ***possible fens***, and 1,5873 ***low confidence fens.***

On average the likely fens much were larger in size than the possible and low confidence fens (4.48 acres vs. 4.32 or 3.14 acres), resulting in 977 acres of likely fens, 2,160 acres of possible fens, and 4,954 acres of low confidence fens. The size of individual potential fens ranged from over 268 acres to 0.06 acres. The largest mapped likely fen at 107 acres is located north of Bull Trout Lake, spanning Boise and Custer counties (Figure 7). The second largest mapped likely fen is Warm Lake Fen (Figure 8) located on the southeast shore of Warm Lake. The third largest likely fen is located on the east side of Burnt Log Road, surrounding Mud Lake (Figure 9). These three fen locations were botanically surveyed by Mabel Jankovsky-Jones in 2001 and are described in *A Preliminary Summary of Peatlands on the Boise National Forest* (Jankovsy-Jones 2001).

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

Confidence	*Count*	*Acres*	*Average size (acres)*
5 – Likely Fen	218	977	4.48
3 – Possible Fen	500	2,160	4.32
1 – Low Confidence Fen	1,573	4,954	3.14
TOTAL	**2,291**	**8,091**	**3.53**

The sections that follow (4.2 through 4.5) break down the fen mapping by elevation range, geology, EcoMap Subsection and HUC12 (synonymous with 6th-field HU's) watershed. The last section summarizes observations made by the fen mappers during the mapping process, including potential floating mat fens.

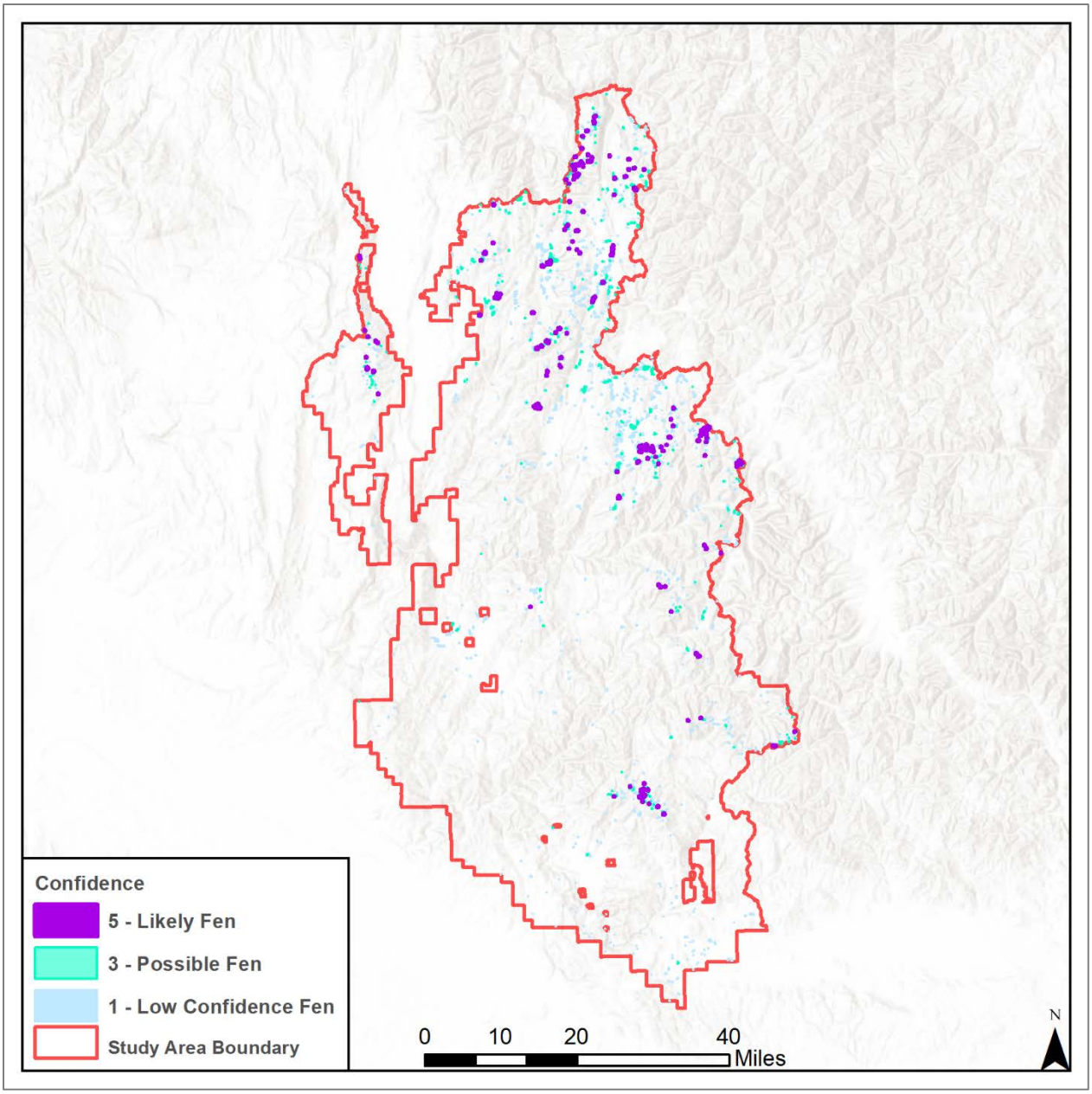

Figure 5. All potential fens within the fen mapping study area.

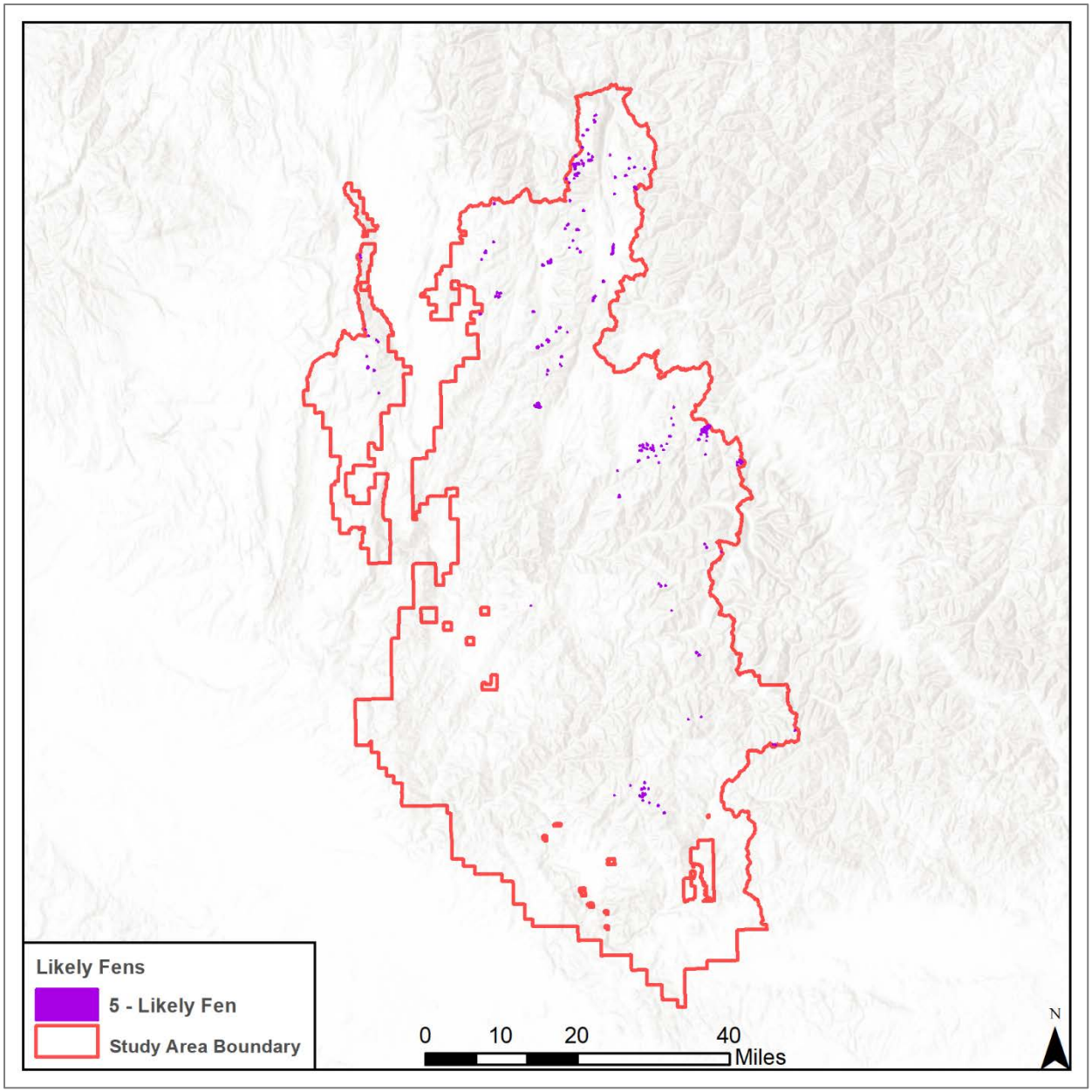

Figure 6. Likely fens (confidence rating = 5) within the fen mapping study area.

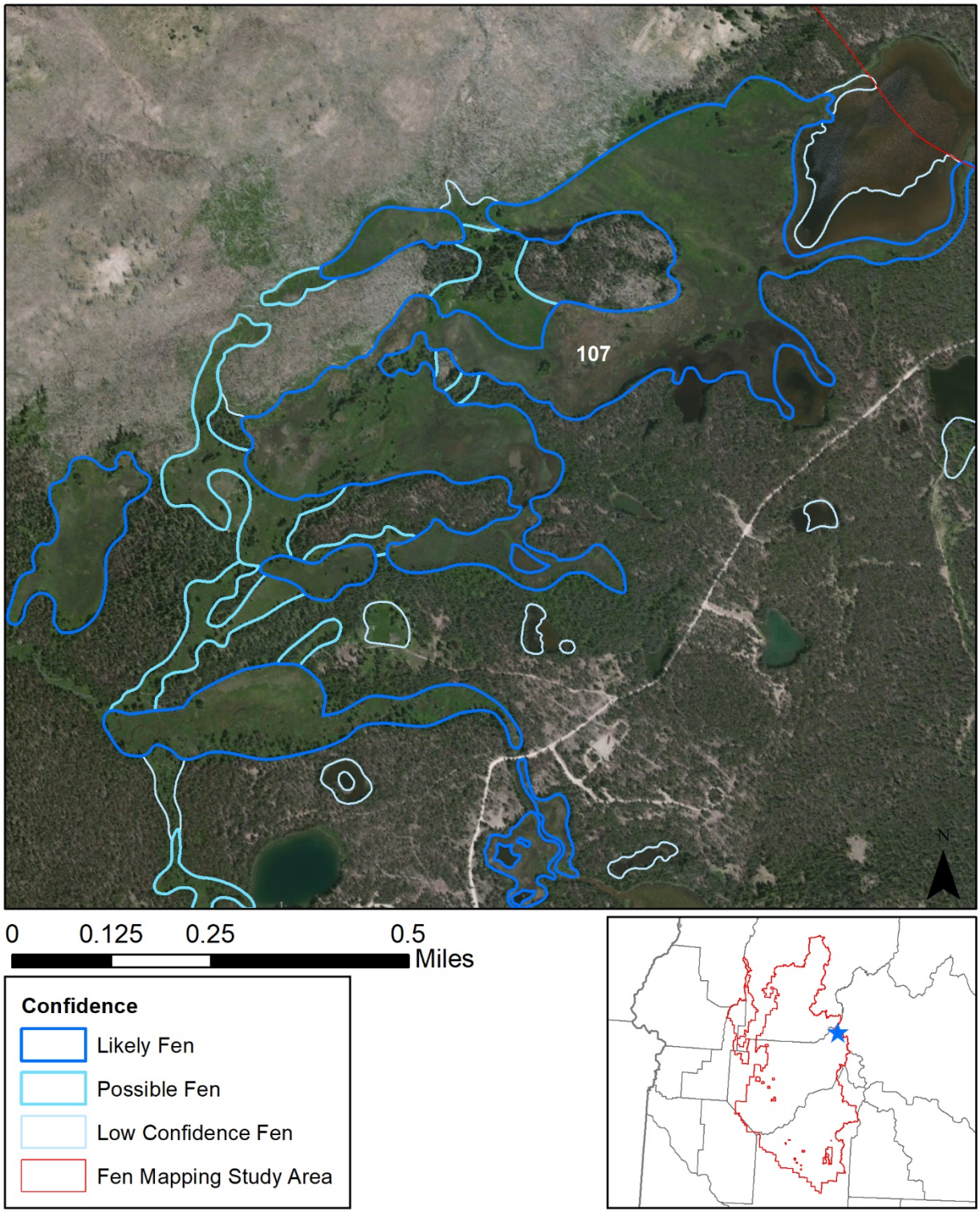

Figure 7. Largest mapped likely fen, 107 acres within one polygon. This fen is located just north of Bull Trout Lake, spanning the Boise and Custer county boundary.

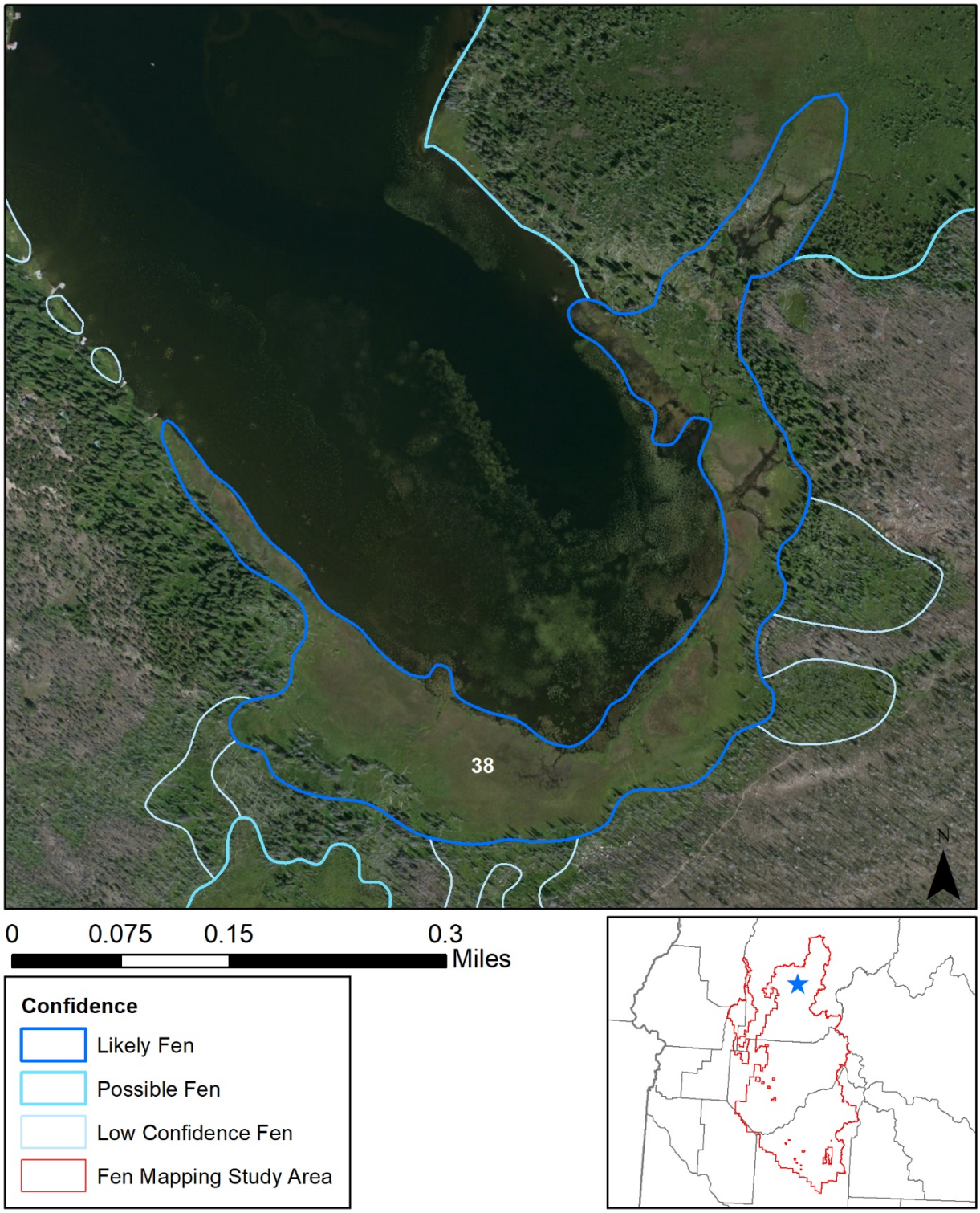

Figure 8. Warm Lake Fen mapped at 38 acres in Valley County, ID. This likely fen is located where Warm Lake Creek flows into Warm Lake.

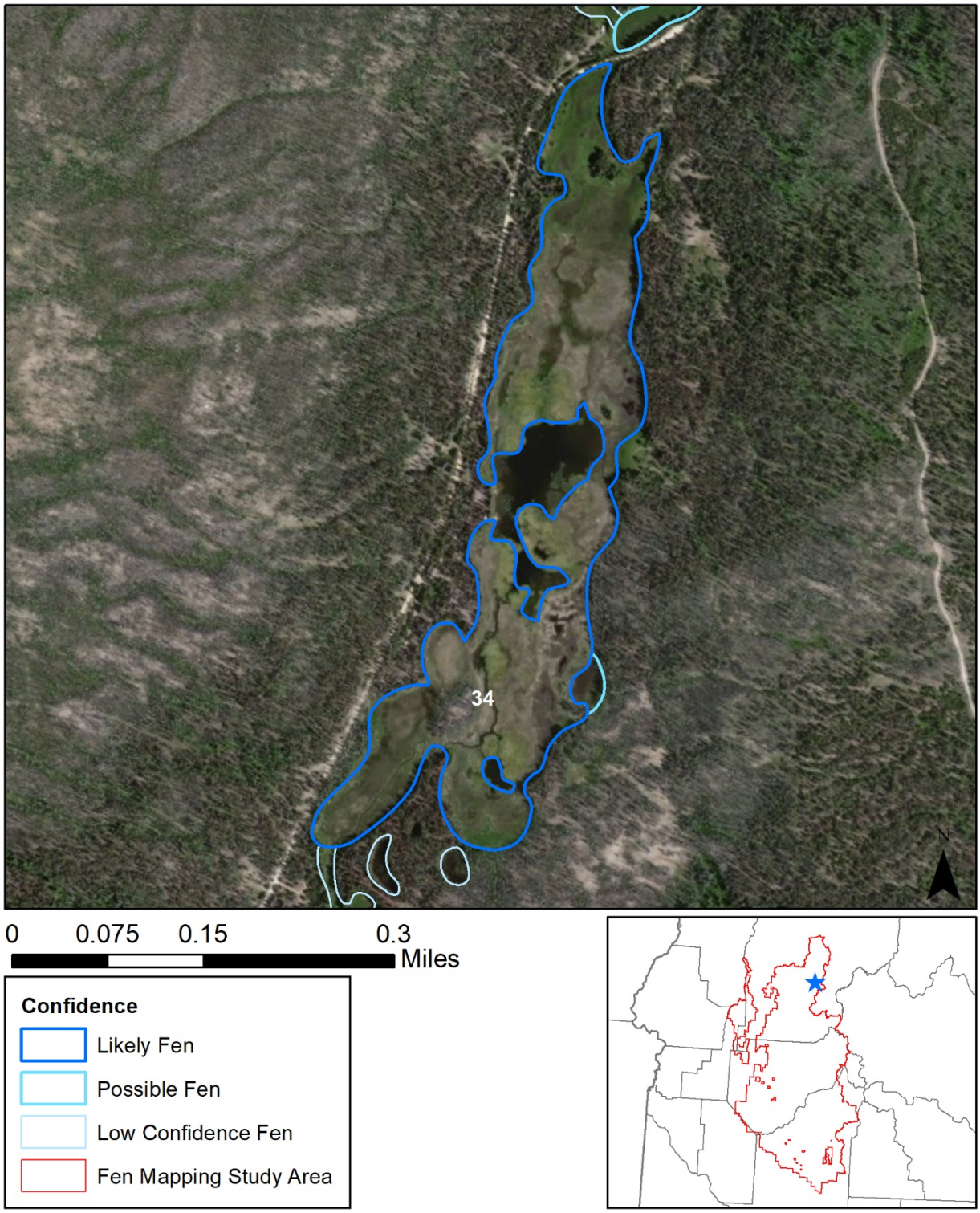

Figure 9: The third largest likely fen surrounds Mud Lake and is located along Burnt Log Road in Valley County, ID. This likely fen is the largest possible floating mat fen identified in this project.

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, 916 polygons (2,198 acres) were mapped between 7,000 and 8,000 feet, which represents 40% of potential fen locations and 27% of potential fen acres (Table 3; Figure 10). Of the 218 total likely fens mapped, 130 polygons (60%) and 441 acres (45%) were located between 7,000 and 8,000 feet (Table 3; Figures 11 through 14). This is one zone of maximum fen formation for the Boise National Forest.

In addition, the elevation band of 6,000 to 7,000 feet also contains many potential and likely fens. Between 6,000 to 7,000 feet, there were 646 mapped potential fens (3,799 acres), which represent 28% of potential fen locations and 47% of potential fen acres. In addition, there were 37 likely fens (376 acres), which represent 17% of likely fen locations and 38% of likely fen acres. The elevation band of 8,000 to 9,000 feet contains 49 likely fens (113 acres) which represent 5% of likely fen locations and 12% 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*
< 4,000	22	22	-	-
> 4,000 – 5,000	149	320	-	-
> 5,000 – 6,000	246	1,252	2	48
> 6,000 – 7,000	646	3,799	37	376
> 7,000 – 8,000	916	2,198	130	441
>8,000	312	501	49	113
Total	**2,291**	**8,091**	**218**	**977**

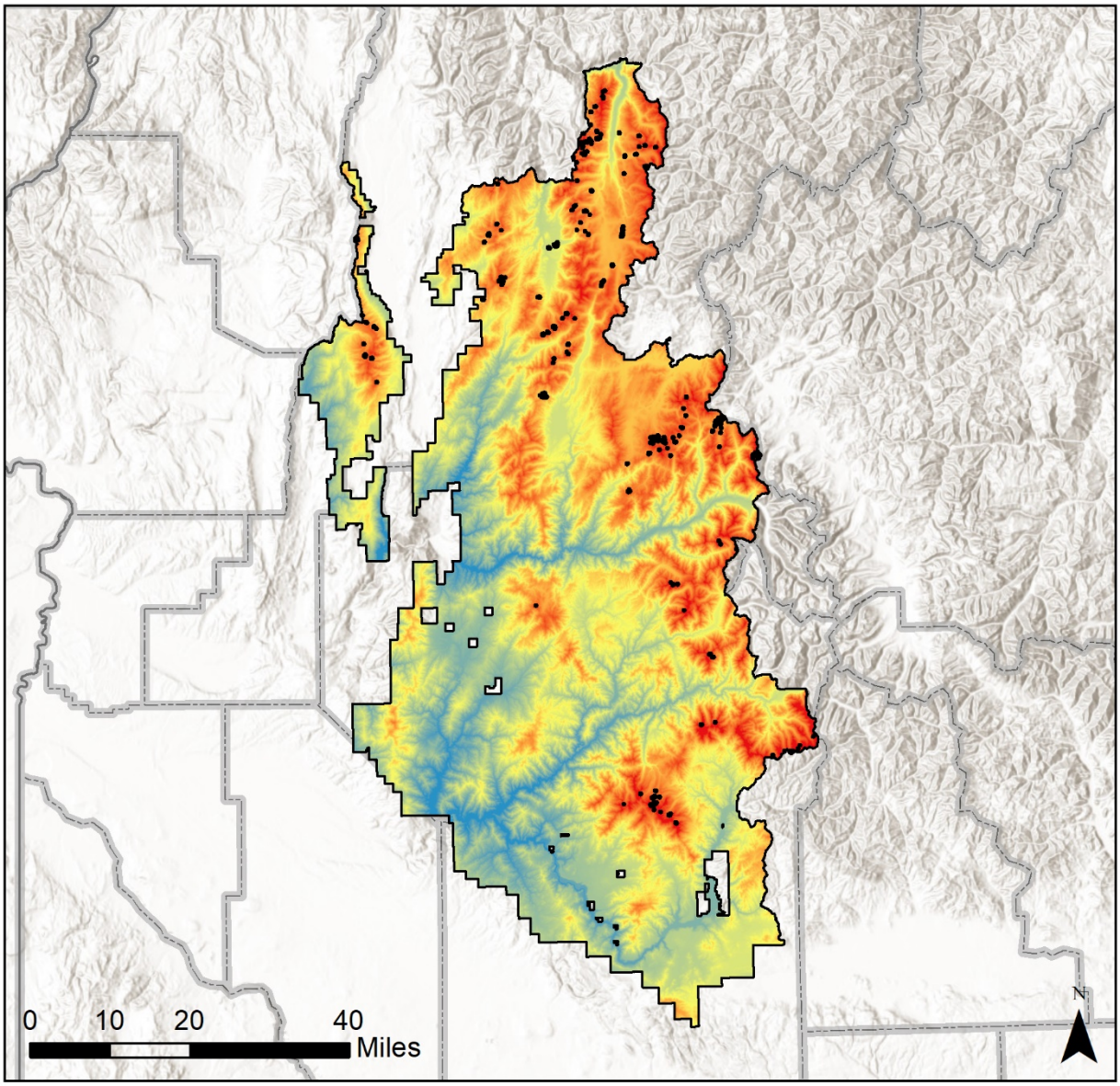

Figure 10: Likely fens (confidence rating = 5) and elevation within the fen mapping study area.

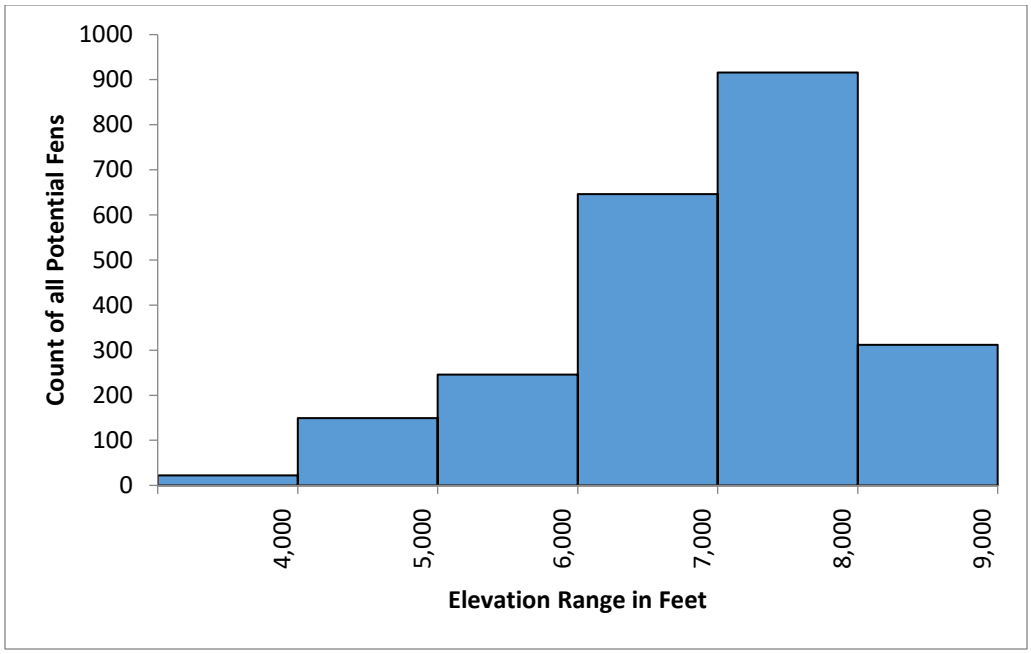

Figure 11. Histogram of all potential fens by elevation within the fen mapping study area.

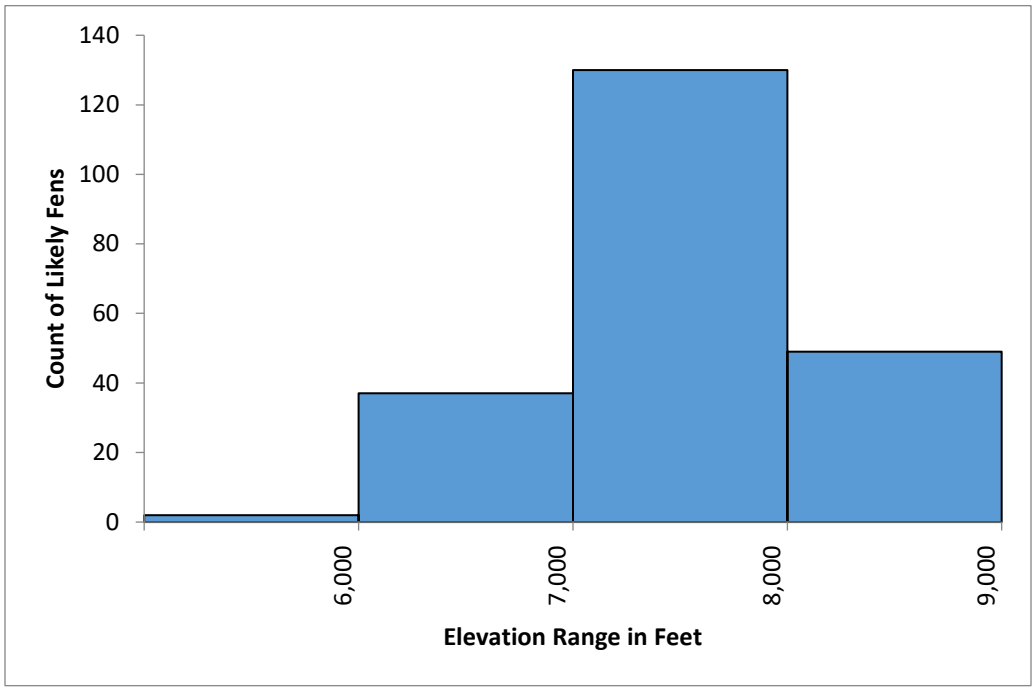

Figure 12. Histogram of the most likely fens by elevation within the fen mapping study area.

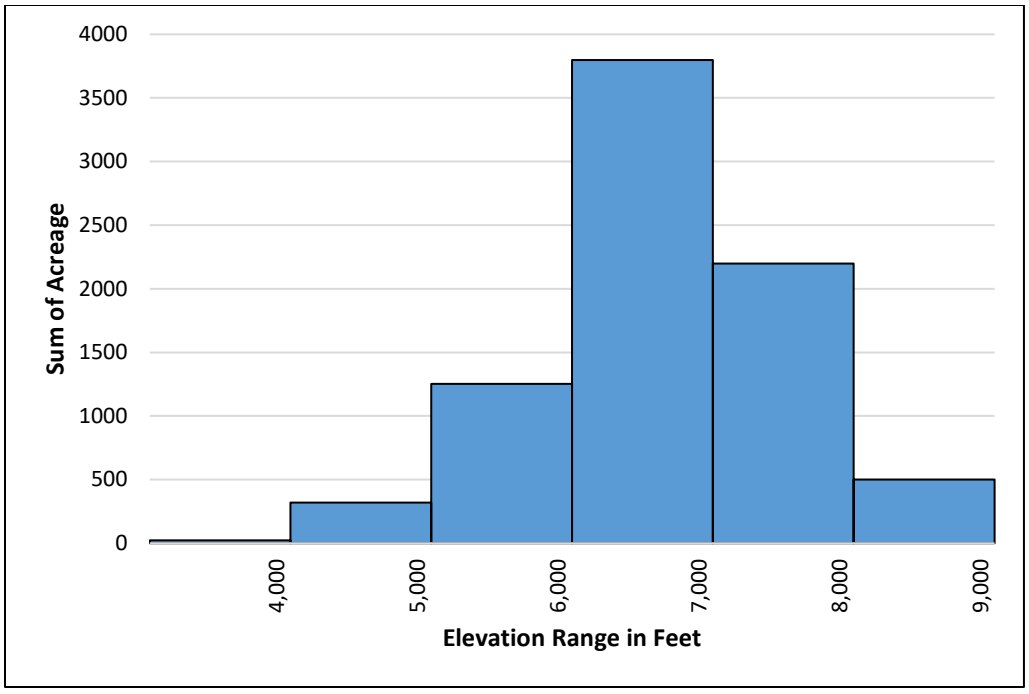

Figure 13. Graph of the sums of potential fen acreage by elevation within the study area.

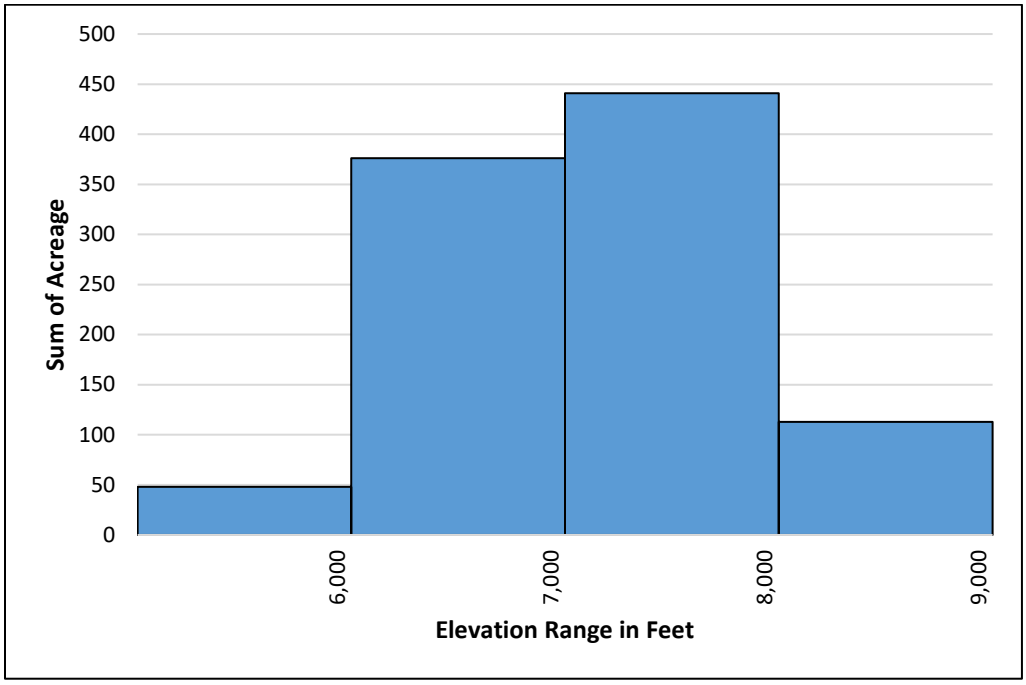

Figure 14. Graph of the sums of likely fen acreage by elevation within the study area.

4.3 Mapped Potential Fens by Geology

The most common geologic substrate under potential fens in Boise National Forest was the volcanic formation granodiorite, which underlies 1,901 mapped potential fens (5,952 acres). The most common geologic substrates under likely fens was also granodiorite, which underlies 189 mapped likely fens (745 acres) (Table 4). Granodiorite is the most common geologic substrate in the Forest, it underlies 86% of the Forest, 83% of all potential fens and 87% of likely fens occurred in these areas. Granodiorite is a volcanic rock formation that along with granite composes most of the Idaho batholith. Till and areas classified as water (pond and lakeshores) underlies most of the remaining likely fen acres, with 13 likely fens and 76 likely fen acres on till (8% of likely acres) and 3 likely fens and 114 likely acres on water (12% of likely acres).

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

Geology	*Acres of Geologic Substrate Within BNF*[1]	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
granodiorite	2,188,892	1901	5,952	189	745
till	50,543	160	803	13	76
alluvium	45,284	69	757	-	-
tholeiite	53,655	34	114	2	1
rhyolite	22,619	27	11	-	-
granitoid	22,834	19	88	3	9
basalt	35,386	18	22	4	5
granite	72,406	18	38	2	5
quartzite	12,723	18	101	1	5
mica schist	1,782	11	44	-	-
water	15,240	8	134	3	114
quartz monzodiorite	5,295	7	27	1	17
tuff	800	1	<1	-	-
		2,291	**8,091**	**218**	**977**

[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 Boise National Forest.

4.4 Mapped Potential Fens by Ecological Subsection

The Bear Valley – Landmark Basin and Uplands Ecological Subsection covers 13% of the Boise National Forest, but this Subsection contains 34% of potential fens (789) and 35% likely fen locations (76). The Middle Fork Payette Canyon and Stream Cut Lands Subsection covers 14% of the Forest and contains 17% of potential fens (381), and 18% of likely fens (39). The South Fork Boise River Uplands Subsection covers 9% of the Forest, yet it contains 196 mapped potential fens (287 acres) and 25 likely fens (66 acres) (Table 5).

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

EcoMap Ecological Subsection Name	*Acres within Boise National Forest*[1]	*# of All Potential Fens*	*All Potential Fen Acres*	*# of Likely Fens*	*Likely Fen Acres*
Bear Valley - Landmark Basin and Uplands	329,044	789	3857	76	342
Middle Fork Payette Canyon and Stream Cut Lands	345,518	381	1668	39	218
South Fork Boise River Uplands	238,609	196	287	25	66
Upper Middle Fork Boise River	241,648	187	312	14	22
Danskin Mountains and Valleys	150,137	126	122	0	0
Monumental Summit Mountains	42,915	90	408	13	63
Sawtooth Range	28,173	87	193	14	24
Long Valley Basin	60,334	85	203	11	29
Long Valley Foothills	46,540	59	150	5	17
Middle and South Forks Boise River	372,971	58	122	2	3
Boise Basin Lands	164,481	52	161	0	0
South Fork Payette and Stream Cut Lands Canyons	199,239	49	104	1	1
Stanley Basin-Sawtooth Valley	3,125	37	285	11	166
Weiser River Valley and Uplands	85,468	22	66	1	15
Fitsum Peak Glaciated Lands	5,157	17	43	1	5
Mt. Bennett Hills-Camas Prairie	19,323	17	23	0	0
Soldier Mountain Foothills	41,865	17	51	0	0
Salmon River Canyonlands	15,156	14	20	5	7
Boise Ridge	129,187	8	16	0	0
		2,291	**8,091**	**218**	**977**

[1] Acres of Ecological Subsections 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 Boise National Forest.

4.5 Mapped Potential Fens by Watershed

An analysis of likely fens in HUC12 (6th-field HU's) watersheds revealed interesting patterns. Three watersheds in particular had significant numbers of likely fens (Figure 13). Ditch Creek – Johnson Creek (HUC12: 170602080104) had 17 likely fens, which covered 0.53% of the landscape in this watershed. Cache Creek – Bear Valley Creek (HUC12: 170602050202) also had 17 likely fens, covering 0.20% of the landscape. Upper Warm Spring Creek (HUC12: 170501200203) had 16 likely fens, representing 0.33% of the landscape. Cape Horn Creek (HUC12: 170602050302) watershed has the highest fen density (0.64%) with 2 likely fens at 112 acres. This watershed is adjacent to Upper Warm Spring Creek watershed, contains the largest mapped likely fen and spans the Forest border. See Appendix A for the full HUC12 watershed and likely fens table.

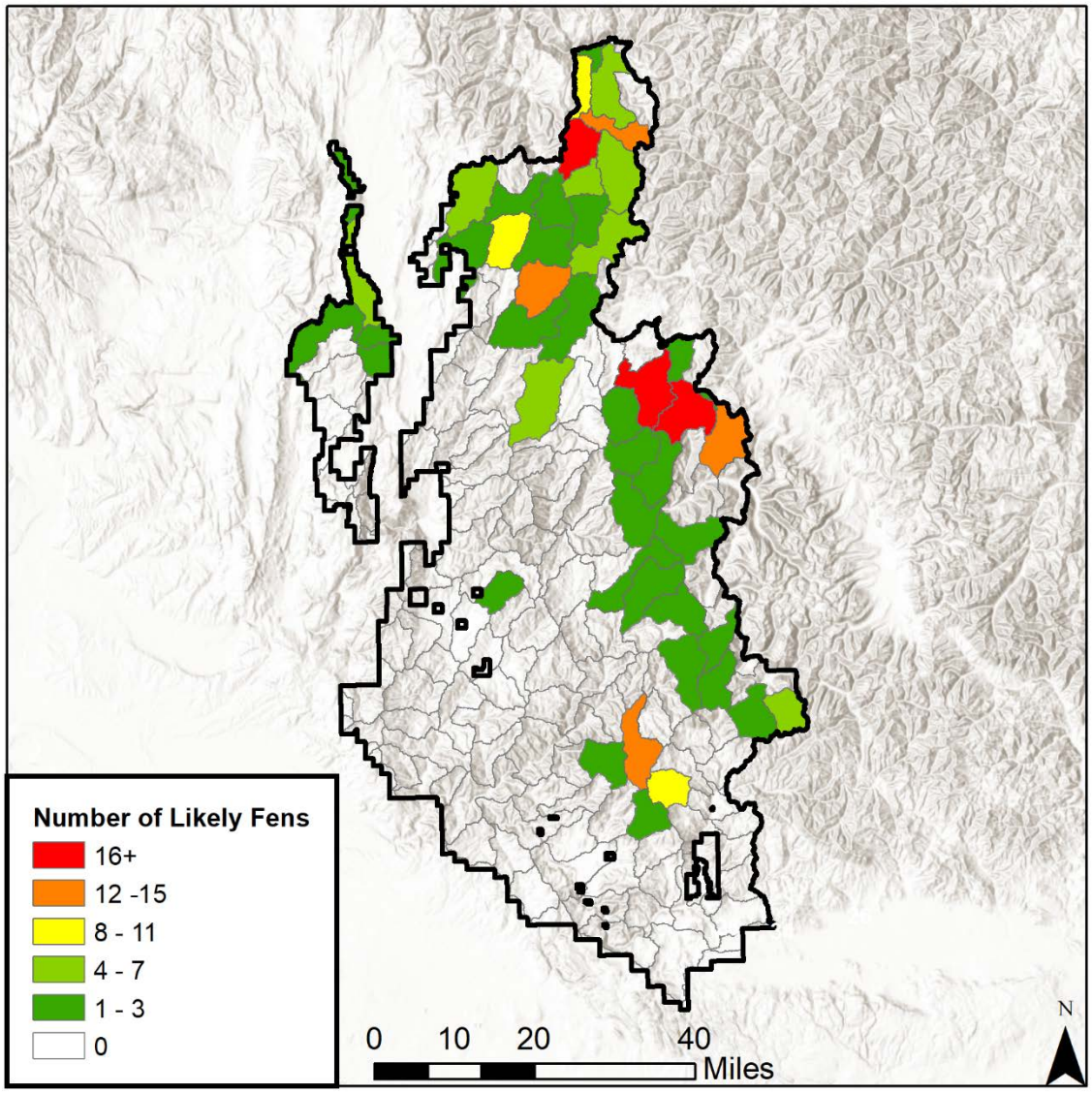

Figure 15. Likely fens by HUC12 watershed within the fen mapping study area.

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 National Forests throughout the intermountain region (Kate Dwire, Research Ecologist at the US Forest Service Rocky Mountain Research Station, *personal communications in 2016*). Nine potential fens (41 acres) and five likely fens (39 acres) were identified as potential floating mat fens. Figure 9 shows Mud Lake Fen which may contain floating mat components. Also see Figure 14 for a likely fen that shows floating mat characteristics (particularly the finger of landmass in the pond) located in Boise County, Idaho.

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 and fifty-six potential fens and one likely fen were observed in proximity to springs. Figure 15 shows a 1 acre likely fen mapped in Elmore County that is located on a spring according to the USGS topographic map.

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. Sixty-two potential fens (451 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	256	348	1	1
Possible Floating Mat	9	41	5	39
Beaver Influence	62	451	--	--
Total	**327**	**840**	**6**	**40**

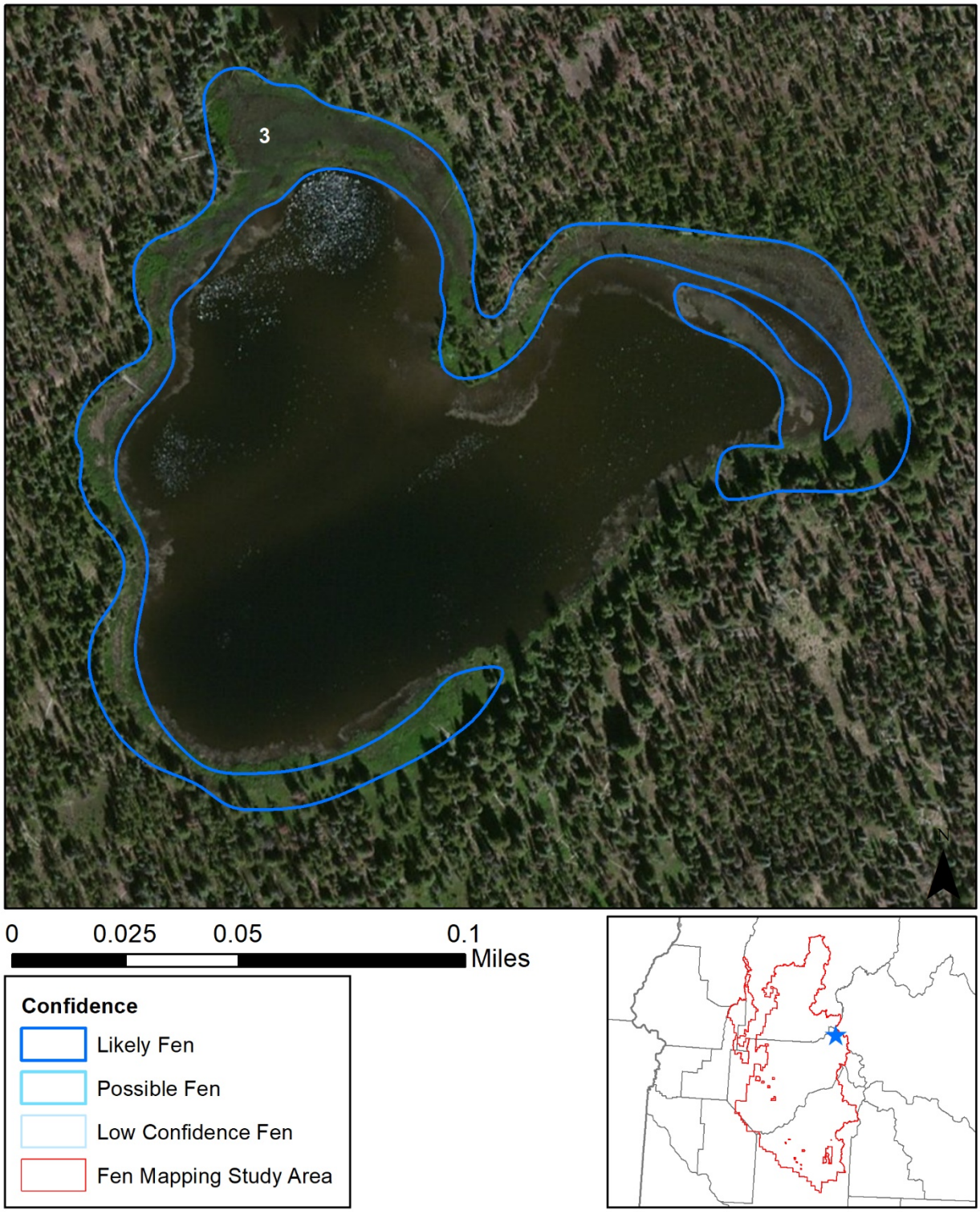

Figure 16: Second largest likely fen with a possible floating mat component located in Boise County, Idaho very close to the northeastern Forest boundary.

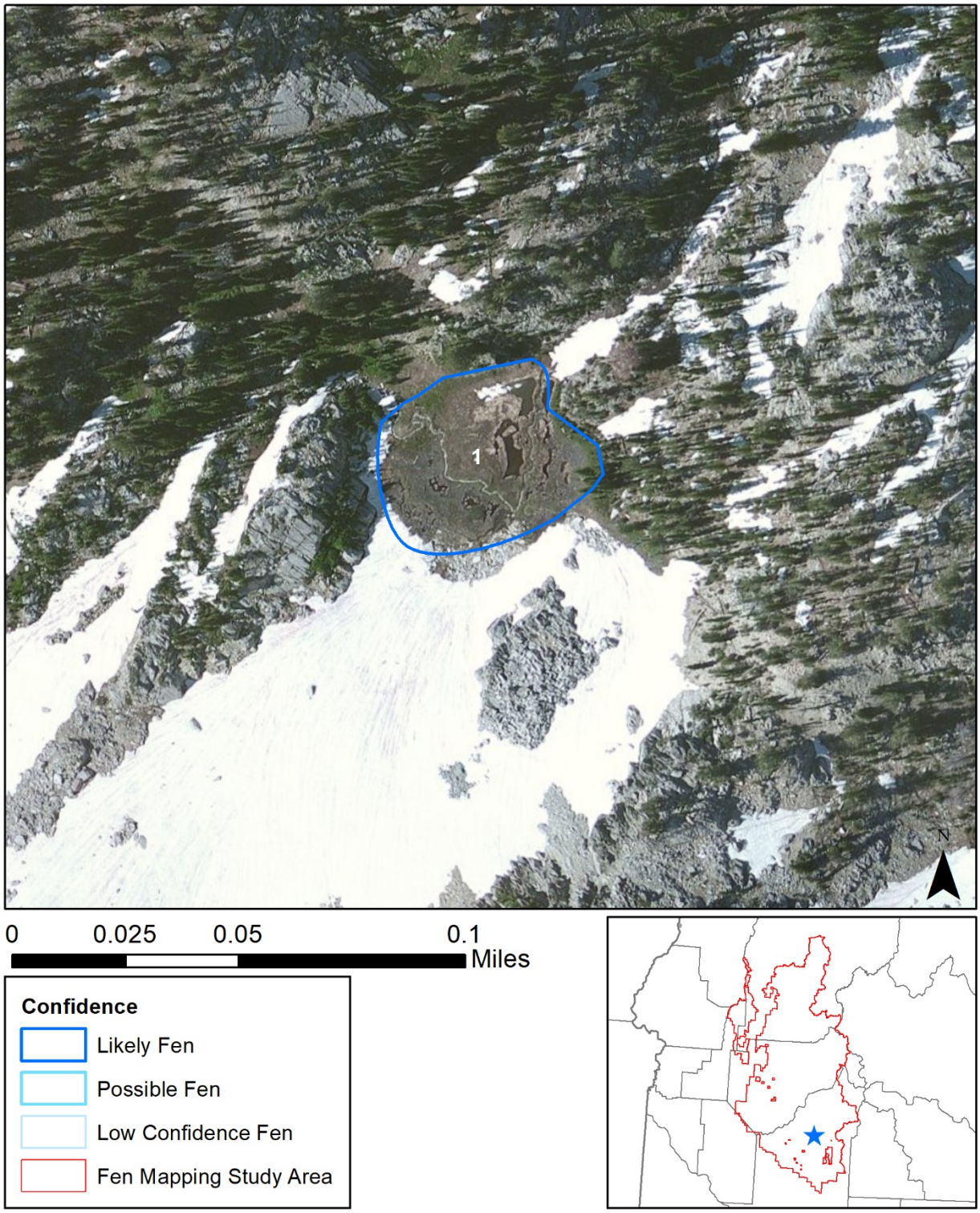

Figure 17: Largest spring influenced likely fen located in Elmore County, Idaho.

5.0 DISCUSSION

The Boise National Forest contains a relatively small number of potential fen wetlands, covering up to 8,091 acres across its jurisdiction. While the potential fen resource represents a very small portion of the entire landscape, these fen wetlands are an irreplaceable resource for the Forest and the citizens of Idaho. 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, 2,291 potential fens were mapped throughout the Boise National Forest, of which only 218 were most likely to be fens. Analysis of the potential fen data showed clear hotspots for fens in the Boise National Forest, particularly the Ditch Creek – Johnson Creek and Upper Warm Spring Creek watersheds. A 2001 survey of peatlands in the Boise National Forest documented the following rare and uncommon plant species: *Carex buxbaumii, Cicuta bulbifera, Scheuchzeria palustris, Rhynchospora alba,* and *Scirpus subterminalis* as well as the following rare and uncommon plant communities: *Scirpus cespitosus*, *Carex limosa, Eleocharis pauciflora,* and Carex *lasiocarpa* (Jankovsky-Jones, 2001). There is a strong elevation pattern found within the mapping, with 60% of likely fens falling between 7,000 and 8,000 feet and nearly all likely fen acres occurring above 6,000 ft.

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 Boise 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 Boise National Forest showed little sign of human disturbance, particularly at higher elevations.

This report and associated dataset provide the Boise National Forest with a critical tool for conservation planning at both a local and Forest-wide scale. These data will be useful for the Boise National Forest assessment required by the 2012 Forest Planning Rule, by being used to prioritize sites for future field surveys on fens.

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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
170602080104	Ditch Creek-Johnson Creek	16,239	17	87	0.53%
170602050202	Cache Creek-Bear Valley Creek	25,389	17	51	0.20%
170501200203	Upper Warm Spring Creek	22,442	16	75	0.33%
170501200202	Canyon Creek	21,732	11	20	0.09%
170501110703	Roaring River	20,398	11	42	0.20%
170602080106	Trapper Creek-Johnson Creek	12,584	11	69	0.54%
170602080401	Headwaters South Fork Salmon River	20,999	11	60	0.29%
170602080402	Curtis Creek	17,476	9	21	0.12%
170501130504	Rainbow Creek-Trinity Creek	13,177	8	15	0.11%
170602080301	Caton Creek	17,784	7	29	0.16%
170501200403	Deadwood Reservoir-Deadwood River	32,276	6	64	0.20%
170501110103	Decker Creek	13,564	6	8	0.06%
170602080105	Burntlog Creek	25,204	6	12	0.05%
170602080108	Porcupine Creek-Johnson Creek	21,529	6	12	0.06%
170501230304	North Fork Gold Fork River	26,234	5	19	0.07%
170501230400	Duck Creek-Cascade Reservoir	55,596	5	11	0.02%
170602080103	Sheep Creek-Johnson Creek	10,403	5	28	0.27%
170602080101	Headwaters Johnson Creek	23,671	4	71	0.30%
170501200205	Tenmile Creek	21,107	3	3	0.02%
170501200301	Upper Clear Creek	16,940	3	8	0.05%
170501200304	Fivemile Creek-South Fork Payette River	23,519	3	9	0.04%
170501200401	Stratton Creek-Deadwood River	27,006	3	13	0.05%
170501210102	Bull Creek	24,269	3	5	0.02%
170501230208	Poison Creek-North Fork Payette River	18,258	3	2	0.01%
170501110401	Taylor Creek-North Fork Boise River	18,275	3	5	0.03%
170501110501	Upper Crooked River	18,447	3	6	0.03%
170602080102	Lunch Creek-Johnson Creek	15,414	3	8	0.06%

170602080404	Warm Lake Creek	15,093	3	41	0.27%
170501220302	Pole Creek-Squaw Creek	30,453	2	17	0.06%
170501230504	Lower Big Creek	19,768	2	4	0.02%
170501110104	Yuba River	17,316	2	2	0.01%
170501110203	Black Warrior Creek	13,003	2	3	0.02%
170602080302	Loosum Creek-East Fork South Fork Salmon River	16,175	2	2	0.01%
170602050201	Headwaters Bear Valley Creek	17,137	2	2	0.01%
170602050302	Cape Horn Creek	17,487	2	112	0.64%
170501200303	Eightmile Creek	18,159	1	1	0.01%
170501230501	Upper Big Creek	26,147	1	3	0.01%
170501230507	Olson Creek-North Fork Payette River	11,978	1	12	0.10%
170501230601	Fawn Creek-North Fork Payette River	17,801	1	2	0.01%
170501110204	Bald Mountain Creek-Middle Fork Boise River	14,622	1	2	0.01%
170501110205	Swanholm Creek-Middle Fork Boise River	21,358	1	2	0.01%
170501110402	Bear River	22,657	1	1	0.00%
170501120102	Smith Creek-Clear Creek	11,667	1	1	0.01%
170501120501	Upper Sheep Creek	16,067	1	1	0.00%
170602080403	Bear Creek-South Fork Salmon River	20,191	1	10	0.05%
170602080406	Six-bit Creek-South Fork Salmon River	15,087	1	1	0.00%
170602050203	Wyoming Creek-Bear Valley Creek	16,503	1	3	0.02%
170501130701	East Fork Fall Creek	13,433	1	3	0.02%