BOTANY INVENTORIES IN SELECT FENS OF THE CARIBOU-TARGHEE AND BRIDGER-TETON NATIONAL FORESTS,
Sublette and Teton Counties, Wyoming

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ABSTRACT

Botany inventories were conducted for the rarest plant species in 16 fen sites of the Bridger-Teton and Caribou-Targhee National Forests. Even though rare plant species typically found in fen habitats were known from these National Forests, almost no fen sites were described as such or surveyed for all potential rare plant species. We used available species' distribution information as a basis to locate fen sites and conduct botany inventories in 16 select areas in the Forests. As a result, 35 population records of 12 rare plant species in fen settings were located or relocated; the 12 species include three rare plant species newly-recognized as fen specialists in Wyoming. This status information is needed to assess species conservation priorities on Bridger-Teton and Caribou-Targhee National Forests, and it has potential bearing on management activities. We also expanded upon floristic inventories data, mapped peatland habitat, sampled fen vegetation, and collected site-level information consistent with the USFS Groundwater Dependent Ecosystems Level 1 Inventory Field Guide. Results provide a reference for special status species review and expanded work.

ACKNOWLEDGEMENTS

The 2018 field surveys were conducted with the able help and expertise of Rose Lehman (Caribou-Targhee National Forest), Martina Keil (Bridger-Teton National Forest) and Michael Mancuso (botany contractor). This study would not have happened if not for the coordination of Rose Lehman and the original support of John Proctor (Intermountain Regional Office). This work reflects on a wealth of information generated by researchers in previous studies at the same sites. Groundwater Dependent Ecosystem (GDE) objectives were added at the encouragement of Gary Beauvais and George Jones (Wyoming Natural Diversity Database; WYNDD). Data entry into the WYNDD-version of a GDE database was made possible by Joy Handley (WYNDD). *Sphagnum* specimen determinations were made by Yelena Kosovich-Anderson. The field accompaniment and site discussions of Kate Olsen (Bridger-Teton National Forest) at Kendall Warm Springs, and the equine expertise of two horse-packing teams (Bridger-Teton National Forest) are greatly appreciated. The use of resources at the Rocky Mountain Herbarium (RM), help of B.E. Nelson, and floristic foundation laid by RM studies are acknowledged with gratitude. Earlier drafts of this report benefited from review by Kate Dwire, Rose Lehman and John Proctor.

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Cover photo: Upper Green River Lakes Fen has a series of marl pools developed within alkaline fen, photo by B. Heidel

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INTRODUCTION

The primary purpose of this project was to survey the rarest fen plant species of the Bridger-Teton and Caribou-Targhee National Forests (NFs), USFS Intermountain Region (Region 4) at prospective fen locations. It represents a baseline upon which to build elsewhere in the two National Forests. Secondary purposes were to document fen plant species diversity, representative fen vegetation, fens as groundwater-dependent ecosystems (GDEs; including water chemistry and hydrology), conduct pilot work on the *Sphagnum* flora, and document the amphibian fauna at the visited sites.

Some fens harbor high concentrations of species recognized as Wyoming plant species of concern (Heidel 2018), several of which are designated as sensitive by the Rocky Mountain Region (U.S. Forest Service Region 2; U.S. Forest Service 2011). These rare fen species may occur together in highly specialized habitat, making collective survey efforts more effective than surveying for them individually. Fen species inventories have been effective in documenting new locations of sensitive fen plants and basic species information on the Bighorn National Forest (Heidel 2011), Medicine Bow National Forest (Heidel and Jones 2006, Heidel et al. 2013), and the Shoshone National Forest (Heidel et al. 2017). The current project was designed to survey the rarest fen plant species at prospective fen sites[1].

The first fen research conducted in the state of Wyoming was in the Bridger-Teton NF (Cooper and Andrus 1994). Some of the first rare vascular plant records documented from fens in the Bridger-Teton NF were incidental to Special Interest Area documentation (Fertig 1995) at Kendall Warm Springs. The Bridger-Teton NF supported the first and only targeted survey for a rare fen species in the USFS Intermountain Region (R4), *Primula egaliksensis* (Greenland primrose; Fertig 1996). A flurry of newer rare plant records of vascular fen species was documented on the Caribou-Targhee NF incidental to broad floristic inventory objectives (Kesonie 2009, Kesonie et al. 2011). These inventories and others produced a tantalizing number of rare species records, though few in number for any given species. This project benefited greatly from previous work, integrating results into a broader and more cohesive picture of baseline fen resource inventories.

This project also provides information to the National Forests and the USFS Groundwater Program regarding groundwater resources and characteristics of valued groundwater dependent ecosystems (https://www.fs.fed.us/science-technology/geology/groundwater). The addition of objectives to document Groundwater Dependent Ecosystem (GDE) features expanded the scope of work and hopefully, the utility of results.

BACKGROUND INFORMATION ON FEN HABITAT

Peatlands are defined by three criteria: peatland soils comprised of undecayed plant material (histosols), peat depth/thickness (minimum of 40 cm [15 in] continuous profile; USDA

[1] The term "site" is used in this report to refer to geographically discrete places that have hydrological separation. Most are discrete basins around lakes and ponds. Some in the Bridger-Teton National Forest are in riparian settings. Use of the term parallels that in the GDE Manual except that our work did not inventory all palustrine vegetation, only that with peat formation. The term "study area" as used in this report refers to clusters of peatland sites in close proximity. There were two study areas, one on each National Forest, plus isolated sites.

Soil Conservation Service 1992), and characteristic vegetation made up of hydrophytes (Lichvar et al. 2016). Peat accumulates under anaerobic and stable hydrological conditions that keep soils saturated at or near the surface. Peat accumulates at very low rates so fens are essentially irreplaceable ecosystems.

At boreal and subarctic latitudes, as in Alaska and northern Canada, peat can accumulate under incipient precipitation levels where climate conditions include cool annual temperatures, humid climates, and short growing seasons; allowing organic matter to accumulate faster than it can be decomposed. At temperate latitudes, including the Rocky Mountains of the United States, stable groundwater conditions are necessary to maintain peat accumulation, counteracting moderate annual temperatures and aridity during the growing season. Peatlands that are supported mainly by groundwater rather than precipitation are fens, whereas peatlands that are supported mainly by precipitation are bogs. The latter term has been used in a colloquial reference to fens, a source of confusion. Fens generally have higher pH values and are richer in nutrients than bogs because supporting groundwater frequently contains dissolved ions, derived from substrates and soils through which it flows. Fens form in basin, riverine, hillslope, and other settings (Chadde et al. 1998, Weixelman and Cooper 2009, Rydin and Jeglum 2013). The term "fen" as used in this report refers implicitly to a discrete wetland site that meets all soil, peat depth and vegetation characteristics of a groundwater-fed peatland.

The photograph on the cover of this report provides an example of the challenges of identifying and confirming fen habitat. Ground level views do not necessarily provide a basis for distinguishing this marl pool from any muddy swale, and its graminoid fen vegetation from that occurring in wet meadows with mineral soils. The belowground peat profile is out of view, the hydrology and water chemistry are indiscernible at a glance, the high graminoid cover has little detail unless one discerns flowering indicator species. This fen, the Upper Green River Lakes Fen, has not been called a fen in any prior written information. However, it hosts a fen obligate plant species, *Primula egaliksensis* (Greenland primrose) known from only one other place in Wyoming, Swamp Lake Fen, the largest known fen in the state, and this other fen meets all NRCS fen criteria.

Some fens support a disproportionately high number of rare plant species and uncommon vegetation types due to their environmental conditions. In the Rocky Mountains of the United States, fen floras and vegetation can consist of many vascular plant species and bryophytes that are more typical of boreal regions of Alaska and Canada and that are otherwise absent from wetland habitats in surrounding areas. Many fen plants are considered disjunct from the core of their center of distribution, and sparse in the cordilleran landscape. Fens of the United States have received attention because of their unique floras and vegetation (highlighted for the northern Rocky Mountains in Chadde et al. 1998), paleoecological records, and ecosystem services (Bedford and Goodwin 2003). More detailed documentation of fen functional attributes and biodiversity are presented by Bedford and Goodwin (2003), Chadde et al. (1998), and Heidel et al. (2017).

TARGET SPECIES

Over 40 plant species that are found in fens have been characterized as rare in Wyoming and tracked as species of concern by the Wyoming Natural Diversity Database (past or present) (Heidel 2006). Over 20 of these species have been documented from the Bridger-Teton and Caribou Targhee NFs in a compilation prepared for this study from WYNDD datasets. This project focused on the rarest species, i.e., the 12 vascular plant species that are currently tracked or watch in Wyoming (Table 1), and treated their known locations on the National Forests as targets for intensive inventory. Wyoming does not have a bryophyte species of concern list, but the species *Meesia triquetra* is described in the literature as a fen obligate(Vitt 2014), was first found in Wyoming at Swamp Lake Fen, and is included in the target list.

Table 1. Rare fen species known from Region 4 National Forests before 2018

Scientific Name	Common Name	Grank/ Srank	No. BTNF records	BTNF Locations	No. CTNF records	CTNF Locations
Carex concinna	Low northern sedge	G5/S1	1	Upper Green R Lk	0	-
Carex microglochin var. microglochin	Fewseeded bog sedge	G5?/S2	1	Kendall Wm Spr	0	-
Drosera anglica	English sundew	G5/S3	0	-	3	Loon Lake, Fish Lake, Tillery Lake
Eriophorum gracile	Slender cottongrass	G5/S3	1	Buffalo R	2	Loon Lk, Tillery Lk
Lycopus uniflorus	Northern bugleweed	G5/S1	0	-	1	Loon Lk
Meesia triquetra	Three-ranked humpmoss	[in rev.]	1	Barnes Lk area	0	-
Potamogeton amplifolius	Largeleaf pondweed	G5/ S1S2	1	New Fk Lk	0	-
Primula egaliksensis	Greenland primrose	G4/S1	1	Upper Green R Lk	0	-
Salix candida	Sageleaf willow	G5/ S2	1	Kendall Wm Spr	0	-
Scheuchzeria palustris	Rannoch-rush	G5/S1	0	-	1	Rock Lk area
Trichophorum pumilum	Rolland's bulrush	G5/S1	1	Alkali Cr	0	-
Utricularia intermedia	Flatleaf bladderwort	G5/S1	1	Gros Ventre Canyon	0	-
Utricularia minor	Lesser bladderwort	G5/S3	0	-	1	Loon Lk

Most of the target species locations on these two National Forests were discovered in recent decades. However, the sensitive plant species list of the Intermountain Region (Region 4) was last updated regionwide in 1993 and not updated for the four Region 4 National Forests in Wyoming since that time. The Region 4 sensitive plant list includes almost no fen species. Several rare plant species present in fens of Region 4 are recognized as sensitive by the USFS Rocky Mountain Region (Region 2) and USFS Northern Region (Region 1). Meanwhile, the Region 4 sensitive species list is undergoing review and, in a policy change, will be replaced by "Species of Concern" that are designated on a Forest-by-Forest basis.

The species compiled in Table 1 had not been studied in Region 4 within Wyoming except for a survey report on *Primula egaliksensis* (Fertig 1996). Two of the 12 vascular species (Table 1) were first-time additions to the Caribou-Targhee National Forest when documented by the author in a 2015 fieldtrip to Loon Lake. A peatland thesis conducted in adjoining Yellowstone National Park focused on vegetation and addressed many of the species in Table 1 in the course of vegetation sampling (Lemly 2007, Lemly and Cooper 2011). The proximal National Park data and the relative paucity of fen floristics data from the two National Forests placed a premium on pinpointing the habitat supporting rare species.

In order to locate prospective fen sites, this study also compiled data on species previously tracked by Wyoming Natural Diversity Database that have been found in fens. In some cases, the species might be rare in Region 4 as a whole. These rare species were formerly tracked or watch[2], and include: *Carex buxbaumii* (Buxbaum's sedge), *Carex echinata* (Star sedge), *Carex leptalea* (Bristlystalk sedge), *Carex limosa* (Mud sedge), *Comarum palustre* (Marsh cinquefoil), *Epilobium palustre* var. *palustre* (Swamp willow-herb), *Juncus filiformis* (Threadleaf rush), *Sparganium natans* (Small bur-reed), *Symphyotrichum welshii* (redetermination of *Symphyotrichum boreale*; Welsh's aster rather than Northern bog aster), and *Thalictrum alpinum* (Alpine meadow-rue).

STUDY AREAS

Two areas were targeted in the Bridger-Teton (BTNF) and in the Caribou-Targhee (CTNF) National Forests (Figure 1). They were selected from available species' distribution information based on the literature and rare plant species records in the WYNDD database (Table 1).

- Barnes Lake area is in the Wind River Range (BTNF; in Bridger Wilderness Area of the Wind River Range). It is located in the in Falls Creek and Upper Pole Creek watersheds.
- Winegar Hole area is located s between the Yellowstone Plateau and the Teton Range (CTNF; both in and outside of Winegar Hole Wilderness Area). It straddles subtle divides between Boone Creek, Calf Creek-Fall River, and Upper Fall River-Winegar Creek watersheds.

Select sites for comparison outside these study areas were included on both National Forests.

[2] Plants and animals are considered for inclusion on the **Species of Concern List** (also known as tracked species) if they are vulnerable to extirpation at the global or state level due to:

- their rarity (e.g., restricted distribution, small population size, low population density)
- inherent vulnerability (e.g., specialized habitat requirements, restrictive life history)
- threats (e.g., significant loss of habitat, sensitivity to disturbances)

Additionally, our **Species of Potential Concern List** (SOPC, also known as watch species) includes species that appear to be secure at present, but because they have limited distribution as regional or state endemics they could become vulnerable under large-scale changes. Species with this status warrant periodic checks.

- Kendall Warm Springs is in the Kendall Warm Springs Special Interest Area (SIA); (BTNF)
- Upper Green River Lakes is upstream of Kendall Warm Springs (BTNF) Tillery Lake area (CTNF)

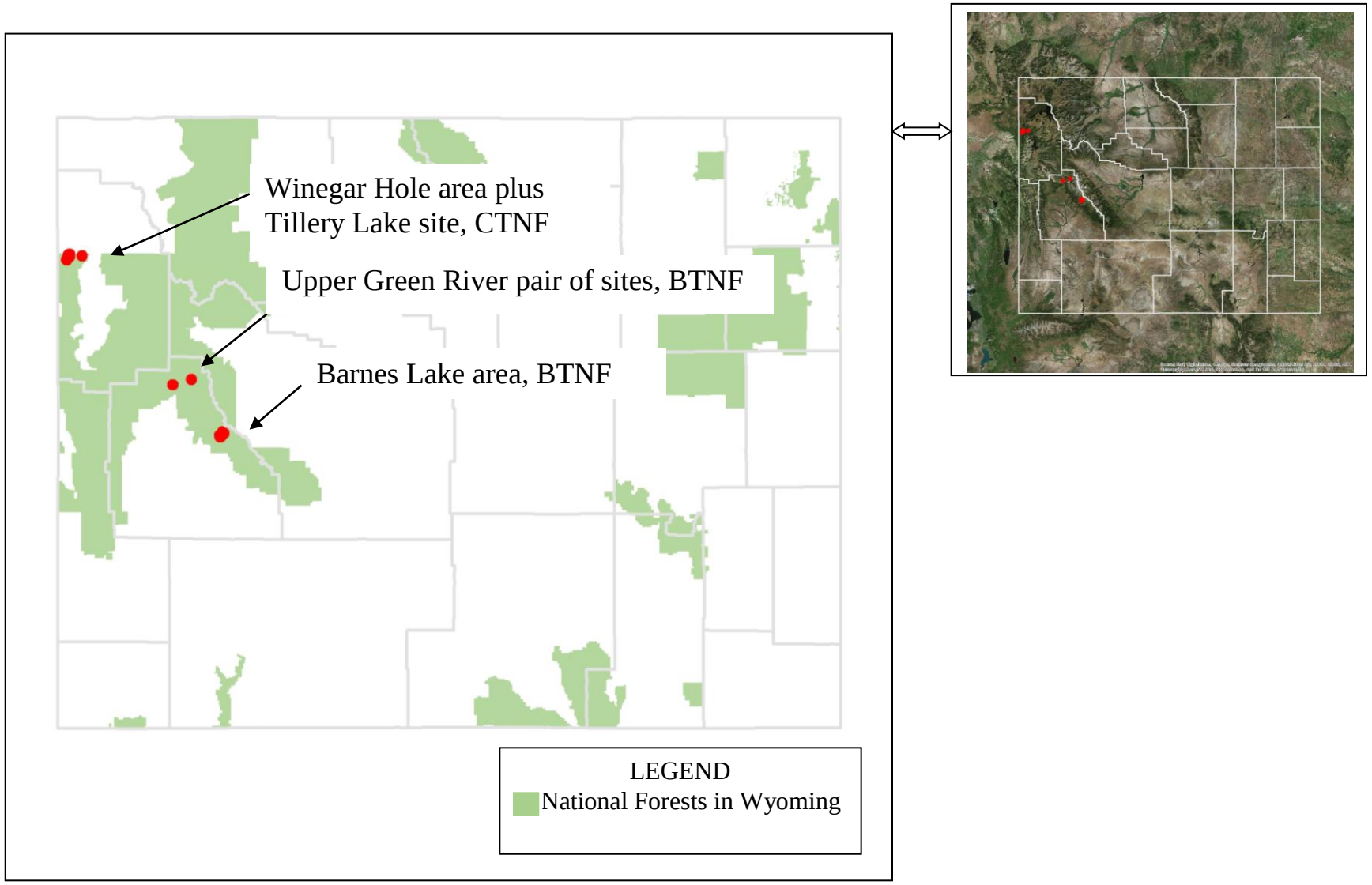
The Barnes Lake area is located near the middle of the Wind River Range, with metamorphic bedrock derived from deep Precambrian crust, part of a giant thrust fault that arose 55-60 million years ago (Lageson and Spearing 1988). There have been three documented glaciations in the Wind River Range, but outcrops of ancient (plutonic) metamorphic bedrock prevail across much of the surface with deeply-fractured, pillowed contours, and with glacial deposits limited to low-lying valleys and bedrock fractures. Study site elevations visited in the Barnes Lake area range from 9640-10,120 ft. The other two Bridger-Teton NF study sites are in foothills of the Wind River Range in the Green River valley, where the valley bottom is mapped as Quaternary alluvium, and the two sites range in elevation from 7860-8000 ft.

The Winegar Hole area, in the Caribou-Targhee NF, is a much lower area of many kettle lakes between the Yellowstone Plateau and the Teton Range. It has extrusive igneous basalt flows (Love and Christianson 1985), but the lakes are in extensive areas of local alluvium derived from glacial till, loess and ash (USDA Forest Service 1999). Outcrop cliffs border a couple of the fen sites, comprised of Huckleberry Ridge Tuff of the Yellowstone Group. Despite the scattered promontories across the landscape, base elevations of the Winegar Hole-area fen sites vary little, ranging from 6440-6450 ft. The outlying Caribou-Targhee NF site at Tillery Lake lies at the toe of the Teton Range in an area of glacial deposits, at 7140 ft.

The 16 study sites are referred to by their place names on the U.S.G.S. Topographic Maps (7.5'), with the exception of the Barnes Lake area wetlands. For these, we used the identifiers assigned by Cooper and Andrus (1994; as represented with cartographic accuracy in Figure 1 of their publication) assigning each a code that included "WR" (Wind River) and number. In cases where their identifiers referred to more than one discrete wetland, a geographic modifier was added, to distinguish between wetlands. In both the Barnes Lake area and Winegar Hole areas, sites were added opportunistically while traveling to the targeted sites. They included Moose Lake, WR3 add-on and WR5 add-on.

The study areas are located within landscapes having state-significant wetland density, as assessed by Copeland et al. (2010). Priority was placed on intensive, targeted site work to produce the most complete botany inventory results for a specific wetland rather than pursue a broad landscape approach covering all local wetlands. The intensive site work and targeted species inventory differs from the broad vegetation gradient sampling objectives of Cooper and Andrus (1994). Among the 17 Barnes Lake areas in Cooper and Andrus (1994), we targeted a subset having what the authors referred to as "peatland expanse" vegetation.

Figure 1. Bridger-Teton and Caribou-Targhee 2018 study areas and isolated sites



METHODS

The 2018 fieldwork was conducted between 23-31 July on Bridger-Teton National Forest, most of which was conducted by a two-person team (Martina Keil, Bonnie Heidel) and from 27-31 August conducted by a two- or three-person team (Rose Lehman, Bonnie Heidel, Michael Mancuso).

Digital orthophotographs of potential survey sites (from Table 1) were carried into the field to use in groundtruthing rare plant habitat based on digital color imagery (World Imagery). Nearby wetland sites were considered if there were orthophotographs and time. Rare plant data was collected on the Element Occurrence Form, used by USFS Region 4 (Appendix A). Waypoints were recorded for mapping the rare plant population as a point or polygon, photographs were taken, and specimens were collected if population numbers were adequate. The extent of potential rare plant habitat, corresponding to potential peatland habitat, was traversed at each wetland and waypoints were recorded to delimit peatland extent. A soil auger was used to sample soils and determine peat depth. Peat thickness exceeded probe length in all cases except where suspended above the water column or one same site with interbedded organic and mineral layers.

The Rocky Mountain Herbarium (RM) online specimen database was searched to prepare initial checklists of the plants already collected from each site using both polygonal searches, and place name searches. Checklists were carried into the field so as to add to rather than repeat floristic documentation. The Kendall Warm Springs SIA had a thorough checklist (Fertig 1995); the Barnes Lake area also had a lengthy list prepared for the general area including both vascular species and bryophytes (Cooper and Andrus 1994). When collections were made, each specimen had information on species' location and habitat recorded in the field for later use in preparing collection labels.

Representative fen vegetation was sampled in a central area of relatively homogeneous vegetation within a transect belt of 5 m^2 using a Region 4 vegetation sampling form (Appendix B). The sample area was set without acquiring instructions to go with it. Waypoints were collected at the origin of the transect belt. Measurements of pH and electrical conductivity were measured with a Hanna pH/Conductivity meter (H98129) calibrated daily to pH 7 and compared to pH 4 calibration at a subset of locations (how were locations chosen? Using criteria in the GDE protocol. A set of three photographs were usually taken, looking the length of the transect in both landscape and portrait composition, and then looking vertically down into the first 1 x 1 m cell. A whiteboard with the sample identifier was included in each photo. Samples were identified using a code that included National Forest (BT for Bridger-Teton and CT for Caribou-Targhee National Forests), the study area, and was followed by a serial pair of digits assigned in the sequence that samples were collected within the BT and CT sample sets. Vegetation sampling was conducted on hands-and-knees for completeness.

Site-level information was collected according to the Groundwater-Dependent Ecosystems: Level 1 Inventory Field Guide (USDA Forest Service 2012) on modified forms

(Appendix C; Jones 2016). The modified forms included fields to record information on the following eight components.

- Survey information and GDE setting information
- Photo list also cross-referencing the reference GDE photos, rare plant photos, vegetation photos, amphibian photos
- Floristic list also cross-referencing rare plant forms, specimen collections, and each species that were in vegetation sampling
- Soil, water table and water conditions
- Vegetation composition (less detailed than the vegetation form)
- A specific pair of photos including the peatland landscape on the ground, and the peatland extent as digitized onto orthophoto
- Disturbance notes
- Amphibian records, where present

The peatland extent was georeferenced by collection of waypoints. The GDE extent at most sites was larger than the area occupied by peatland vegetation. The peat depth at all sites exceeded the 70-80 cm length of the sampling device except for a lesser peat thickness at Kendall Warm Springs. GDE boundaries of Bridger-Teton NF sites were delimited by Martina Keil. On the Caribou-Targhee NF, all peatland habitat bordered lakes where the GDE boundary corresponds to mapped National Wetland Inventory boundaries, though some also had perennial streamflow inlets.

We did not document bryophytes in the Bridger-Teton National Forest. The Barnes Lake study area had robust bryophyte documentation by Richard Andrus (Cooper and Andrus 1994). We collected species of *Sphagnum* in the Caribou-Targhee National Forest where *Sphagnum* species were dominant during vegetation sampling. Specimens of *Sphagnum* were sent to Yelena Kosovich-Anderson for identification.

Amphibian observations were recorded on a modified GDE Amphibian Form. All boreal chorus frog records were based on vocalizations with a few visual observations. Only the Columbia spotted frog record included a photograph.

All unidentified vascular plant specimens were identified and collection labels prepared for submittal to the Rocky Mountain Herbarium (RM) where they will be databased and scanned. All tracked and watch plant records and amphibian records were entered into the WYNDD database. All GDE records were entered into a WYNDD ACCESS database for conveyance to the forests, R4 staff, and SpringsOnline (http://springstewardshipinstitute.org) as represented in Appendix D. All photos were compiled, culled and cross-referenced to subject (species, vegetation, GDE reference), and to site as submitted with report copies. All waypoints were attributed and linked to the above databases, to map rare plant populations, vegetation samples, GDE reference points, and peatland extent – rare plant records and photo files are also submitted with report copies.

RESULTS - Rare Plants

Sixteen fen sites were surveyed, documenting 12 rare vascular fen plant species at 11 of the 16 fen locations (Table 2). Nine of the rare fen plant species are listed as tracked or watch target species in Table 1, and they include three additional tracked species now recognized to be associated with fen habitat in Wyoming as a result of this project. Of the rare plant records, 21 were new records from places where they were not previously known and 14 were revisits to known populations to acquire current, detailed information. Two of the prior rare plant records were not relocated, *Cicuta bulbifera* and *Drosera anglica*, both at Tillery Lake.

Table 2. Rare plant species records documented in 2018[3]

Scientific /Common Name	New	Revisit	BTNF Fen Locations	CTNF Fen Locations
Carex microglochin Fewseeded bog sedge	0	1	Kendall Wm Spr.	-
Cicuta bulbifera Bulbet-bearing water hemlock	2	0	-	Fish Lk, Moose Lk [Failed to find: Tillery Lk]
Drosera anglica English sundew	1	4	-	Fish Lake, Junco Lk, Loon Lk, Moose Lk, Rock Lk [Failed to find: Tillery Lk]
Eriophorum gracile Slender cottongrass	1	2	-	Loon Lk, Moose Lk, Tillery Lk
Lycopodiella inundatum Inundated clubmoss	1	0	-	Moose Lk
Lycopus uniflorus Northern bugleweed	4	1	-	Fish Lk, Junco Lk, Loon Lk, Rock Lk, Moose Lk
Primula egaliksensis Greenland primrose	0	1	Upper Green R Lk area	-
Salix candida Sageleaf willow	0	1	Kendall Wm Spr.	-
Scheuchzeria palustris Rannoch-rush	2	3	-	Fish Lk, Junco Lk, Loon Lk, Moose Lk, Rock Lk
Selaginella selaginoides Northern spikemoss	1	0	Upper Green R Lk area	-
Trichophorum pumilum Rolland's bulrush	2	0	Upper Green R Lk area, Kendall Wm Spr	-
Utricularia minor Lesser bladderwort	7	1	Kendall Wm Spr, Barnes Lk area (WR3, WR5, WR10)	Fish Lk, Loon Lk, Moose Lk, Tillery Lk
TOTAL	21	14		

[3] Highlighted species rows are species additions to the target list (Table 1); *Cicuta bulbifera* and *Selaginella selaginoides* have not been reported previously in fen habitat of Wyoming; *Lycopodiella inundatum* was not previously known from Wyoming).

Moose Lake had the highest number of rare species, with seven rare species. One of the Moose Lake rare species (*Lycopodiella inundata*) was not previously known from the state and another (*Cicuta bulbifera*) had not been attributed to fen habitat (Table 2). At Moose Lake and other Winegar Hole study sites, *Lycopus uniflorus* was ubiquitous in all peatland zones and occurred in such high abundance that it may no longer be appropriate to track as a Wyoming Species of Concern.

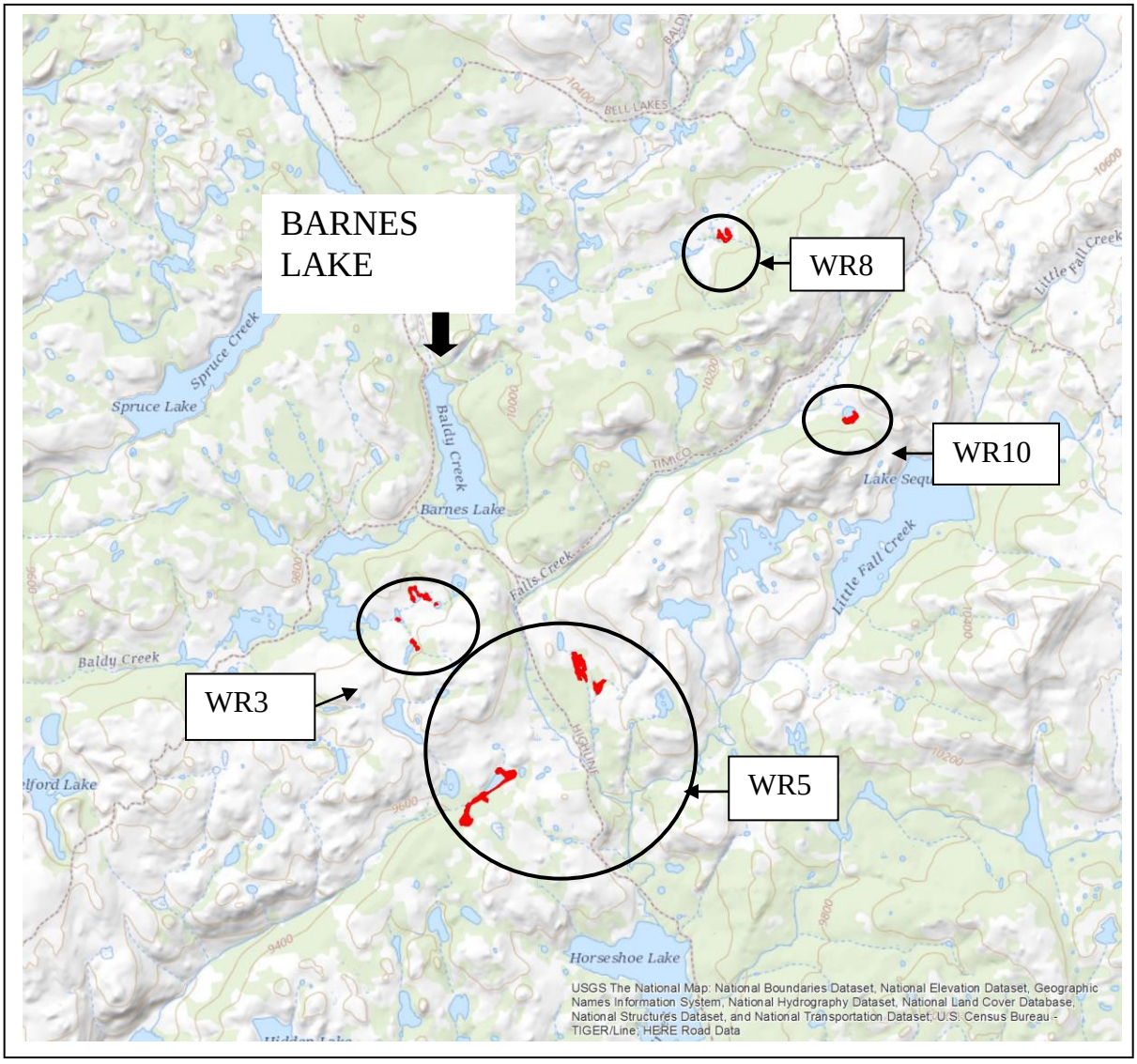
Maps of rare plant species distributions were prepared as points or polygons from waypoints collected in the field. All rare species distributions were nested with mapping of peatland extent, also digitized from waypoints after the field season. The peatland extents are presented as study area overview maps in Figure 2, and in greater detail with GDE records in Appendix D.

Following the maps of Figure 2 is a table of data collected at each of the 16 study sites (Table 3), and it cross-references rare plant species results. Most of the rare plant species occupied only a fraction of the peatland habitat at any given site, but this mapping of the peatland system buffers the habitat occupied by rare species. Some species could only be found in an area of less than 5 m radius, and were mapped as points. Attributed GIS shapefiles are conveyed with this report as representing all mapping of peatland extent, plus all rare plant mapping whether as polygon or point.

The rest of 2018 rare plant species survey products that are not contained in this report or appendix are submitted separately. They include:

- Electronic GIS files of all rare plant distribution and peatland extent
- Electronic image files of all photograph references, labelled by: site, subject, and photographer initials (including all photographs in this report and all vegetation sampling images)
- Voucher specimens with collection labels, as submitted to Rocky Mountain Herbarium (https://www.uwyo.edu/botany/rocky-mountain-herbarium/) for databasing, scanning and posting (includes rare vascular species, other vascular species not previously documented from the vicinity, and a small set of *Sphagnum* specimens collected on Caribou-Targhee NF) – to become available for public access. Collection information (collector initials and numbers) are cross-referenced by species and by site in the fen floristic checklist (Appendix E).

Figure 2a. Peatland mapping – Barnes Lake area of Wind River Range, Bridger-Teton NF[4]



Barnes Lake area study sites are in headwater valley and basin settings. Those above pool or small lake features have less riverine system influence than palustrine- or lacustrine-influence.

[4] See the enlarged peatland mapping for each site at the end of the GDE information packet for each sites in Appendix D.

Figure 2b. Peatland mapping – Upper Green River sites, Bridger-Teton NF

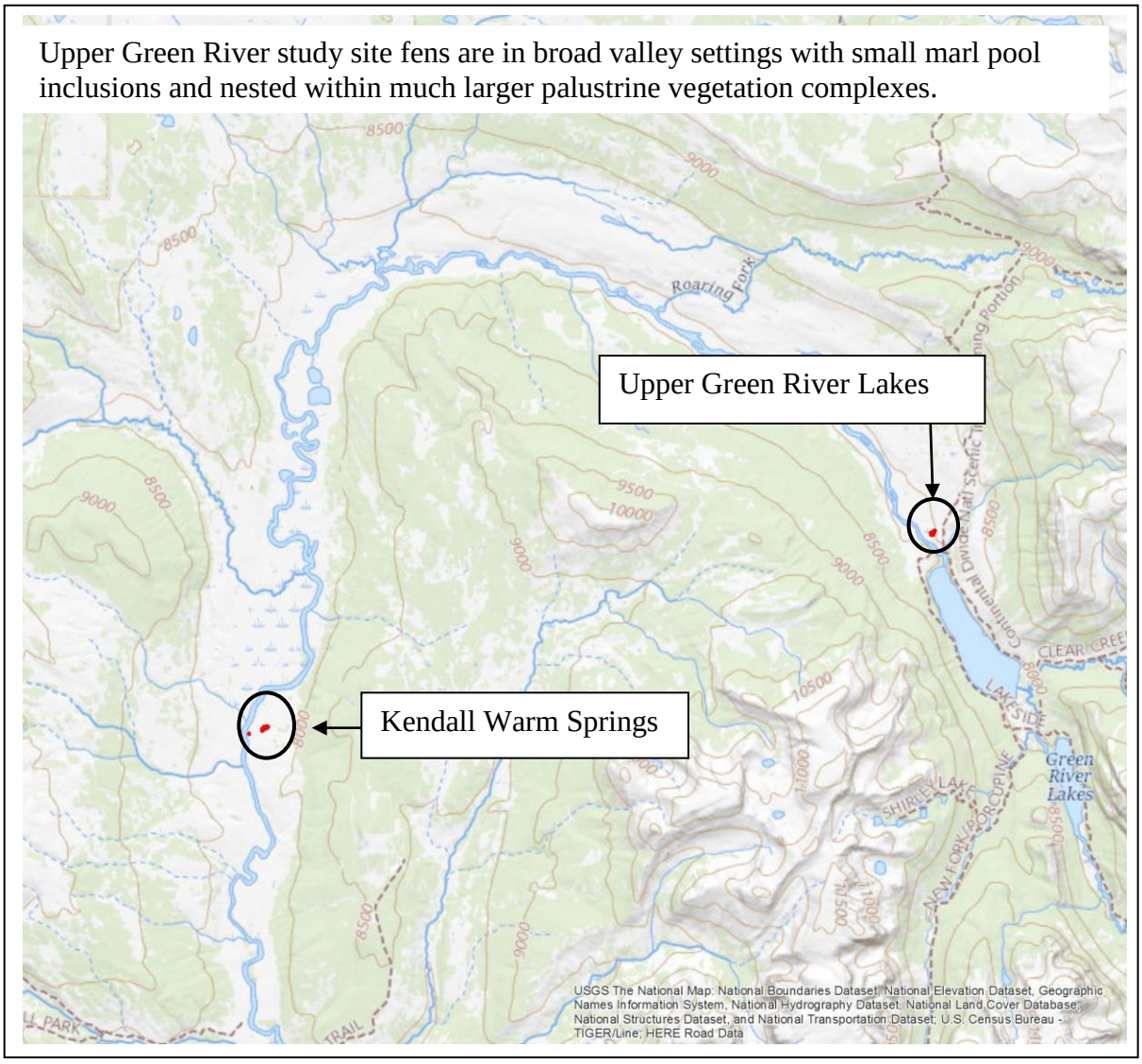
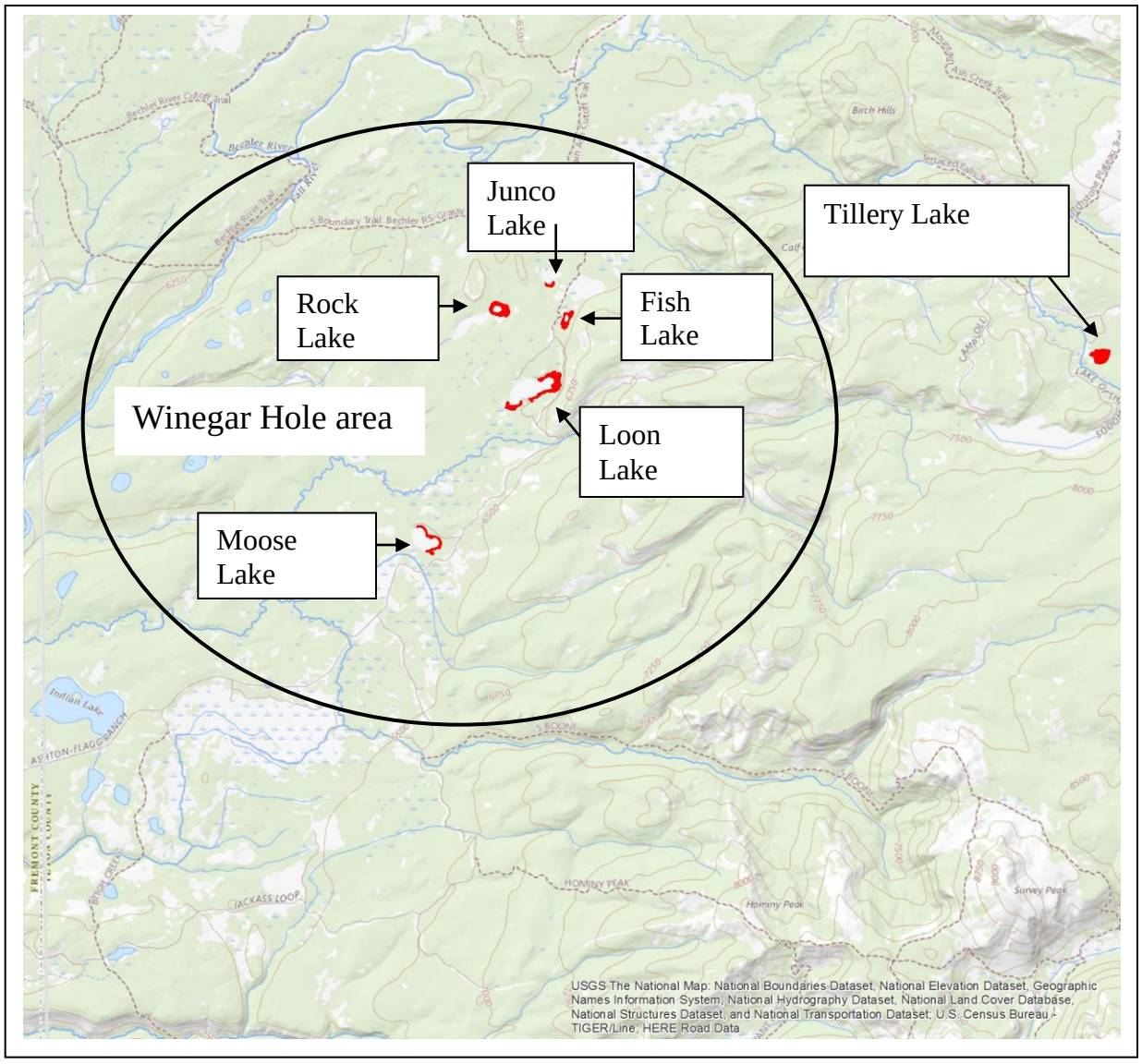


Figure 2c. Peatland mapping – Winegar Hole area study sites, Caribou-Targhee NF



Winegar Hole study site fens and that of the outlying Tillery Lake area are mainly in basin settings along lakes or along large ponds above lakes.

Table 3. 2018 fen rare plant results by study sites and associated data. **Study Sites/ Study Areas**	**Peatland Extent ac (ha)**	**Elev. ft (m)**	**Rare species**	**pH**	**Conductivity**	**Dominants**	**Settings**
Bridger-Teton National Forest							
Kendall Warm Springs SIA/ Upper Green River	2 areas: 3.45 ac total (3.05+0.42) 1.41 ha total	7860 (2396)	*Carex microglochin* var. *microglochin, Salix candida, Trichophorum pumilum, Utricularia minor*	6.1-6.75	1238-1588	*Carex simulata*/br moss	Riverine*
Upper Green River Lakes area/ Upper Green Ruver	2.61 (1.06)	8000 (2438)	*Primula egaliksensis, Selaginella selaginoides, Trichophorum pumilum*	7.4	866	*Carex simulata*/ br moss	Riverine
WR3 (including eastern, central, western, and addon)/ Wind River	1.05 (0.42) central 0.05 (0.02) eastern 0.09 (0.04) western 0.34 (0.14) addon 1.53 (0.62) total	9740-9760 (2969-2975)	*Utricularia minor* (@WR3 central)	Gap 6.9 7.19 7.26	Gap 30 38 14	*Eleocharis quinqueflora; Carex limosa* *Carex limosa-C. vesicaria* *Eleocharis quinqueflora* *Carex saxatilis*	Palustrine and riverine
WR5 (including original and addon)/ Wind River	2.24 (0.91) original 4.07 (1.65) addon 6.31 (2.56) total	9640-9720 (2938-2963)	*Utricularia minor* (@WR5 original)	6.85 5.97-6.92	30 30-70	*Eleocharis quinqueflora-Carex aquatilis;; Eleocharis quinqueflora-Carex limosa; Eleocharis quinqueflora-Carex utriculata; Eleocharis quinqueflora*/br moss	Intermed. Lacustrine/palustrine*
WR8/ Wind River	0.80 (0.32)	10,120 (3085)	-	5.53	28	*Eleocharis quinqueflora*	Riverine
WR10/ Wind River	0.90 (0.36)	10,110 (3082)	*Utricularia minor* [Note: *Agoseris lachschewitzii* collected nearby]	7.0-7.5	19-38	*Carex limosa-C. scopulorum/ Sphagnum* spp.	Intermed. Lacustrine/palustrine**
Caribou Targhee National Forest							
Fish Lake/ Winegar Hole	4.31 (1.74)	6450 (1966)	*Cicuta bulbifera, Drosera anglica, Lycopus uniflorus, Scheuchzeria palustris*	5.27-5.58	67-134	*Carex lasiocarpa; Carex buxbaumii*	Intermed. Lacustrine/palustrine
Junco Lake/ Winegar Hole	1.13 (0.46)	6440 (1963)	*Drosera anglica,,Lycopus uniflorus, Scheuchzeria palustris*	4.78	42	*Carex lasiocarpa; Comarum palustre/Sphagnum squarrosum*	Lacustrine
Loon Lake/ Winegar Hole	15.77 (6.38)	6440 (1963)	*Drosera anglica,,Lycopus uniflorus, Scheuchzeria palustris, Utricularia minor*	5.86-6.06	39-85	*Carex lasiocarpa; Carex lasiocarpa-Comarum palustre/Sphagnum squarrosum; Eleocharis quinqueflora*	Lacustrine
Moose Lake/ Winegar Hole	3.75 (1.52)	6440 (1963)	*Cicuta bulbifera, Drosera anglica, Lycopus uniflorus, Scheuchzeria palustris, Utricularia minor*	4.98-5.13	35-59	*Carex lasiocarpa; Carex lasiocarpa/Sphagnum squarrosum*	Lacustrine

Table 3. 2018 fen rare plant results by study sites and associated data. **Study Sites/ Study Areas**	**Peatland Extent ac (ha)**	**Elev. ft (m)**	**Rare species**	**pH**	**Conductivity**	**Dominants**	**Settings**
Rock Lake/ Winegar Hole	9.13 (3.69)	6440 (1963)	*Drosera anglica, Lycopus uniflorus, Scheuschzeria palustris*	5.77	64	*Carex lasiocarpa*	Intermed. Lacustrine/palustrine
Tillery Lake/ Jedediah Smith	12.26 (4.96)	7310 (2228)	*Eriophorum gracile, Utriularia minor* [Failed to find *Cicuta bulbifera, Drosera anglica*]	5.29-5.78	40-68	*Carex aquatilis; Carex limosa; Salix wolfii/Carex utriculata*	Lacustrine
16 sites	61.95 ac (25.07)						
BTNF total	15.60 (6.31)						
CTNF total	46.35 (18.76)						

*The Kendall Warm Springs fen was the only place found in 2018 surveys where the peat mat was floating over the water column within the 80 cm length of the soil auger.

**One of the WR5 sites included the only place found in 2018 surveys where sloping peatland was found, at the southwest arm of WR5 addon. All other peat surfaces were essentially flat.
***The WR10 site included the only place found in 2018 surveys with a complex pattern of peat mounds-and-pools. All other peat zonation was irregular.

Results for each of the 12 rare plant species are presented with background information on the following pages. The latter includes classification, status, and description; followed by information on distribution and habitat that pertains to Bridger-Teton and Caribou-Targhee National Forests and to the state as a whole.

FEWSEEDED BOG SEDGE (*Carex microglochin* Wahlenb var. *microglochin*)

Classification
Scientific Name: *Carex microglochin* Wahlenb.
Synonyms: none
Common Name: Fewseeded bog sedge (False uncinia sedge)
Family: Cyperaceae
Size of Genus: The sedge genus is the largest genus of vascular plants in Wyoming. There are 115 species in Dorn (2001) and additions since that time have brought the total to 124 (Nelson 2018).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S2
WYNDD Plant List: Conservation of fewseeded bog sedge as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. It present as a disjunct across the Rocky Mountains.

Status:
US Fish & Wildlife Service: none
Agency Status: none

Figure 3: *Carex microglochin* at Kendall Warm Springs by B. Heidel

Description
Technical Description: Fewseeded bog sedge is a slender, low growing perennial with stems (culms) 2-25 cm high from slender, elongate rootstalks. Leaves are 4-8 to a culm, 0.3-0.6 mm wide, shorter than the inflorescence, and have in-rolled (involute) edges. Flower spikes are solitary, 7-15 mm long, and have staminate flowers at the tip and pistillate flowers at the base. Pistillate scales are obtuse and very early deciduous. The green to straw-colored perigynia are slender, dart-like with long-tapering tips and typically reflexed at maturity. Achenes have 3 stigmas (Hermann 1970;

Moss 1983; Fertig and Jones 1992).

Local Characteristics: The long, tapering perigynia and their reflexed angle on the inflorescence are diagnostic (Figures 3, 4). Perigynia persist for only a short time once they mature.

Similar Species: *Carex gynocrates* has ovoid shaped perigynia. *C. nigricans* has dark brown, non-tapering perigynia.

Geographic Distribution

Range: Newfoundland to Alaska, south to Connecticut, Pennsylvania, Minnesota, and Washington. Disjunct populations occur in Montana, Wyoming, Colorado, New Mexico and Utah. In Wyoming it is known from the Yellowstone Plateau, northern Absaroka and Wind River Ranges and the Upper Green River Basin in Fremont, Park, and Sublette counties (Figure 5).

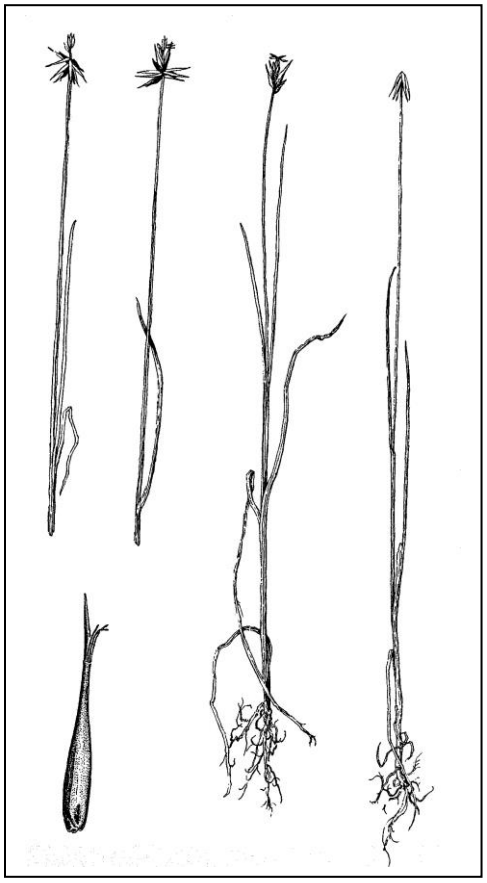


Figure 4. *Carex microglochin* illustration from Hermann (1970)

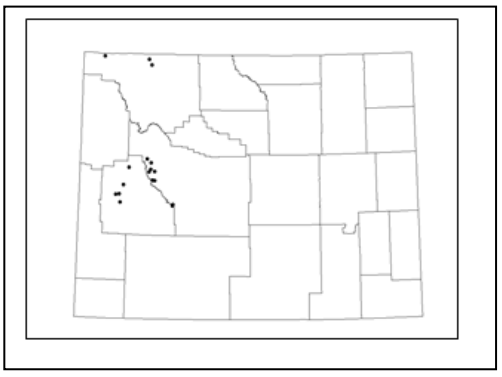


Figure 5. *Carex microglochin* in Wyoming

Extant Sites: *Carex microglochin* is known from 17 extant occurrences in Wyoming, all of which have been discovered since 1985 (last observed in 2018), one of which is on the Bridger-Teton NF. The Kendall Warm Springs population was revisited in 2018 (Table 4). One of the two reported spots were mapped with greater precision. No new occurrences were found in 2018.

Table 4. *Carex microglochin* occurrence in Bridger-Teton National Forest

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
#001	Kendall Wm Springs	Teton	T38N R110W Sec 2	7800	Klondike Hill

Historic Sites: none

Figure 6. *Carex microglochin* habitat along marl pool outlet at Kendall Warm Springs by B. Heidel.

Habitat

Settings and Vegetation: In Wyoming, *Carex microglochin* occupies graminoid and shrub fens, including floating mat and patterned zones, often with marl accumulation, at 6600-10,240 ft. It is sometimes at or near the borders of springs and rivulets in the fen habitat (Figure 6). Most known occurrences are in montane settings. In 2012 it was found in the Upper Green River Basin.

Frequently Associated Species: Grows with *Carex simulata, Thalictrum alpinum, C. aurea, Triglochin maritimum, Swertia perennis* and *Trichophorum pumilus* at Kendall Warm Springs. It is frequently associated rare species and at Swamp Lake grows among *Trichophorum pumilus, Primula egaliksensis*, and *Kobresia simpliuscula*. At alpine elevations, it is associated with other rare species including *Carex misandra, C. nelsonii, Eriophorum callitrix* and *Juncus triglumis* var. *albescens*.

Topography: Basin and valley settings.

Water and Soil Relationships: Saturated and super-saturated histosols with a high water table

Population Biology and Demography

Flowering/Fruiting Period: June-August

Population Size and Condition: This species is often restricted to very small clumps though it may be high density there. At Kendall Warm Springs, it originally was estimated as having 2000-3000 plants (Fertig 1995) though possibly connected by rootstocks.

Threats: Vulnerable to heavy trampling and hydrological changes.

BULBET-BEARING WATER HEMLOCK (*Cicuta bulbifera* L.)

Classification
Scientific Name: *Cicuta bulbifera* L.
Synonyms: none
Common Name: Bulbet-bearing water hemlock
Family: Apiaceae
Size of Genus: There are two species in the Wyoming flora (Dorn 2001).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Conservation of Bulbet-bearing water hemlock as a peripheral species in Wyoming signifies a low-level contribution to rangewide conservation.

Description
Technical Description: Bulb-bearing water-hemlock is a poisonous, perennial forb with single stems 30-100 cm tall from slender fibrous roots or thickened clusters (but not taprooted). Leaves are found only along the stem and are alternate. The middle to lower leaves are pinnately dissected into narrowly linear, entire or few-toothed leaflets less mostly 0.5-1.5 mm wide and 4 cm long. Upper leaves are smaller, with entire or few- lobed blades that may contain bulbils (small, bulb-like asexual propagules) in the axils. The inflorescence is a simple umbel (or often lacking, in which case plants reproduce entirely by leaf bulbils). Flowers are white or greenish, small, and borne on slender stalks 1-2.5 cm long. Fruits are round and appear vertically striped (from the broad ribs alternating with narrow spaces) (Dorn 2001; Hitchcock and Cronquist 1961).

Figure 7: *Cicuta bulbifera* at shore of Moose Lake by B. Heidel

Local Characteristics: Linear leaflets and presence of asexual bulbils are distinctive among species in the family (Figures 7, 8)

Similar Species: *Cicuta maculata* lacks bulbils in the leaf axils and has lance-shaped to ovate leaflets 5-35 mm wide with prominent teeth and veins ending in the sinus of the teeth. *Conium maculatum* has thrice-compound, fern-like leaves, lacks bulbils, and has a taproot (Dorn 2001).

Geographic Distribution

Range: Occurs from Alaska to Nunavut, across Canada, and across northern tiers of states from Washington and Oregon to New Jersey, south in the Great Plains to Kansas, and south on the Atlantic Coast to North Carolina. In Wyoming, known only from the Teton Range and Yellowstone Plateau (Teton County).

Extant Sites: Known from four sites in Wyoming, all on the Caribou-Targhee NF (Figure 9, Table 5). Two were added in the 2018 study. One of the prior ones could not be relocated.Historic Sites: Not applicable.

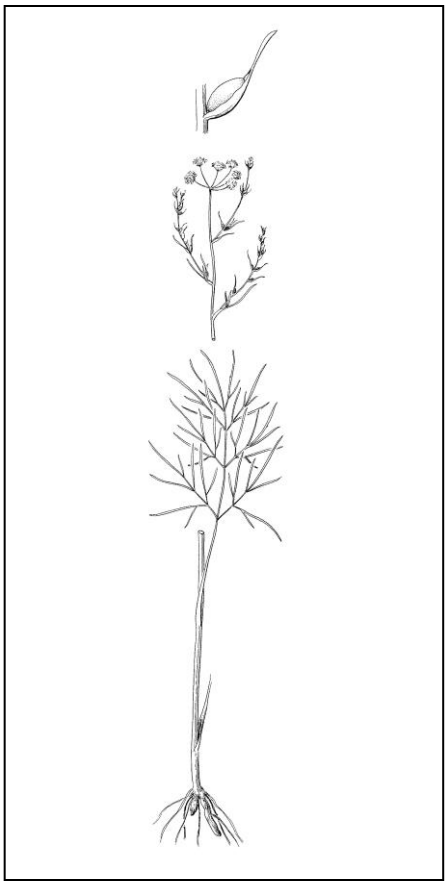


Figure 8. *Cicuta bulbifera* illustration by Jeanne R. Janish. From: Hitchcock and Cronquist (1961)

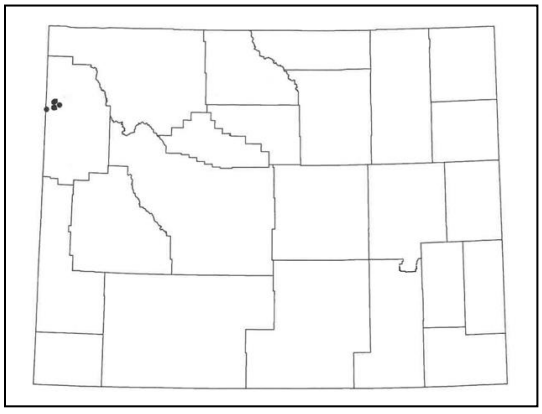


Figure 9. *Cicuta bulbifera* in Wyoming

Table 5. *Cicuta bulbifera* occurrences in Caribou -Targhee National Forest

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
#001	Indian Lk	Teton	T47N R118W Sec 4 SW of NW	6400	Sheep Falls
#002	Tillery Lk	Teton	T48N R117W Sec 13 SE	7310	Survey Peak
#003	Fish Lk	Teton	T48N R117W Sec 18 SW of SE	6450	Hominy Peak
#004	Moose Lk	Teton	T48N R118W Sec 25 SW	6440	Hominy Peak

Habitat

Settings and Vegetation: Marshes, bogs, and wet meadows often with standing water in valley bottoms and lowlands (Hitchcock and Cronquist 1961). Wyoming populations are along lake shores, possibly restricted to fen shorelines (Figure 10). The occurrence that we failed to relocate at Tillery Lake was said to be at a "small stream in mixed conifer forest." In Idaho, it has also been documented on peat (Moseley et al. 1991).

Figure 10. *Cicuta bulbifera* habitat at Fish Lake (foreground) by Rose Lehman, USFS

Associated Species: Grows with *Carex lasiocarpa, Menyanthes trifoliata, Comarum palustre, Calamagrostis stricta, Lycopus uniflorus*.

Topography: Basin and valleys.

Water and Soil Relationships: Found where the water table is at or close to the surface in saturated or supersaturated conditions. At least two of the four Wyoming occurrences are specifically restricted to peatland margins of the lakeshore (this report).

Population Biology and Demography

Flowering/Fruiting Period: August-September.

Population Size and Condition: The Moose Lake population was tallied at 37 plants that were widely-scattered, often as individual plants, but sometimes 2-8 plants in a place. The Fish Lake population was tallied at 16 plants. The Indian Lakes population was reported as "few" and there is no information on local numbers at Tillery Lake.

Threats: Vulnerable to heavy trampling along shorelines and to lake level alteration.

ENGLISH SUNDEW (*Drosera anglica* Huds.)

Classification

Scientific Name: *Drosera anglica* Huds.
Synonyms: *Drosera longifolia*.
Common Name: English sundew
Family: Droseraceae
Size of Genus: This is the only species of *Drosera* reported for Wyoming in Dorn (2001).
Phylogenetic relationships: This species is believed to be a fertile amphiploid (2n=40) derived from *D. anglica* (2n=20) and another diploid species with narrow leaves (Hitchcock and Cronquist 1964).

Present legal or other formal status

U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none; Sensitive in Rocky Mountain Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2018) reported an SRANK of S3 and transferred it from recognition of a tracked species to watch status. It remains as a watch species as long as it is on the Region 2 Sensitive list.
WYNDD Plant List: Conservation of English sundew as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Caribou-Targhee NF populations are at the margins of the greatest concentration of Wyoming populations as found on the Yellowstone Plateau.

Description

English sundew is an insectivorous perennial herb with stems 6-18 cm tall. Leaves have oblong to spoon-shaped blades 1-3 cm long by 3-4 mm wide, petioles 2-6 cm long, and are covered by long reddish, glandular-tipped hairs which snare insects. The inflorescence is a one-sided raceme of 1-10 flowers with 5 white petals 3-7 mm long. The fruit is a 3-5 valved capsule (Dorn 2001, Hitchcock et al. 1961; Marriott 1991).

Local field characteristics: The reddish gland-tipped hairs are diagnostic (Figures 11, 12).

Similar species: This is the only species of *Drosera* in Wyoming. However, *Drosera anglica* is known from adjoining states to the north, south and west of Wyoming. An excellent review of the two species of *Drosera* in adjoining Idaho and their differences is presented by Kinter (2018).

Geographical distribution

Range: Circumboreal, in North America from Labrador and Newfoundland to Alaska, south to California, Colorado, northern Great Lakes states, and Maine. In Wyoming, known from the Yellowstone Plateau and Absaroka, Beartooth, Big Horn, Teton and Wind River mountains in Big Horn, Fremont, Johnson, Park, Sheridan and Teton counties. In past decades, it was only reported from two sites in all of Wyoming and one in Colorado (Wolf and Cooper 2006). There have been more recent discoveries made in the Beartooth Mountains, Caribou-Targhee National Forest and particularly in Yellowstone National Park,

as well as documentation of two populations in the Big Horn Mountains (Figure 13). The former Yellowstone National Park Botanist noted it as locally common and widespread in suitable habitats of the Bechler region where it is under-documented (Whipple pers. commun. 2011).

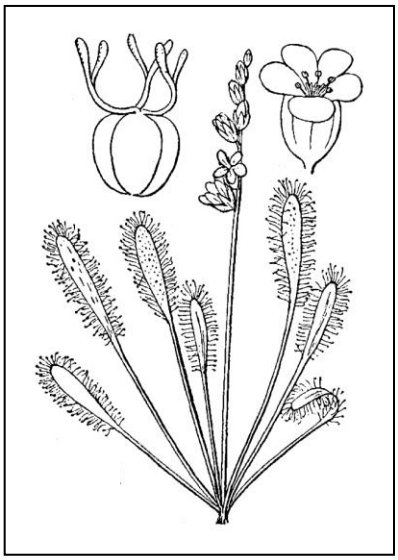


Figure 11 (left). *Drosera anglica* at Moose Lake.
Note perennating buds and the captured dragonfly by B. Heidel
Figure 12 (right). *Drosera anglica* illustration from Britton and Brown (1913)

Extant Sites: Known from 30 recent records (most recently observed in 2018), including clusters of five records that have been provisionally lumped as a single giant population complex in the Winegar Hole area. By this counting convention, there are two occurrences on Caribou-Targhee National Forest (Table 6), but we failed to relocate the species at Tillery Lake. The specimen collection label from Tillery Lake (Hartman and Scott 86594 RM) describes its habitat as "small stream in mixed conifer forest" which does not describe fen habitat. Unlike the five lakes where we did find it, Tillery Lake did not have *Sphagnum*-dominated areas of peatland that we could find. We did find one *Sphagnum*-dominated mound at a raised springhead in willow carr habitat southwest of Tillery Lake. We did not cover all steam settings in the vicinity. It is mapped on the northwest corner of Tillery Lake based on the GPS point of its original collectors. If there is wetland habitat in this corner, it has not been surveyed.

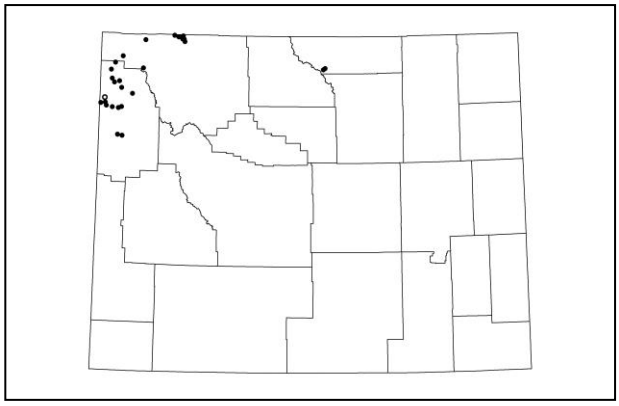


Figure 13. *Drosera anglica* in Wyoming

Table 6. Caribou -Targhee National Forest occurrences of *Drosera anglica*

EO#	Location	County	Legal Description	Elev.	USGS 7.5'
Part of #018	Fish Lk	Teton	T48N R117W Sec 18 SE of SE	6450	Hominy Peak
Part of #018	Junco Lk	Teton	T48N R117W Sec. 18	6440	Cave Falls
Part of #018	Loon Lk	Teton	T48N R118W Sec 18, 19	6440	Hominy Peak
Add to #018	Moose	Teton	T48N R118W Sec 25 NW of SW	6440	Hominy Peak
Part of #018	Rock Lk	Teton	T48N R117W Sec 18; T48N R118 Sec 13	6440	Cave Falls
#028	Tillery Lk	Teton	T48N R117W Sec 13 SE	7310	Survey Peak

Historical sites: There is one historical collection record from the southwest corner of Yellowstone National Park (the Bechler region) that has not been relocated since 1930.

Habitat

Settings and associated vegetation: Occupies a wide array of bogs and fens across its range (Wolf et al. 2006). In Wyoming, English sundew is found in floating and anchored peat mats and shallow pools of poor to transition fens, and geothermally-influenced mineral soils that remain saturated. It is fen obligate in Wyoming outside of the geothermally-influenced settings of Yellowstone National Park. In Caribou-Targhee National Forest, English sundew occupies saturated peat dominated by *Sphagnum*, and super-saturated peat dominated by *Carex lasiocarpa* (Figure 14).

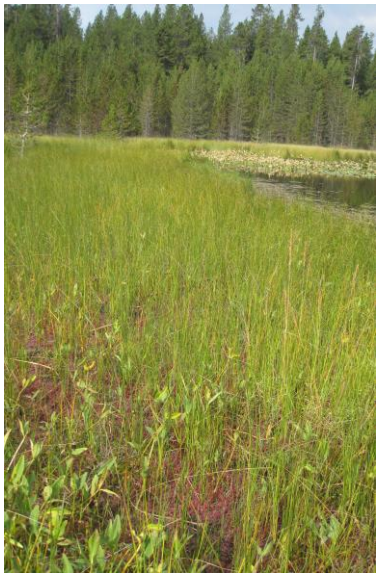


Figure 14. *Drosera anglica* habitat at Junco Lake (note red coloration of its leaves in the foreground among *Carex lasiocarpa* and *Menyanthes trifoliata*) by B. Heidel

Frequently Associated Species: English sundew may grow in floating mats of *Sphagnum* or of sedges (*Carex lasiocarpa, C. limosa*), and among floating or submerged aquatic plants such as bog buckbean (*Menyanthes trifoliata*), marsh cinquefoil (*Comarum palustre*), and lesser bladderwort (*Utricularia minor*).

Topography: The Caribou-Targhee NF sites of English sundew are all located close to open water, including lakes and large ponds. It often grows on saturated *Sphagnum* mats but is also on supersaturated flats.

Water and soil relationships: The roots of English sundew require stable, saturated or standing water conditions associated with peat. Past reports have mentioned floating peat mats (e.g., Heidel 2011) but all of the Caribou-Targhee National Forest sites visited in 2018 are on anchored peat.

Population biology and demography

Phenology: Flowers in July to early August, and fruits in August.

Population size and condition: The Loon Lake population was the most extensive of sites visited in 2018, and the Rock Lake population was the smallest, perhaps less than 10 m^2. Plants are very small and often in high density with high overlap between individuals and low flowering, so estimates are generally conservative. There were some individual plants that were completely submerged at Junco Lake that appeared to be in varying stages of dying.

Threats: There are no reports of the species being collected commercially, or excessively by tourists. Persistence of the species has not been addressed in the wake of crown fires through uplands or in drought-induced stages of wetland dessication. Its highest numbers are in Yellowstone National Park, where many are in backcountry. Two of the larger populations on Caribou-Targhee National Forest are in lakes with common loons, where foot traffic is discouraged through the first half of the growing season. The failure to relocate the species at Tillery Lake is more apt to be due to incomplete survey coverage if it is located above the western shore, than habitat loss. The potential impact of beaver activity to the species or its habitat has not been addressed but portions of the Junco Lake population were fully submerged at the time of visit, and some of submerged plants showed sign of death and decay (Figure 15).

Figure 15. Submerged *Drosera anglica* at Junco Lake (upper half of photo) by B. Heidel

SLENDER COTTONGRASS (*Eriophorum gracile* Koch)

Classification

Scientific Name: *Eriophorum gracile* Koch
Synonyms: none
Common Name: Slender cotton-grass
Family: Cyperaceae
Size of Genus: There are seven species of *Eriophorum* reported for Wyoming in Dorn (2001). There are eleven species of *Eriophorum* reported in the *Flora of North America* (Ball and Wujek 2002).
Phylogenetic relationships: unknown

Present legal or other formal status

U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none. Sensitive in Rocky Mountain Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2018) reported an SRANK of S3 and transferred it from recognition of a tracked species to watch status. It remains as a watch species as long as it is on the Region 2 Sensitive list.
WYNDD Plant List: Conservation of slender cottongrass as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description

Technical description: Slender cottongrass is a grass-like perennial with stems (culms) 20-60 cm high arising singly from a slender rhizome. The leaf blades are less than 2 mm wide and triangularly channeled for their entire length. The inflorescence consists of 2-5 heads (spikelets) on short, drooping stalks that often exceed the single green, leafy inflorescence bract. Scales are greenish-brown to blackish with a slender midrib. The perianth consists of numerous cottony, white bristles. Fruits are straw-colored achenes. (Ball and Wujek 2002, Dorn 2001, Hitchcock et al. 1969).

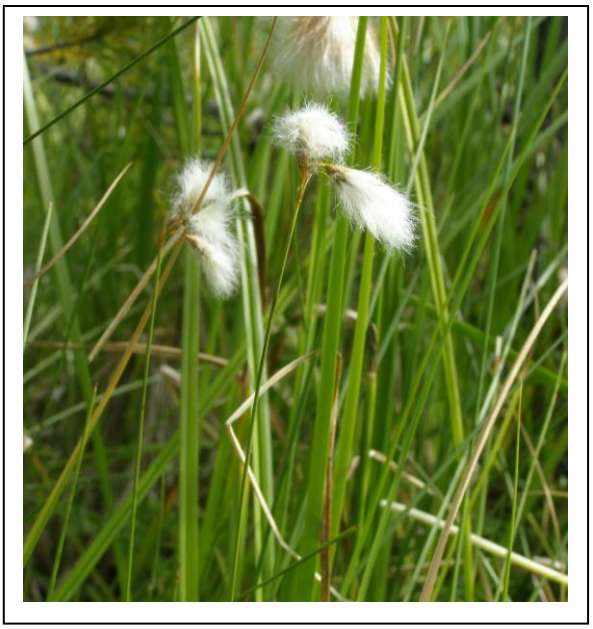
Local field characters: The multiple heads, slender stem and narrow leaves are distinctive characteristics (Figures 16, 17).

Similar species: *Eriophorum polystachion* and *E. viridicarinatum* have leaves that are flattened at the base and have two or more leafy inflorescence bracts. *E. chamissonis, E. callitrix*, and *E. scheuchzeri* have single spiklets at the tip of the stem.

Geographical distribution

Range: Circumboreal; from Alaska to Labrador, and south from California to Colorado, and from Iowa to Pennsylvania (Ball and Wujek 2002, Hitchcock et al. 1969). In Wyoming, it is known from the Jackson Hole, the Beartooth, Big Horn, and Medicine Bow ranges in Albany, Johnson, Park, Sheridan, and Teton counties.

Extant Sites: Known from 27 recent records (most recently observed in 2018). There are three records in Caribou-Targhee National Forest (Figure 18, Table 7).



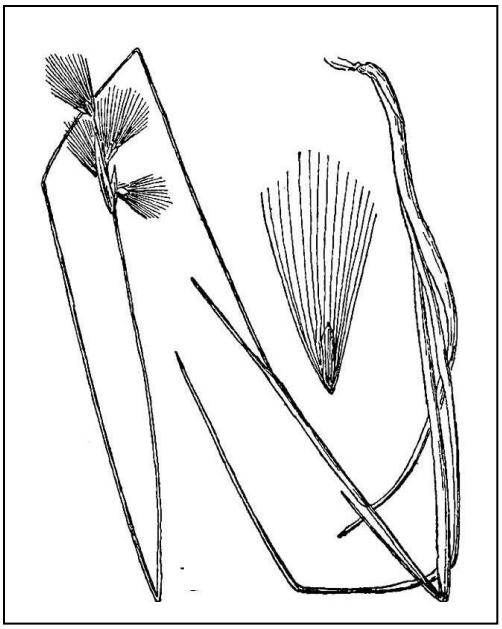


Figure 16 (left). *Eriophorum gracile* in Bighorn National Forest by B. Heidel
Figure 17 (right). *Eriophorum gracile* illustration from Britton and Brown (1913)

Historical sites: none

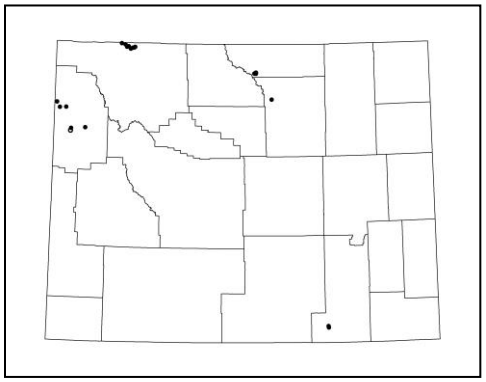


Figure 18. *Eriophorum gracile* in Wyoming

Table 7. Caribou-Targhee National Forest occurrences of *Eriophorum gracile*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
#014	Tillery Lk	Teton	T48N R117W Sec 13 SE	7310	Survey Peak
#021	Loon Lk	Teton	T48N R118W Sec 19	6440	Hominy Peak
#027	Moose Lk	Teton	T48N R118W Sec 25	6440	Hominy Peak

Habitat

Settings and associated vegetation: At temperate latitudes, *Eriophorum gracile* is associated with the vegetation characteristic of fens and saturated soils (Decker et al. 2006) (Figure 19).

Figure 19. *Eriophorum gracile* habitat at Tillery Lake (corresponds with central reddish brown area of *Carex limosa*) by Rose Lehman, USFS

Frequently Associated Species: A 2006 comparison of species associated with *Eriophorum gracile* in Colorado vs. Wyoming (Decker et al. 2006) indicated that more of the associated species are in one state or the other than shared between states. Commonly associated Wyoming species include *Carex aquatilis, C. lasiocarpa, C. limosa, C. utriculata, Eleocharis quinqueflora, Comarum palustre, Drosera anglica, Pedicularis groenlandica* and *Menyanthes trifoliata.* In fens with shrub cover, associates may include *Salix planifolia, S. candida, Dasiphora floribunda* and *Betula glandulosa*.

Topography: The Caribou-Targhee National Forest sites of *Eriophorum gracile* are all located fairly close to open water, in basin settings including lakes and large ponds.

Water and soil relationships: It often grows on supersaturated flats but also in low numbers on saturated *Sphagnum* mats with a high water table.

Population biology and demography

Phenology: Flowers in late July-August, and fruits in August-September.

Population size and condition: The Tillery Lake population of *Eriophorum gracile* is magnitudes larger than the Loon Lake and Moose Lake populations, where it is found in high density and in a central, discrete area. The other two populations had widely-scattered plants in low numbers. Many Wyoming populations of this species appear to be small, so the large Tillery Lake population is significant.

The 2018 surveys on Caribou-Targhee National Forest were conducted in late August. Though inflorescences were still intact at this time, heavy rains at the start of fieldwork

matted the inflorescence hairs into a wad that was less discernible than when fresh (Figure 20). This matted condition also required closer inspection to distinguish the multiple heads of *Eriophorum gracile* from the single heads of *E. angustifolium.* The latter species is not rare. Thus, 2018 mapping of *E. gracile* and the population census or estimate information is conservative. In general, it is not possible to discern that portion of a cottongrass population in vegetative condition, so this puts a caveat on any population census or estimate.

Threats: Vulnerable to heavy trampling and water level alteration.

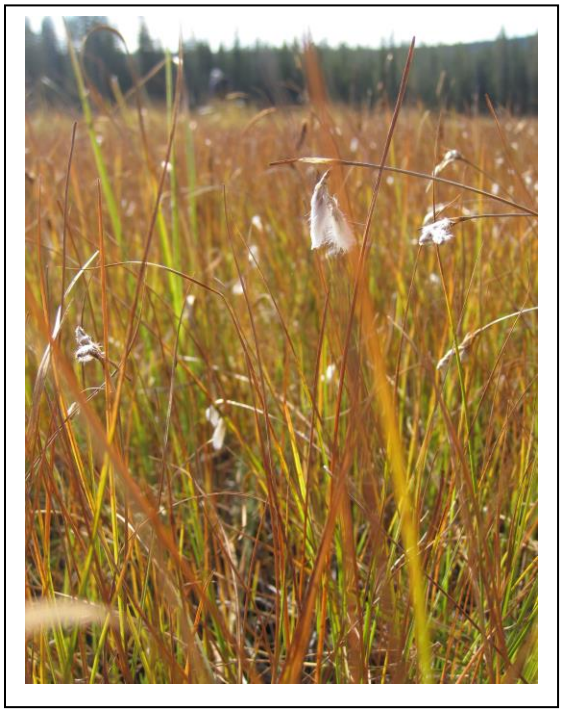


Figure 20. *Eriophorum gracile* after heavy rains at Tillery Lake by B. Heidel

INUNDATED CLUBMOSS (*Lycopodiella inundata* (L.) Holub)

Classification
Scientific Name: *Lycopodiella inundata* (L.) Holub
Synonyms: *Lycopodium inundatum*
Common Name: Inundated clubmoss
Family: Lycopodiaceae
Size of Genus: There are four species in the Club moss Family as previously reported for Wyoming in Dorn (2001), all of which were placed in the same *Lycopodium* genus at one time: *Lycopodium annotinum*, *L. dendoideum*, *Diphasiastrum complanatum* (*Lycopodium complanatum*), and *Huperzia haleakale* (*Lycopodium haleakalae*). Under current taxonomic treatment (Wagner and Beitel 1993), *Lycopodiella inundata* is the only species of the genus in Wyoming.
Phylogenetic relationships: *Lycopodiella inundata* is the only boreal species in the *Lycopodiella* genus. The others are temperate species centered in the eastern United States. It is represented as central in phylogenetic relations of the genus (Wagner and Beitel 1993), possibly reflecting an ancestral position.

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none; Sensitive in Northern Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Track as SOC. Conservation of inundated clubmoss as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description
Technical description: Inundated clubmoss has leafy prostrate stems that root and produce fertile shoots usually 3.5-6 cm high (sometimes up to 10 cm high), at irregular intervals. The narrow, pointed leaves are 4-8 mm long, thin, entire, and crowded along the branches in 8-10 ranks. A dense spike tops each erect stem, producing a spore case, or sporangia, at the base of each fertile bract, or sporophyll, that is similar to the vegetative leaf but broadened at the base. Sporangia are ellipsoid-globose and about 1 mm wide (Wagner and B

Local field characteristics: The prostrate stems often blend in with mossy background vegetation, so the fertile shoots are key to locating the species (Figures 21, 22).

Similar Species: Superficially resembles a moss (bryophyte). *Lycopodium annotinum* and other species of the genus in Wyoming have sporophylls in dense cone-like spikes that are obviously different from the vegetative leaves, seldom more than twice as long as wide and not obviously photosynthesizing. *Selaginella selaginoides* is superficially similar but produces two kinds of spores including separate megaspores and microspores, and the leaves have ligules.

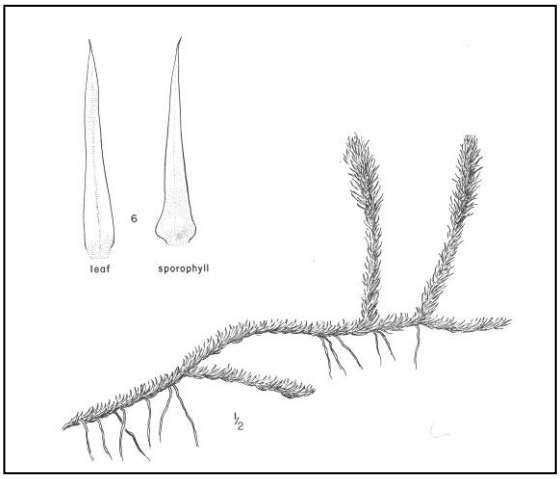


Figure 21. *Lycopodiella inundata* by Jeanne R. Janish, from: Hitchcock, C. L. et al. 1969. Vascular Plants of the Pacific Northwest, Part 1: Vascular Cryptogams, Gymnosperms and Monocotyledons. Pages 1-914. University of Washington Press, Seattle, WA.

Figure 22. *Lycopodiella inundata* and *Drosera anglica* by Marlene Renwyck. Used with permission.

Geographical Distribution

Range: Occurs in Alaska and in all Canadian provinces south to California, Idaho and Wyoming; and in the eastern United States south to Iowa, Illinois, Kentucky and North Carolina. The Wyoming population occurs in the Yellowstone Plateau (Teton County), the southernmost location in the Rocky Mountains. The nearest population is in Yellowstone National Park (Idaho).

Extant Sites: Known from one site in Wyoming (discovered in 2018) (Figure 23, Table 8).

Historical Sites: Not applicable.

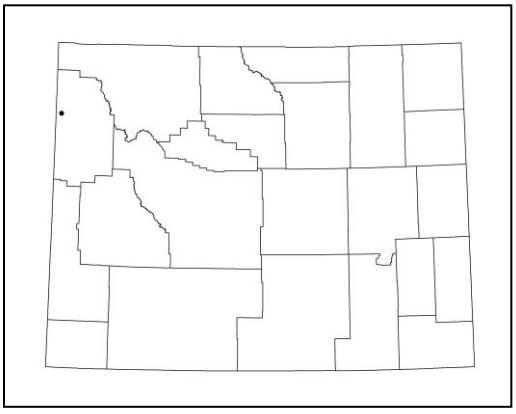


Figure 23. *Lycopodiella inundata* in Wyoming

Table 8. Caribou -Targhee National Forest occurrences of *Lycopodiella inundata*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
#001	Moose Lk	Teton	T39N R108W Sec 30 NE of SE	8000	Green River Lakes

Habitat

Settings and Vegetation: Mostly in *Sphagnum* bogs (Hitchcock et al. 1969). In Wyoming, found on saturated *Sphagnum* mat vegetation in lakeside setting on alluvium at 6440 ft. (Figure 24).

Figure 24. *Lycopodiella inundata* habitat on *Sphagnum* mats, obscured by *Carex lasiocarpa* (habitat is in the background to the upper right, by the squatting botanist) by Rose Lehman, USFS

Associated Species: *Sphagnum squarrosum, Carex lasiocarpa, C. echinata, Drosera anglica, Lycopus uniflorus.*

Topography: At or near the level of open water.

Water and Soil Relationships: Super-saturated peat (fibrist) with high water table.

Population Biology and Demography

Flowering/Fruiting Period: Spores produced in sporangia from August to September.

Population Size and Condition: Less than 50 fertile shoots found in a small area in 2018; incomplete survey. Because this species is rhizomatous, the number of stems does not necessarily equal the number of genetically distinct individuals.

Threats: Vulnerable to trampling and lake level alteration.

NORTHERN BUGLEWEED (*Lycopus uniflorus* Michx.)

Classification
Scientific Name: *Lycopus uniflorus* Michx.
Synonyms: None
Common Name: Northern bugleweed
Family: Lamiaceae
Size of Genus: There are three species in the genus as reported for Wyoming in Dorn (2001).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Conservation of northern bugleweed as a widespread peripheral species in Wyoming signifies a low-level contribution to rangewide conservation that may not be warranted in light of local abundance. It is proposed for removal from tracking based on this 2018 study.

Description
Technical Description: Northern bugleweed is a perennial forb with mostly unbranched, grooved, pubescent stems (3) 10-60 cm tall from a stolon-bearing tuber. Leaves are elliptic to lance-shaped, 2-8 cm long, 1-4 cm wide, punctate (pitted with shallow glands), sparsely pubescent, and nearly sessile with shallowly-toothed margins. The inflorescence consists of whorls of 2-12 sessile flowers in the axils of the upper leaves. The calyx is bell-shaped with 5 short-acute teeth that are equal or shorter than the nutlets at maturity. The corolla is 5-lobed, white to pinkish, 2.5-3.5 mm long, pubescent, and radially symmetrical. Fruits consist of 4 brownish nutlets 1-1.2 mm long with thin, wavy-toothed margins (Hitchcock et al. 1959; Great Plains Flora Association 1986).

Local Characteristics: The species is highly variable in stature. It is readily confirmed by its swollen underground tuber (Figures 25, 26).

Similar Species: *Lycopus americanus* and *L. asper* have elongate-tipped calyx lobes that are longer than the mature nutlets. *Mentha arvensis* has pink, purple, or rarely white flowers with 4 anther-bearing stamens and is strongly aromatic.

The only overlap that *L. uniflorus* had with the above species in the study area was presence of *L. asper* at Junco Lake, although the latter was not in peatland habitat.

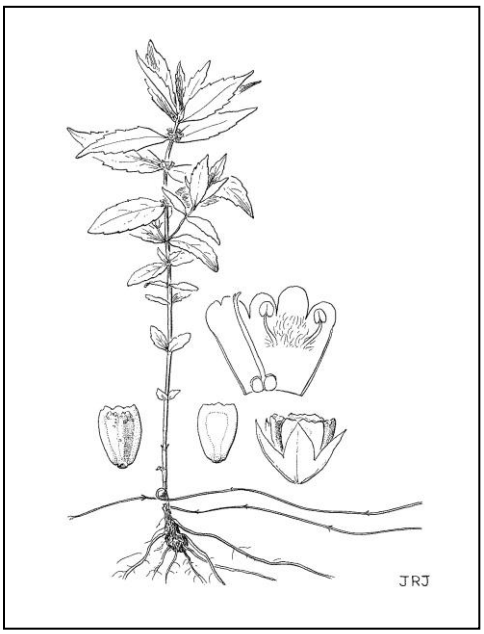


Figure 26. *Lycopus uniflorus* by Jeanne R. Janish from Hitchcock et al. (1959)

Geographic Distribution

Range: Alaska to Newfoundland, south to California, Montana, Nebraska, Arkansas, and North Carolina. In Wyoming, known from the Black Hills in Crook County and the Yellowstone Plateau (Teton County), at opposite corners of the state.

Extant Sites: Previously known from three locations in the Black Hills of northeastern Wyoming and two in northwestern Wyoming (one in Yellowstone National Park and one recent discovery at Loon Lake in Caribou-Targhee NF). Four more locations were documented in 2018 in Caribou-Targhee NF (Figure 27, Table 9).

Historic Sites: Not applicable.

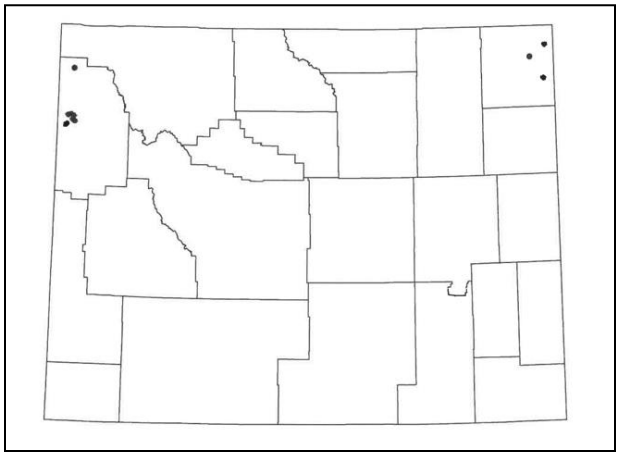


Figure 27. *Lycopus uniflorus* in Wyoming

Table 9. Caribou-Targhee National Forest occurrences of *Lycopus uniflorus*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
007	Fish Lk	Teton	T48N R117W Sec 18 SW of SE	6450	Hominy Peak
009	Junco Lk	Teton	T48N R117W Sec 18	6440	Cave Falls
003	Loon Lk	Teton	T48N R118W Sec 19	6440	Hominy Peak
008	Moose Lk	Teton	T48N R118W sec 25 W2	6440	Hominy Peak
006	Rock Lk	Teton	T48N R117W Sec 18; T48N R118W Sec 13	6440	Cave Falls

Habitat

Settings and Vegetation: In Wyoming, found in open to shady areas along streambanks, seeps, marshes, and peatland at 4700-8200 feet. The streambank and marsh settings are in northeastern Wyoming; the peatland settings are in northwestern Wyoming.

Associated Species: Highly variable because in this study, it was ubiquitous throughout peatland microhabitats. Includes: *Carex lasiocarpa, C. echinata, C. limosa, Comarum palustre, Drosera anglica, Menyanthes trifoliata, Sphagnum squarrosum, Tofieldia glutinosa*.

Topography: In valleys and basins.

Water and Soil Relationships: Seasonally moist to saturated organic soils, including those with fluctuating water levels. The first time it was located in the study area, at Loon Lake in 2015, it was present at the highwater mark of a backwater swale where it formed a pronounced band growing in profusion.

Population Biology and Demography

Flowering/Fruiting Period: July-September.

Population Size and Condition: Of all the rare plant species targeted for study in 2018, *Lycopus uniflorus* was the most locally extensive and abundant. Estimated numbers ranged as high as 1,000,000 at Loon Lake. It was perhaps the most abundant dicot in peatland habitat of each site in the Winegar Hole area. Maps of peatland extent generally corresponded to species' local distribution.

Figure 28. *Lycopus uniflorus* in high density at Loon Lake by B. Heidel

Numbers sometimes exceeding 100+ individuals in various microhabitats no larger than a dinner plate (Figure 28), including the highwater marks previously mentioned, mossy hummocks, and other zones. Its tuber is associated with vegetative reproduction by stolons so the tally of flowering stems do not represent genetically unique individuals.

Threats: Low vulnerability, apart from lake level alteration.

GREENLAND PRIMROSE (*Primula egaliksensis* Wormsk. ex Hornem.)

Classification
Scientific Name: *Primula egaliksensis* Wormsk. ex Hornem.
Synonyms: none
Common Name: Greenland primrose
Family: Primulaceae
Size of Genus: There were three species of *Primula* recognized in Wyoming (Dorn 2001). Subsequently, botanists compiling both chloroplast and nuclear DNA data determined that the *Dodecatheon* genus is nested within the *Primula* genus (Mast and Reveal 2007) and thus three more species in the state were transferred to *Primula*.
Phylogenetic relationships: *Primula egaliksensis* is an allotetraploid thought to have its parental species in two difference sections of the *Primula* genus (Kelso 1991, reviewed in Anderson et al. 2006).

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: Sensitive; Rocky Mountain Region: Sensitive
Global Heritage rank: G4
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Track as SOC. Conservation of Greenland primrose as a disjunct species in Wyoming generally signifies a medium-level contribution to rangewide conservation.

Figure 29. *Primula egaliksensis* in Shoshone NF by Walter Fertig

Figure 30. *Primula egaliksensis* illustration by Walter Fertig in Fertig et al. (1994)

Description
Technical Description: Greenland primrose is a slender, glabrous herb with leafless flowering stems to 12 cm high. Leaves are oblong or spoon-shaped, light-green, and in a basal rosette. The inflorescence is an umbel of 1-3 flowers which occur singly or in pairs. Petals are white, pink, or lilac with a yellow throat, and are wedge-shaped with notched tips. The fruits are erect, narrowly cylindric capsules opening at the top by tooth-like valves (Fertig et al. 1994).

Local Characteristics: Distinguished by the green leaves and white-, pink- or lilac-colored flowers (Figures 29, 30).

Similar Species: *Primula incana* has whitish-yellow, mealy coated leaves and stems. *Parnassia parviflora* has leafy stems, white flowers, and broad, oval-shaped fruit. *Dodecatheon* spp. can be distinguished in fruit by their broader capsules.

Geographic Distribution

Range: Greenland and Northern Canada to northeastern Asia; disjunct in central Colorado and northwest Wyoming. In Wyoming it is known only from the Clarks Fork Valley and Upper Green River Valley in Park and Sublette counties.

Extant Sites: Known from two extant occurrences in Wyoming, last observed in 2018 (Figure 31, Table 10).

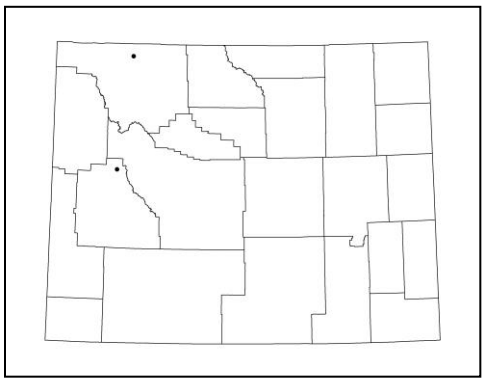


Figure 31: *Primula egaliksensis* in Wyoming

Historic Sites: None

Table 10. Bridger-Teton National Forest occurrence of *Primula egaliksensis*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
002	Upper Green R Lakes	Sublette	T39N R108W Sec 30 NE of SE	8000	Green River Lakes

Habitat

Settings and Vegetation: Wet meadows along waterways and in montane fens, often on hummocky terrain that is locally drier than its wet, marshy surroundings at 6600-8000 feet.

Associated Species: *Eleocharis quinqueflora, E. rostellata, Triglochin palustre, Carex simulata, Deschampsia cespitosa, Gentiana detonsa,*

Topography: Valley wetlands.

Water and Soil Relationships: Saturated and super-saturated peat, sometimes with marl accumulation, with a high water table

Population Biology and Demography

Flowering/Fruiting Period: Flowers May-July. Fruits June-August. Note: It had completely dried and turned brown by the time of the late July fieldwork in 2018. Its flowering is earlier than most other rare species in this study.

Population Size and Condition: One-time population estimates were made by Walter Fertig, estimating 2000-4000 plants widely-scattered over a large area but in small colonies at Swamp Lake (1992) and 8000-10,000 plants in much higher density at Upper Green River Lakes area (1995).

Threats: Vulnerable to trampling and water table alteration.

SAGELEAF WILLOW (*Salix candida* Fluggë ex Willd.)

Classification
Scientific Name: *Salix candida* Fluggë ex Willd.
Synonyms: none
Common Name: Sageleaf willow
Family: Salicaceae
Size of Genus: There are about 450 species of *Salix* in the world; 113 in the North American flora (Argus 2010) and 32 in Wyoming (Dorn 2001).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none; Sensitive in the Rocky Mountain Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S2S3
WYNDD Plant List: Track as SOC. Conservation of sageleaf willow as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Figures 32, 33. *Salix candida* at Kendall Warm Springs ranges from 10 - 35 cm in height. Photos by B. Heidel

Description
Technical Description: Sageleaf willow is a low shrub (10) 50-120 cm tall. The branches are light brown and mostly glabrous. Twigs of the current year are densely white pubescent. This pubescence may persist into the second year. The leaves are narrowly elliptic to narrowly ovate, 3-8 cm long, and have entire, inrolled margins. The upper leaf surface is dark green with scattered tufts of woolly hair, while the lower surface is densely white-tomentose. Catkins appear with the leaves and are borne on short leafy branchlets or are nearly sessile. Flower bracts are brownish and wavy-pubescent.

Staminate catkins are 1.5-2.5 cm long with 2 stamens and reddish-purple anthers. Pistillate catkins are 2-5 cm long with tomentose, tawny capsules, styles 0.8-1.6 mm long, and stipes 0.5-1.2 mm long (Dorn 1997, Hitchcock and Cronquist 1964).

Local Characteristics: The dense wooly surface of the leaf underside is diagnostic (Figures 32, 33).

Similar Species: *Salix drummondiana* is a taller shrub and has thin, silvery, appressed hairs on the leaves, pruinose leaves and inrolled leaf margins. *S. brachycarpa* has relatively smaller elliptic leaves that are densely gray-hairy on both sides (Dorn 1997).

Geographic Distribution

Range: Ranges from Labrador to Alaska and south to the Great Lakes states, South Dakota, Colorado, and Idaho (Hitchcock and Cronquist 1964). In Wyoming, known from the Absaroka, Beartooth, Laramie, Medicine Bow and Wind River ranges, Yellowstone Plateau, and upper Green River Basin.

Extant Sites: Known from 25 extant occurrences in Wyoming. Most recently surveyed in 2018 (Figure 34, Table 11).

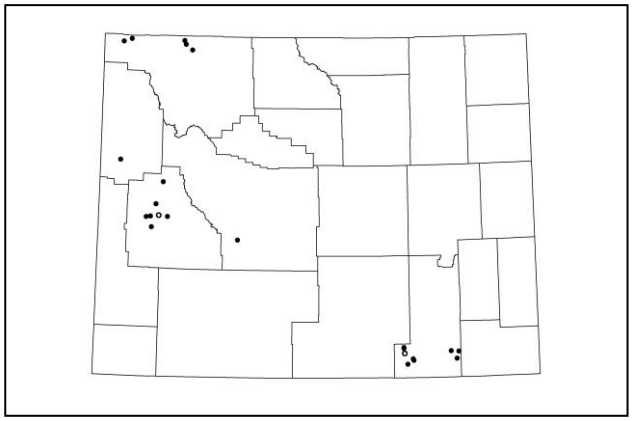


Figure 34: *Salix candida* in Wyoming

Table 11. Bridger-Teton National Forest occurrence of *Salix candida*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
#014	Kendall Wm Springs	Sublette	T38N R110W Sec 2 NE of SW	7800	Klondike Hill

Historic Sites: Collections were made in 1895, 1902 and 1930 outside the town of Centennial (Albany County) from locales that appear to have been close together. There are nearby populations in the Medicine Bow Mountains but the historic collection locations appear to be in the Laramie Basin.

Habitat

Settings and Vegetation: The Colorado habitat of *Salix candida* has been described as calcareous, rich or extremely rich fens (Decker 2006). Wyoming habitat has been described in broader terms as fens and willow thickets around ponds on wet to saturated, histic soils, sometimes influenced by limestone. At Kendall Warm Springs, it grows close to open water of marl pools (Figure 35). Elevation 6600-9200 feet.

Associated Species: *Betula glandulosa, Carex aquatilis, C. simulata, C. utriculata, Dasiphora fruticosa, Eleocharis quinqueflora, Parnassia palustris, Muhlenbergia filiformis, Salix brachycarpa, S. planifolia, Thalictrum alpinum*

Topography: Basins and valleys.

Figure 35. *Salix candida* habitat at Kendall Warm Springs is located close to a large marl pool by B. Heidel

Water and Soil Relationships: Saturated or super-saturated organic soils with a high water table

Population Biology and Demography
Flowering/Fruiting Period: Early June-late July.

Population Size and Condition: Known populations are mostly very small and restricted to specialized wetland habitats that are themselves very uncommon.

Threats: Vulnerable to water diversions, impoundments, livestock grazing pressure and possibly to wildlife herbivory (on the National Elk Refuge).

RANNOCH-RUSH (*Scheuchzeria palustris* L.)

Classification
Scientific Name: *Scheuchzeria palustris* L.
Synonyms: none
Common Name: Rannoch-rush
Family: Scheuchzeriaceae
Size of Genus: Monotypic genus
Phylogenetic relationships: Scheuchzeriaceae appears to be related to Juncaginaceae even though it is a separate family.

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Track as SOC. Conservation of rannoch-rush as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description
Technical Description: Rannoch-rush is a rhizomatous perennial grass-like herb with erect, slightly zig-zagging stems 10-40 cm tall. Leaves are linear, alternate, 10-40 cm long, and strongly sheathing and somewhat inflated at their bases. Ligules are 2-10 mm long and rounded. The inflorescence is a 3-12 flowered raceme subtended by a leafy bract. The flowers are bisexual and consist of 6 greenish-white or yellowish tepals that are 3 mm long. The greenish-brown fruits consist of three spreading, leathery, oval, pod-like follicles that are joined only at the base and contain 1-2 seeds (Hitchcock et al. 1969; Nienaber 2000).

Local Characteristics: Zig-zag stems, grass-like habit, 6-tepaled whitish flowers, and pod-like fruits are distinctive (Figures 36, 37).

Similar Species: none

Figure 36. *Scheuchzeria palustris* at Moose Lake by B. Heidel

Geographic Distribution

Range: Circumboreal distribution in the Northern Hemisphere from Alaska to Newfoundland, south to northern California, Idaho, Wyoming, Iowa, Indiana, and West Virginia (Hitchcock et al. 1969, Nienaber 2000). In Wyoming, known only from the Yellowstone Plateau (Teton County).

Extant Sites: Known from 6 extant records in Wyoming, five of which are on Caribou-Targhee NF (Figure 38, Table 12). The latter are on separate lakes but all within 2 km of one another and might represent a population complex.

Figure 37. *Scheuchzeria palustris* by Jeanne R. Janish in Hitchcock et al. 1969

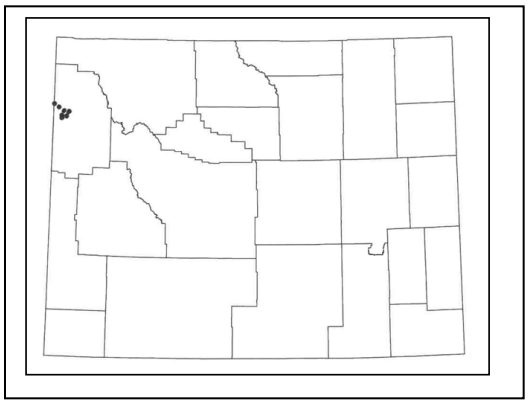


Figure 38. *Scheuchzeria palustris* in Wyoming

Table 12. Caribou-Targhee National Forest occurrences of *Scheuchzeria palustris*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
002	Rock Lk	Teton	T47N R118W Sec 18 SW of NW	6440	Cave Falls
003	Loon Lk	Teton	T48N R118W Sec 18 SW of SE	6440	Hominy Peak
004	Moose Lk	Teton	T48N R118W Sec 25 N of SW	6440	Hominy Peak
005	Junco Lk	Teton	T48N R117W Sec. 18	6440	Cave Falls
006	Fish Lk	Teton	T48N R117W Sec. 18 SE of SE	6450	Hominy Peak

Historic Sites: none

Habitat

Settings and Vegetation: Graminoid fens, often on or near *Sphagnum* mats (Figure 39).

Associated Species: *Carex lasiocarpa, C. echinata, C. limosa, Comarum alustre, Drosera anglica, Menyanthes trifoliate, Pedicularis groenlandica, Sphagnum* spp., *Tofieldia glutinosa.*

Topography: Basins

Figure 39. *Scheuchzeria palustris* habitat at Loon Lake by B. Heidel

Water and Soil Relationships: Saturated and supersaturated peat with a high water table

Population Biology and Demography

Flowering/Fruiting Period: August-September.

Population Size and Condition: In the five sites surveyed in 2018, numbers ranged from 3 – 1000+. It reproduces vegetatively by rhizomes so the number of stems is likely to exceed the number of genetically unique individuals.

Threats: Vulnerable to trampling and water table alteration.

NORTHERN SPIKEMOSS (*Selaginella selaginoides* (L.) Beauv. ex Schrank & Mart.)

Classification
Scientific Name: *Selaginella selaginoides*
Synonyms: none
Common Name: Northern spikemoss
Family: Selaginelliaceae
Size of Genus: Over 700 species are in the genus, including 38 in North America (Valdespino 1993) and six in Wyoming (Dorn 2001).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none; Sensitive in Rocky Mountain Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Track as SOC. Conservation of northern spikemoss as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description
Technical Description: Low spike-moss is a moss-like, glabrous, perennial herb with slender branched, prostrate, sterile stems and ascending fertile stems arising 3-10 cm above the ground. The thin, narrowly lance-shaped leaves are 1-3 mm long, spirally arranged on the stem, and have bristles on the margin though not on the tip. The upper leaves of fertile stems are larger, with spore-bearing receptacles at their base (Dorn 2001, Hitchcock et al. 1969).

Figure 40. *Selaginella selaginoides* at Upper Green River Lakes by B. Heidel

Local field characteristics: The prostrate stems often blend in with mossy background vegetation, so the fertile shoots are key to locating the species.

Local Characteristics: The upper leaves of fertile fronds resemble the fertile shoot of a clubmoss (Figures 40, 41).

Similar Species: Other species of *Selaginella* have bristle-tipped leaves, a dorsal midvein, 4-angled fertile stems, and occur in rock outcrops or dry, gravelly soils.

Geographic Distribution

Range: Ranging across the Northern Hemisphere, extending south as far as Nevada and Wyoming, Michigan and Maine. Wyoming populations are known from the Upper Green River Basin, foothills of the Wind River Range, and Teton Range in Sublette and Teton counties.

Extant Sites: Known from four Extant Sites in Wyoming (Heidel and Handley 2006), including the new 2018 record (Figure 42, Table 13).

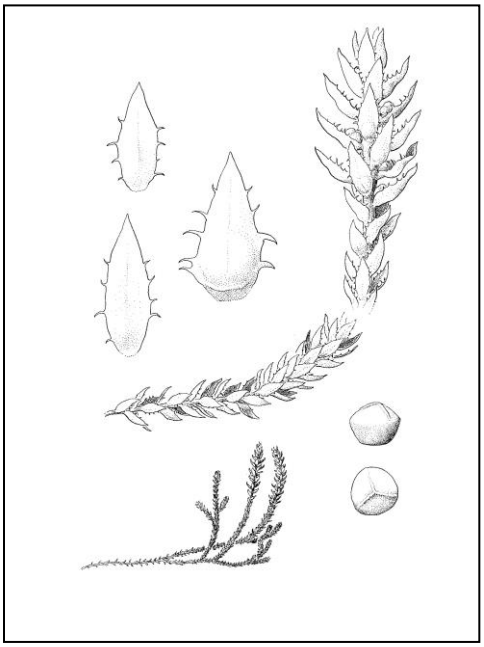


Figure 41. *Selaginella selaginoides* illustration by Jeanne R. Janish in Hitchcock et al. 1969

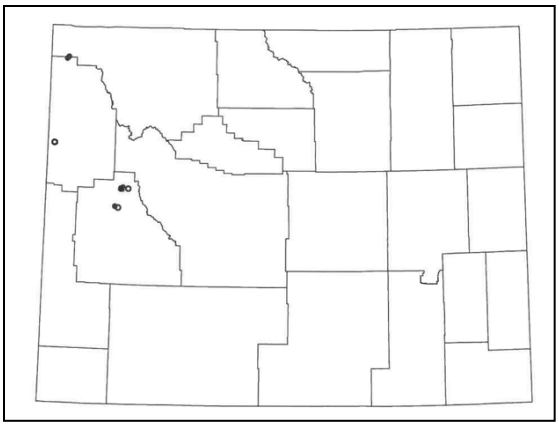


Figure 42. *Selaginella selaginoides* in Wyoming

Historic Sites: There are also four historic occurrences in Wyoming. Three of the four historic collections made between 1925-1956 were in Region 4 (Figure 42, Table 13). One of the historic collection sites is located within a couple miles of the new occurrence.

Table 13. Bridger-Teton and Caribou-Targhee National Forest occurrences of *Selaginella selaginoides*

EO#	Location	County	Legal Description	Elev.	USGS 7.5' Quad
001	Treasure Mtn Scout Camp	Teton	T44N R118W Sec 25 NE	6850	Granite Basin
002	New Fork R below loser New Fork Lk	Sublette	T36N R110W Sec 16?	7700	New Fork Lakes
003	Lower Green R Lake, sw. bank	Sublette	T38N R108W Sec. 5	8000	Green River Lakes
008	Upper Green R Lakes	Sublette	T39N R108W Sec 30 NE of SE	8000	Green River Lakes

Habitat

Settings and Vegetation: Mossy banks and saturated moss-covered zones in wet meadows. It specifically occupies fen habitat, in part or all of its Wyoming habitat, usually among shrubs on mossy mounds. The low shrub cover of its habitat is not apparent at a distance (Figure 43).

Associated Species: *Carex simulata, Salix glauca, Primula egaliksensis Polygonum vivipara, Juncus balticus, Swertia perennis.*

Topography: Valleys

Water and Soil Relationships: Restricted to high water table settings, if not to fens in particular.

Figure 43. *Selaginella selaginoides* habitat at Upper Green R Lakes area, by the lower of two pools in this photo by B. Heidel

Population Biology and Demography

Flowering/Fruiting Period: Spores produced July-August.

Population Size and Condition: Locally common but in small area of Upper Green R Lakes site, est. less than 5000. In Wyoming, most populations are small and all are restricted to specialized microhabitat.

Threats: Vulnerable to trampling and water table alteration.

ROLLAND'S BULRUSH (*Trichophorum pumilum* (Vahl) Schainz & Thell.))

Classification
Scientific Name: *Trichophorum pumilum* (Vahl) Schainz & Thell.
Synonyms: *Scirpus pumilus*
Common Name: Rolland's bulrush (pygmy bulrush)
Family: Cyperaceae
Size of Genus: There are nine species in the genus including six in North America (Crins 2002) but only one in Wyoming (Dorn 2001).
Phylogenetic relationships: The genus is circumpolar and Trichophorum is also in Europe and Asia. Variety level differences between T. *pumilum* var. *rollandii* in North America and Eurasian are "elusive" (Crins 2002).

Figure 44. *Trichophorum pumilum* in Medicine Bow NF by B. Heidel

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
WYNDD Plant List: Track as SOC. Conservation of Rolland's bulrush as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description
Technical Description: Rolland's bulrush is a low-growing tufted perennial with slender rhizomes. Stems are 5-10 cm tall, round in cross-section, green, and leafless. Leaf blades are 0.5-1 mm long and located near the base of the stem. The inflorescence consists of a single oval spikelet composed of 3-5 flowers borne at the tip of the stem. The smooth, 2-sided achenes are dark brown and subtended by 3-6 red bristles and short, white-membranous scales (Beetle 1941; Dorn 2001; Fertig et al. 1994).

Local Characteristics: The shiny dark brown achenes and dense rhizomatous colonies are characteristic (Figures 45, 46).

Similar Species: Low-growing *Eleocharis* spp. have a cap-like structure at the top of the achene (actually the enlarged base of the style), a feature absent in *Scirpus* species (Fertig et al. 1994). Other *Scirpus* spp in Wyoming have 2 or more spikelets per stem and leafy inflorescences or stems (Dorn 2001).

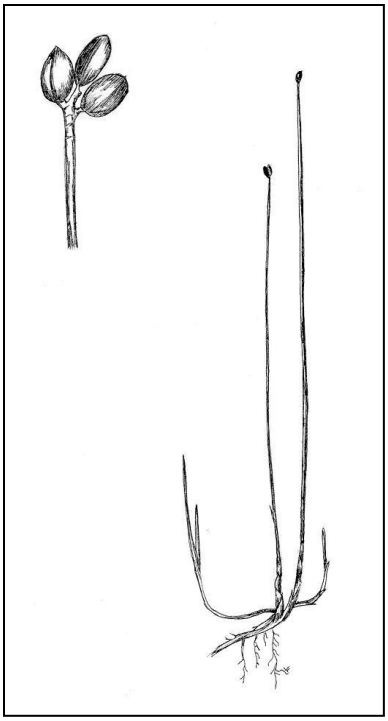


Figure 45. *Trichophorum pumilum* illustration by Walter Fertig, in Fertig et al. (1994)

Geographic Distribution

Range: Circumboreal, with disjunct populations in Idaho, Colorado, Wyoming, California, and Montana. In Wyoming it is known from the Medicine Bow, Absaroka, and Gros Ventre ranges, Green River Basin, and Jackson Hole in Albany, Park, Sublette, and Teton counties.

Extant Sites: Known from ten occurrences, most recently surveyed in 2018 (Figure 46, Table 14).

Table 14. Bridger-Teton National Forest occurrences of *Trichophorum pumilum*

EO#	Location	County	Legal Description	Elev.	USGS 7.5'
002	Alkali Creek near Gros Ventre R	Teton	T42N R113W Sec 23 SW4	7400	Grizzly Lake
010	Upper Green R Lakes	Sublette	T39N R108W Sec 30 NE of	8000	Green River
011	Kendall Wm Springs	Sublette	T38N R110W Sec 2 NE of	7840	Klondike Hill

Historic Sites: none

Habitat

Settings and Vegetation: Graminoid fens, often located close to surface water. Associated Species: *Carex simulata, Salix planifolia, Gentiana detonsa, Primla egaliksensis, Parnassia palustris, Carex microglochin*.

Topography: Valleys

Water and Soil Relationships: Saturated and supersaturated peat with high water table.

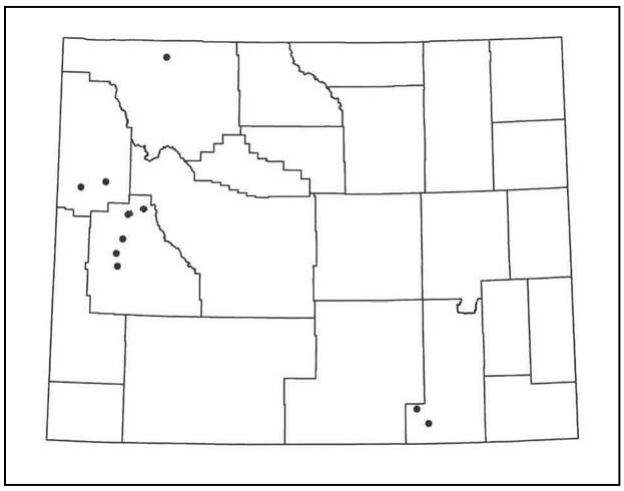


Figure 46: *Trichophorum pumilum* in Wyoming

Population Biology and Demography

Flowering/Fruiting Period: mid July-early September

Population Size and Condition: In small, dense areas that may reflect vegetative reproduction. Both of the populations surveyed in 2018 had over 1000 fruiting stems.

Threats: Vulnerable to trampling and water table alteration.

LESSER BLADDERWORT (*Utricularia minor* L.)

Classification

Scientific Name: *Utricularia minor* L.
Synonyms: none
Common Name: Lesser bladderwort
Family: Lentibulariaceae
Size of Genus: Three species were reported in Wyoming by Dorn (2001), with addition of a fourth species by Hellquist et al. (2014) based on their work in Yellowstone National Park.
Phylogenetic relationships: unknown

Present legal or other formal status

U.S. Fish & Wildlife Service: none
U.S. Forest Service – Intermountain Region: none; Sensitive in Rocky Mountain Region
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2018) reported an SRANK of S3 and transferred it from recognition of a tracked species to watch status. It remains as a watch species as long as it is on the Rocky Mountain Region (R 2) Sensitive list.
WYNDD Plant List: Conservation of lesser bladderwort as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

Description

Technical description: Lesser bladderwort is a perennial aquatic herb with submersed, weak stems and leaves. The leaves are 0.3-1 cm long and finely dissected, with each 3-parted leaflet further divided into 1-3 flat, toothed segments. Small bladders (1-2 mm wide) are scattered along the main leaf blade among the leaflets. The inflorescence is a raceme of 2-9 yellow flowers on an emergent stalk 4-15 cm long. The short-spurred, snapdragon-like flowers are bilobed, with the lower lip 4-8 mm long and about twice as long as the upper lip (Cronquist et al. 1984, Dorn 2001).

Figure 47. *Utricularia minor* visible at surface, in Shoshone NF by B. Heidel

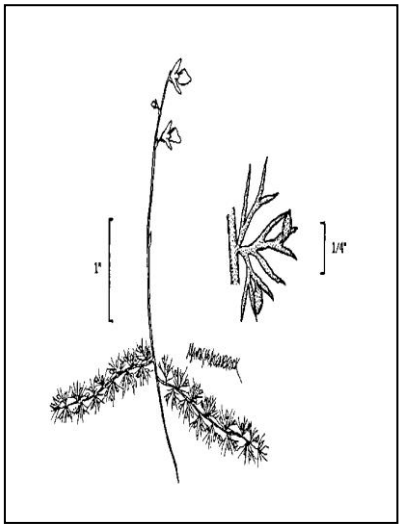


Figure 48 (above). *Utricularia minor* in Bighorn NF by B. Heidel
Figure 49 (right). *Utricularia minor* illustration from USDA NRCS (2011)

Local Characteristics: The dissected leaf is wider than long (Figures 47, 48). Flowering plants are rarely seen, and the delicate submerged plants may be hidden by detritus. Technical keys are needed for positive determination.

Similar Species: *Utricularia macrorhiza* (syn. *U. vulgaris*) has leaves 10-50 mm long, forked leaf segments, and flowers 12-18 mm long. *U. intermedia* has bladders 2.5-4.0 mm long, borne on separate, leafless branches. *Utricularia ochroleuca* was recently added to the Wyoming flora (Hellquist et al. 2014) as known in Yellowstone National Park (Park and Teton counties), as well as collected by the author from Sublette County (cited in Hellquist et al. 2014).

Geographical distribution

Range: Circumboreal, extending south in North America to California, Colorado, Indiana and New Jersey. In Wyoming, known from the Yellowstone Plateau, Jackson Hole, Laramie Basin, and Absaroka, Big Horn, Laramie and Medicine Bow Mountains, in Albany, Fremont, Johnson, Park, Sheridan and Teton counties.

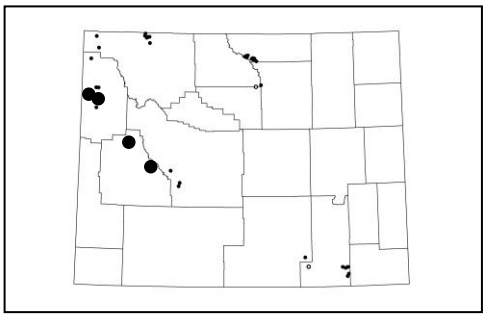


Figure 50. *Utricularia minor* in Wyoming

Extant Sites: Known from 59 recent records (most recently observed in 2018). This species had a total of eight populations documented in 2018 (Figure 50, Table 15), more records than any other species in the study. It was the only target species that was found to be present in both Bridger-Teton and Caribou-Targhee National Forests.

Historical sites: There is one historical record that was collected at the foot of the Medicine Bow Mountains by Aven Nelson in 1900, and another collected in the Big Horn Mountains by C.L. Porter in 1959, neither which have been relocated.

Table 15. Bridger-Teton and Caribou-Targhee National Forest occurrences of *Utricularia minor*

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
42	Loon Lk	Teton	T48N R117W Sec 19 NW4	6440	Hominy Peak
43	Indian Lk	Teton	T47N R118W Sec 4 NW4	6440	Sheep Falls
56	Kendall Wm Spr	Sublette	T38N R110W Sec 2 NE of SW	7800	Klondike Hill
57	WR3	Sublette	T35N R107W Sec 35 SW of SW	9740	Horseshoe Lake
58	WR5	Sublette	T34N R107W Sec 2 NE of NE	9640	Horseshoe Lake
59	WR10	Sublette	T35N R107W Sec 36 NE of NE	10,110	Horseshoe Lake
60	Fish Lk	Teton	T48N R117W Sec 18 SW of NE	6450	Cave Falls
61	Tillery Lk	Teton	T48N R116W Sec. 18 SW	7310	Survey Peak
62	Moose Lk	Teton	T48N R118W Sec 25 N of SW	6440	Hominey Peak

Figure 51. *Utricularia minor* habitat in a small pool among *Carex simulata*, obscured by calcium bicarbonate, at Kendall Warm Springs by B. Heidel

Habitat

Settings and Vegetation: Habitat of lesser bladderwort was originally characterized as submerged in shallow ponds, lakes, and slow-moving streams. More specifically, most Wyoming occurrences are in the small pools of fens (Figure 51). It is also in the geothermally-heated wetland complexes in Yellowstone National Park.

In the Bridger-Teton and Caribou-Targhee National Forests, occurrences are in fens of both riverine and basin settings. It usually grows submerged within small pools bordered by *Sphagnum* mats, but sometimes grows on supersaturated peat at lake level, as though on an exposed sponge. Its distribution on these two National Forests span a range of elevation, from 6440-10,110 ft., that covers almost the full range for the species in the state.

Frequently Associated Species: Lesser bladderwort is associated with species that grow as emergents, in standing water at the margin of peatland pools, or in floating mats, including

mud sedge (*Carex limosa*), water sedge (*C. aquatilis*), slender sedge (*C. lasiocarpa*), beaked sedge (*C. utriculata*), lesser bladder sedge (*C. vesicaria*), Buxbaum's sedge (*C. buxbaumii*), bog buckbean (*Menyanthes trifoliata*) and *Sphagnum* spp. It is sometimes intermixed with common bladderwort (*Utricularia macrorhiza*), but they are more often found at different depths of the same wetland. The submerged plants with which it is most closely associated are often submerged aquatic mosses (*Drepanocladus spp, Calliergon* spp. and others) but information is sketchy.

Topography: It is mainly in basin fen settings, with the exception of a couple well-developed sloping settings.

Water and soil relationships: Requires standing water throughout the growing season and high water table, at least in small pockets between peat mounds.

Population biology and demography

Phenology: Elsewhere this species flowers in August, but it has never been collected in flower in Wyoming. It is identifiable in vegetative condition from at least July-early September.

Population size and condition: This is a very small species that is often submerged, so it is rarely possible to determine more than its frequency and population extent. The species is also sometimes completely obscured by calcium bicarbonate deposits in which case it can only be confirmed by fishing out and rinsing. As such, it is not apt to be picked up in vegetation plots, and the Barnes Lake area collections represent the first time that this species was located on the west side of the Wind River Range.

Threats: This species may have lost habitat to beaver activity where it is in riverine settings, at least in the Laramie Range.

RESULTS - Species Diversity, Vegetation, and GDE Documentation

Fen Plant Species Diversity

A master list of the fen flora for the 16 study sites contains 138 species, as presented in Appendix E. Species that were found only on the margins of peatland and that may be transitional to upland habitats are marked by "~". Submerged species of directly adjoining open water habitats are included in the fen flora list, consistent with Cooper and Andrus (1994).

The fen flora is comprised of at least 41 families, 83 genera and 148 species. This represents about 5.5% of the Wyoming vascular flora in Dorn (2001).

Representative Fen Vegetation

Almost all of the fen vegetation documented in this study is dominated by graminoids There are major composition differences between the graminoid-dominated fens of two main study areas, and of the Upper Green River sites. The lowest elevation fens, found in the Winegar Hole area of Caribou-Targhee National Forest, had *Carex lasiocarpa* as the most widespread dominant or co-dominant. Other co-dominant sedges with high local cover include *C. echinata* and *C. limosa*. There were small areas dominated by *Eleocharis quinqueflora* and *Carex buxbaumii*. Despite the proximity of Tillery Lake to the Winegar Hole area, Tillery Lake had no *Carex lasiocarpa-dominated* vegetation. *Carex aquatilis* was dominant, with codominance of *C. limosa* over a large central area. It also had the only shrub-dominated fen vegetation zone that covered a small area at the margin.

At the highest elevation fens, in the Barnes Lake area of Bridger-Teton National Forest vegetation, was described by Cooper and Andrus (1994), as six "peatland expanse communities" (Table 1 in Cooper and Andrus 1994). They reported that peatland expanse vegetation included both small sedge and large sedge vegetation, and that that the most common small sedge community type was *Carex aquatilis – Viola epipsila*; all are listed below using the names given by Cooper and Andrus (1994).

<u>Small sedge community types</u>
Carex aquatilis – Viola epipsila
Carex bigelowii – Caltha leptosepala
Carex limosa – Menyanthes trifoliata
Eleocharis quinqueflora – Drepanocladus aduncus
Carex canescens

<u>Large sedge community types</u>
Carex utriculata

We found four of the six vegetation units as previously described (Cooper and Andrus 1994).

The *Carex aquatilis – Viola epipsila* type was said by Cooper and Andrus (1994) to be the most abundant vegetation in the Barnes Lake area peatlands. It corresponds closest to

what was recorded in 2018 as *Eleocharis quinqueflora – Carex aquatilis* vegetation. However, we did not find extensive areas having high vegetation cover of *Viola* spp except in small patches, at only one site, at the margin of fen. The matter is a little more confusing taxonomically in that *Viola epipsila* is not recognized in the Wyoming flora (Nelson 2018), but is represented in Flora of North America as a northern species in no other lower 48 states except Colorado. It is part of the *V. palustris* complex (Little and McKinney 2015). We collected what keyed out in Dorn (2001) to *V. macloskeyi*. This type was well-expressed in WR5 wetlands, and at most of the WR3 wetlands, except for absence of high cover of *Viola* species.

The *Carex bigelowii-Caltha leptosepala* type was said by Cooper and Andrus (1994) to replace the *C. aquatilis* type at higher elevations. It is perhaps best explained by checking SEINET (2019) in which there is a COLO specimen of *Carex bigelowii* collected by David J. Cooper from the study area that was later annotated to *C. scopulorum* by Barry C. Johnston in 1999. We did find a site where *C. scopulorum* was co-dominant with *C. limosa* on *Sphagnum* mats of WR10, though did not find a major component of *Caltha leptosepala* there or elsewhere in Barnes Lake area sites.

The *Carex limosa – Menyanthes trifoliata* type was described as forming floating mats in small ponds (Cooper and Andrus 1994). We did find continuous, shoreline *Sphagnum*-dominated mat vegetation at WR5 addon, and at WR10. However, we did not find any floating peat mats perched above water column in the Barnes Lake area. Instead, we found it on anchored peat at the water's edge, where peat was 1-2 m thick.

The *Eleocharis quinqueflora – Drepanocladus aduncus* type was described as typical of sloping peatland stands (Cooper and Andrus 1994). While we did not verify the bryophyte, we did note a brown moss as sometimes co-dominant, consistent with a *Drepanocladus* species (partially submerged, with falcate-secund leaves). In general, we found high cover of *Eleocharis quinqueflora* in other vegetation that were not reflected in those vegetation type names, including codominance with *Carex aquatilis, C. limosa* and *C. utriculata*. The raw species cover data, by stand, in Cooper and Andrus (1994) indicates that they did not find it as major components of other vegetation.

The *Carex utriculata* type was described as common in peatlands throughout the Rocky Mountains that have seasonal standing water up to 40 cm deep (Cooper and Andrus 1994). We documented a *C. utriculata* type growing in a soil profile of interbedded peat and mineral soil. It had peat at the surface but did not meet the peat thickness criteria as determined from the core through the soil profile. Instead, it had a 15 cm peat thickness at the surface, underlain by mineral soil and another 8 cm thickness below. *Carex utriculata* vegetation is definitely part of study area peatland systems though as submerged vegetation.

The *Carex canescens* type was described as present in small stands on the margins of *Eleocharis quinqueflora – Drepanocladus aduncus* vegetation in small seepage slope settings (Cooper and Andrus 1994). We do not have data or observations on local dominance by this species though observed it as present in other types.

The Upper Green River sites contrasted with the two major study areas in having *Carex simulata* as dominant, throughout the two peatland sites except for small patches and zones that differed.

Graminoid fen vegetation of both Barnes Lake and Winegar Hole areas had well-developed, but localized patches of *Sphagnum* mat vegetation. *Sphagnum* species influence microhabitat conditions and succession to an exceptional degree (Rydin and Jeglum 2013) and those sites with *Sphagnum* mat vegetation were most likely to have rare species. In nearly all cases, the *Sphagnum* mats do not prevail in the peatland of any given site or form large continuous areas that can be mapped as separate vegetation zones. The one site where *Sphagnum* mat vegetation was continuous was the Barnes Lake area site WR10 where the only well-developed peatland vegetation was *Sphagnum*-dominated habitat on the south shore of a large pond.

There is a major shrub component throughout the fen at Upper Green River Lakes, though not enough to characterize it as a shrub-dominated community. There is also a shrub-dominated zone at Tillery Lake (Table 3), though covering only a small area.

Fens as Groundwater Dependent Ecosystems

Data collected at each of the 16 GDE sites are recorded in electronic GDE forms (Appendix D), and electronic data entry files will be conveyed separately. Highlights of GDE results are presented in this section and summary data are shown in Table 3. The reader is referred to raw data for the bulk of results.

The six Caribou-Targhee National Forest sites are in basin settings, associated with lakes, or around large ponds in palustrine systems directly above lakes. The ten Bridger-Teton National Forest sites are in riverine settings, and though some are positioned at headwaters and above large ponds in such riverine settings. All 16 sites are inclusions in larger palustrine, lacustrine or riverine systems rather than peatlands covering the entire local wetland feature.

All 16 sites appear to be associated with Quaternary deposits and might be influenced by contact zones between recent deposits and underlying bedrock. The Barnes Lake area sites might be strongly influenced by the bedrock fractures shown in bedrock geology mapping (Love and Christiansen 1985).

A review of statutes and policies that establish management requirements related to GDEs can be found in the Groundwater Dependent Ecosystem Inventory and Monitoring Business Requirements Analysis (USDA Forest Service 2012a,b).

Sphagnum Species and Amphibian Species Diversity

Four species of *Sphagnum* were collected from five of the six sites on Caribou-Targhee National Forest, for a total of eight collections (Table 16). *Sphagnum* species were present but were not collected at Fish Lake. *Sphagnum squarrosum* was dominant in fen settings at Junco, Loon, Moose Lakes. The four species are among the more widespread

species of *Sphagnum* in the state (Kosovich-Anderson pers. commun.) and tend to be generalists in their habitat requirements.

Table 16. *Sphagnum* species collected at Caribou-Targhee National Forest sites in 2018

Species	**Study Site**
Sphagnum squarrosum	Junco, Loon, Moose, Tillery Lakes
Sphagnum subsecundum	Tillery Lake
Sphagnum teres	Moose, Rock Lakes
Sphagnum warnstorfii	Loon Lake

Two of these species, *Sphagnum subsecundum* and *S. teres*, were noted as the two most frequent species of *Sphagnum* sampled in the Barnes Lake area of the Bridger-Teton National Forest study area (Cooper and Andrus 1994).

The five amphibian records from five sites on Bridger-Teton and Caribou-Targhee National Forests are represented in Table 17.

Table 17. Amphibian species recorded at Bridger-Teton and Caribou-Targhee National Forest sites in 2018

Species	**Study Site**
Boreal chorus frog	Junco, Loon, Moose, Tillery Lakes
Columbian spotted frog	Upper Green River Lakes site

RESULTS - Disturbance

Disturbance history is an important context for the rest of results, particularly as peatlands are characterized as stable habitats. On the Bridger-Teton National Forest, all but one of the Barnes Lake study sites had nearby uplands that had burned in the 1988 Fayette Fire. OnlyWR8 was outside of the fire. Most of the surrounding landscape burned as crownfire, with very low or no recruitment since the fire to replace the tree cover, and with standing dead trees remaining throughout much of the area. Though some local Barnes area wetland sites had intact woodland margins (WR5 add-on, WR10), the fires may still have caused erosion and affected their hydrological conditions. There was no mention of fire by Cooper and Andrus (1994) though their study was conducted the next year after the Fayette Fire, in 1989. The much more accessible study sites on the Green River in highly-visited areas of the Forest showed surprisingly few hydrological disturbances.

On the Caribou-Targhee National Forest, there appeared to be both natural and man-made disturbances. The Tillery Lake site is perhaps the most hydrologically-manipulated of 2018 study sites. It has water levels artificially maintained and slightly raised by a lowhead drop structure at the mouth. It also has a nearby diversion that can feed water into Grassy Reservoir, perhaps the reason that the drop structure was constructed. As a result, there are trunks of very old, dead flooded trees poking up like small islands in the lake near fen habitat. Similarly, Junco Lake had flooded trees but most were alive and watermarks around the trunk showed evidence of having reached onetime higher levels earlier in the 2018 growing season, though no earlier years of high water were discerned. We saw at least seven

beavers when we arrived at Junco Lake and every sign is that the lake outlet has been dammed by beaver. It appears as though fen habitat was newly-flooded in 2018 at Junco Lake. The place mapped as Fish Lake (USGS 7.5') had large dead trees near the lake, and smaller trees near the fen wetland area situated above it. Despite the dead trees, we saw no direct evidence of flooded fen habitat. At the other end of the spectrum, the place mapped as Rock Lake (USGS 7.5') had no standing water or vegetation to indicate that it had recently functioned as a lake, or even subsurface moisture at the time of visit. However, the soils and vegetation were consistent with that of an old lakebed. The fen wetland area in the vicinity of the non-existent Rock Lake is over 0.5 km (0.3) mi distant and isolated from the lakebed. It did not appear to have direct hydrological connections to the former lake or show signs of lowered water tables.

DISCUSSION - Fen Rare Plants Species

Rare plant survey results reveal that some of the species sought in 2018 are locally abundant and extensive, such as *Lycopus uniflorus*, and may not be appropriate to track as a state species of concern. Its state rank is being changed from S1 to S2S3 and it will be removed from the species of concern list. *Utricularia minor*, found in both Bridger-Teton and Caribou-Targhee National Forests, is now known from many sites across Wyoming without evidence of decline. Despite its scarcity at many of these sites, it may not warrant Sensitive designation or local concern consideration in Wyoming. It remains as a watch species on the species of concern list pending broader discussion and update of the U.S. Forest Service Rocky Mountain Region sensitive list.

We documented habitat specificity and narrowness of distribution for other rare plant species. Both of the Upper Green River sites had *Trichophorum pumilum* documented for the first time, in small areas within peatland habitat. This species, and some of the others documented in 2018, tend to have small stature. It is highly habitat-specific within an uncommon fen having high electrical conductivity. If there are other such fens that have already been found on the Forest, closer plant surveys may be warranted.

We tried to cover all peatland habitat as potential rare plant habitat at each site but either missed parts of fen habitat at Tillery Lake, or the two rare species that we failed to find do not occupy fen habitat. Both are mapped on the northwest corner of Tillery Lake not far from the outlet, and the slopes above this shoreline did not appear to support wetland habitat in general or fen habitat in particular.

DISCUSSION - Species Diversity, Vegetation, and GDE Documentation

Fen Plant Species Diversity

The 16 study sites host a relatively high diversity of fen species, though not every site has high vascular plant species diversity. The sites with highest species diversity tend to be the largest – Loon Lake has the most extensive peatland habitat of the 16 study sites and has highest reported species diversity (Appendix E). The sites with the "most different" species tend to be those with the greatest difference in environmental conditions, including the Kendall Warm Springs and Upper Green River Lakes sites with their extremely high

electrical conductivity and calcium bicarbonate precipitation (Table 3) that host species not found elsewhere among the 16 study sites.

Only one of the rare plant species targeted in this project is currently recognized as Sensitive in the USFS Intermountain Region, Greenland primose (*Primula egaliksensis*). Like most other target species, it has a disjunct rangewide distribution, one of the more extreme disjunctions. It is a northern species present in a few populations of Colorado and Wyoming, with no other United States populations except in Alaska, and with the nearest Canadian populations in Alberta west of Edmonton. The significance of disjunct species from northern latitudes at southern limits of their range is not universally agreed. In the case of one disjunct alpine plant, Oeder's lousewort (*Pedicularis oederi*), it has been demonstrated that the disjunct populations at the southern limits had much higher genetic diversity compared to northern populations (Marr et al. 2008). It was interpreted that the southern populations had longer times to adapt to their habitats if those habitats remained unglaciated, compared with the relatively short period of time that continental glaciers retreated from boreal zones.

Representative Fen Vegetation

The plot data generated from this study represents a small sample size and has limited value for making generalizations about fen vegetation. While it relates to vegetation types that have already been described, its analysis or crosswalk with other vegetation descriptions require more work.

Aerial imagery used in the field served as a reference for determining whether the peatland vegetation zones showed discernable patterns. Most study area fen vegetation was less than 1 ac, complicating pattern recognition. A distinct pattern of mounds-and-pools was apparent on aerial photos of WR10 and proved to be a sort of latticework of *Sphagnum* mounds and pools, but only when imagery was greatly enlarged.

We did not find patterns consistent with paludification, i.e., with peat growing out across open water. Instead, most of the peat shorelines at all elevations had a vertical "wall" of peat that abruptly dropped-off at the shore. For example, at the shoreline of WR10 with its *Sphagnum* mound vegetation, the water was 2 m deep as measured with a metallic tape measure standing on the anchored edge. Cooper and Andrus (1994) mentioned floating peat vegetation in their paper. The one study site that clearly had peat floating atop the water column was Kendall Warm Springs.

GDE documentation

This project contributes to GDE work on the Forests. GDE boundaries for the sites on the Bridger-Teton NF will be mapped with GDE waypoints collected by Martina Keil. GDE boundaries of Caribou-Targhee NF sites may be circumscribed by mapping the outer palustrine extent of the respective lacustrine systems as consistent with existing National Wetland Inventory maps.

Peatland mapping is not identical to GDE mapping if the entire low-lying area is not peatland. Peatland mapping was the priority for this project to determine potential fen habitat for rare species. The subtle boundaries of peat formation on the Bridger-Teton NF sites and

the combined surface and groundwater hydrology on the Caribou-Targhee NF sites were addressed on preliminary planes.

DISCUSSION - Possible directions for future work

This report represents the first botanical assessment of the biological diversity values associated with 16 fens in the Bridger-Teton and Caribou-Targhee National Forests. It complements Forest and Regional initiatives and provides a basis for maintaining the significant sensitive/rare fen plant species diversity of the USFS Intermountain Region. It provides a framework for evaluating species candidates for designation as Species of Concern in portions of the two forests. The study sites were located inside and outside of wilderness areas and represented an array of settings and conditions (undisturbed vs different natural disturbance vectors). Documentation of concentrated rare species numbers at Moose Lake, where previously none were known, suggests that expanded surveys are warranted if other such sites are possible.

It also provides a framework for expanding baseline inventory of rare fen plant species on Bridger-Teton and Caribou-Targhee National Forests and addressing these species in management planning. Results from this project are relevant to a separate, ongoing wetland mapping effort of the Colorado Natural Heritage Program (CNHP) (Smith and Lemly 2018). Since the size (surface area) of peatland may relate to biodiversity, the largest peatland sites as mapped by CNHP are priorities for groundtruthing and biodiversity survey.

Expanded fieldwork is compelling at any of the 2018 study areas if, for example, there were proposed changes to recreation, transportation, or allotment planning. It might be warranted for other activities at these sites that affect landscape hydrology, whether it be beaver reintroduction or prescribed burning. The 2018 study areas may also be suited for research into landscape hydrology. Finally, additional field surveys are warranted at Tillery Lake in particular to relocate *Cicuta bulbifera* and *Drosera anglica*.

Recent research has addressed the relative stability of montane peatlands as potentially affected by climate change (Millar et al. 2016). They determined that low elevation peatlands are more vulnerable than high elevation peatlands. The current study results might indicate that low elevation peatlands have greater numbers of rare species than those at high elevations. There is a need for additional information on the vulnerability of such low elevation peatlands and their species, with or without natural disturbances.

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