Inventory for Rare and Uncommon Plants in Fen and Fen-like Ecosystems on Ochoco National Forest

South over Bridge Creek and its seasonally wet riparian zone to the classic convex topography of a persistently groundwater-fed toeslope fen in upper Headwaters Bridge Creek wetland-meadow complex, Paulina Ranger District. Elev. = 6200 feet.

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The rare, ORBIC S1, R6 OR-STR parasitic fungus *Arrhenia lobata* on the moss *Drepanocladus aduncus* at the 5800/5810 rd. junction fen, Paulina Ranger District.

Acknowledgements

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Summary

Forty-nine sites in five 8th field HUCs on Ochoco National Forest that were reasonably suspected to include groundwater-fed wetland (fen) habitat were visited during 28 field days between 6/14/2017 and 10/4/2017. This report also includes information collected at 8 sites previously visited in 2007 and 2013. Zero target species and 17 new occurrences of four notable species were detected during the 2017 site visits. A broad-scope discussion of fens, and associated observations and considerations, is presented.

Introduction

This project is part of a series of Forest-level inventories within U.S. Forest Service Region 6 (R6) that are focused on better understanding the regional distribution of rare and uncommon fen-loving plants, as well as of the fens/groundwater-fed wetlands which support them. These inventories typically involve several days of pre-field analysis followed by 3-4 weeks of fieldwork by 1-2 persons. To date, Dewey has conducted either focused or opportunistic inventories for fens and fen-loving rare plants on the Deschutes, Ochoco, Fremont-Winema, Malheur, Umatilla, Wallow-Whitman and Mt. Hood National Forests, and the Klamath Falls Resource Area of the Lakeview U.S. Bureau of Land Management District in Oregon, and the Gifford Pinchot, Olympic, Okanogan-Wenatchee, Colville, and Mt. Baker-Snoqualmie National Forests in Washington. The focused inventories have been supported by grants from the USFS/BLM Interagency Special Status/Sensitive Species Program (ISSSSP). Reports based on these inventories are posted at https://www.fs.fed.us/r6/sfpnw/issssp/.

South along the gently sloping upper portion of the persistently groundwater-fed 4215-150 rd. wetland on the Paulina Ranger District. Elev. = 5200 feet.

While probably somewhat dependent on geographic locale, fens have been noted to play important roles in water quality maintenance and carbon retention. Fen ecosystems in Oregon and Washington are particularly notable for at least two other reasons. First, these ecosystems are locally either rare or uncommon, tending to be quite small in their individual aerial extent, and are generally very sparsely distributed within the mountains of these two states. For instance, on Deschutes National Forest in central Oregon, which may well be the most thoroughly inventoried and fen-rich forest in Oregon or Washington, the collective acreage of currently known fens is only about 460 acres, a mere 0.03% of the total acreage of the 1.6 million acre forest. Second, and as noted by Bedford and Godwin (2003), in spite of being an extremely tiny spatial component of the regional landscape, fen ecosystems generally contribute very disproportionately to local levels of plant biodiversity, particularly with regard to rare and uncommon plant species. Incidence of designated or proposed rare, fen-loving plant species is known to differ significantly among R6 forests where plant surveys within groundwater-fed habitats have occurred. For example, recent surveys have detected 15 species of designated (Washington Natural Heritage Program) or proposed (Dewey, 2017) rare fen-loving species on Okanogan-Wenatchee National Forest, Washington, while similar surveys on Mt. Hood National Forest, Oregon, have detected one designated (Oregon Biodiversity Information Center) rare fen-loving plant species.

Inflorescence of the fen indicator taxon hooded ladies tresses (*Spiranthes romanzoffiana*) at the 4215-150 rd. wetland, Paulina Ranger District.

Objectives

The geographic scope of this project was the Paulina and Big Summit Ranger Districts of Ochoco National Forest. Because of very limited potential fen habitat, surveys were not planned for the Crooked River National Grasslands. The intent of this study was to identify a group of Forest sites that were

reasonably likely to include fen habitats, and could be visited and examined with preferably no more than one hour hiking time, each way. Examination was to include development of a list of on-site bryophytes and vascular plants, including sensitive and other notable plant species, and a cursory description of vegetative structure, site wetness, soils, and site condition. It was hoped that this examination would allow at least a tentative identification of site habitats qualifying as fen, as opposed to other types of wetland or meadow, and allow some form of comparison and ranking among sites. "Target species" are species that Dewey was hoping, if not reasonably expecting, to find within the project area and that 1) have status as Forest Service Region 6 (R6) sensitive (SEN) or strategic (STR) species in Oregon, or 2) are listed as S1-S2 and List1-3 in the August 2016 "Rare, Threatened and Endangered Species of Oregon," published by the Oregon Biodiversity Information Center (ORBIC), and 3) are known associates of groundwater-fed wetlands (Table 1). "Notable species" are fen indicator taxa (FIT) understood to be rare or uncommon on Ochoco National Forest, exhibiting a strong affinity for persistently wet, groundwater-fed habitats, and may be ORBIC S3, List 4, or lack ORBIC status (Table 2). These "notable species" are currently know from one or two sites on the Forest except for *Tomentypnum nitens* (5 sites) and *Meesia triquetra* (6 sites).

Northeast down northern portion of lower, main groundwater-wetted slope at the 4220-151 rd. wetland-meadow complex, Paulina Ranger District. Elev. = 5470 feet.

Table 1. Target taxa for this project. Status sources are the 2016 (current) Rare, Threatened and Endangered species of Oregon, Oregon Biodiversity Information Center (ORBIC) and R6 Regional Forester's list Sensitive (SEN) or Strategic (STR) in Oregon.

Taxon Group	**Species**	**Status**
Bryophytes		
	Calliergon richardsonii	G4; ORBIC S1, List 2
	Calliergon (*Pseudocalliergon*) *trifarium*	G4; ORBIC S1, List 1; OR SEN
	Campylium stellatum	G5; ORBIC S1, List 2
	Harpanthus flotovianus	G5; ORBIC S1, List 2; OR SEN
	Lophozia gillmanii	G5; ORBIC S1, List 2; OR SEN
	Hypnum lindbergii	G5; ORBIC S1, List 3
	Hypnum pratense	G5; ORBIC S1, List 3
	Splachnum sphaericum	G5; ORBIC S1, List 1
Fungi		
	Arrhenia lobata	G5; ORBIC S1, List 3; OR STR
Vascular Plants		
	Carex capitata (capitate sedge)	G5; ORBIC S2, List 2; OR-SEN
	Carex lasiocarpa var. *americana* (slender sedge)	G5; ORBIC S2, List 2; OR-SEN
	Carex saxitilis (russet sedge)	G5; ORBIC S1, List 2; OR-SEN
	Utricularia minor (lesser bladderwort)	G5; ORBIC S2, List 2; OR-SEN

Table 2. Notable species for this project. Status source is the 2016 (current) Rare, Threatened and Endangered species of Oregon, Oregon Biodiversity Information Center (ORBIC).

Taxon Group	**Taxon**	**ORBIC 2016 status**
Mosses		
	Dicranella palustris	None
	Helodium (*Elodium*) *blandowii*	G5, S3, List 4
	Meesai triquetra	None
	Meesia uliginosa	G5, S3, List 4
	Sphagnum sp.	None
	Tomentypnum nitens	G5, S3, List 4
Vascular Plants		
	Betula glandulosa (resin birch)	None
	Eriophorum sp. (cottongrass); either *E. gracile* or *E. angustifolium*	None (ERGR8) or G5, S3, List 4 (ERAN6)

Methods

The primary data source utilized in pre-field analysis for this project was wetland mapping provided by the US Fish & Wildlife Service's National Wetland Inventory (NWI). Secondary data sources commonly used by the project lead, including site information for selected fen indicator taxa (FIT) extracted from the Consortium of PNW Herbaria (CPNWH) website, and Forest Service Natural Resource Manager (NRM) Threatened, Endangered, and Sensitive Plant species databases (TESP), provided little useful information for this project. Site suggestions by Forest staff, were a minor, but significant component of project planning, as was the project lead's incidental detection of potential sites made while conducting other

field projects. The NWI utilizes a very large set of wetland categories. Prior experience with the NWI has allowed Dewey to determine that the PEM1B, followed by PEM1C and PSSB categories, appear to be most strongly correlated with fens and fen-like ecosystems. A more detailed explanation of these codes is available at http://www.fws.gov/wetlands/data/wetland-codes.html, but briefly, "P" = palustrine, "EM" = emergent, "1" = persistent, and "B" = substrate saturated to surface for extended periods during the growing season. "C" = seasonally flooded, and "SS" = scrub-shrub. Because of the remarkably large number of PEM1B sites/polygons mapped on Ochoco National Forest (561), it was decided to evaluate only mapped PEM1B polygons as candidate sites for this project. These mapped PEM1B sites were grouped by 8th field HUC and screened based on size, ease of access, and promise as assessed by examining NAIP aerial imagery views. When more than 25 PEM1B sites were included within a single HUC, generally only polygons $\geq$ 1.0 acres were examined further. A summary of this process is presented in Table 3 below.

The fen-loving moss *Meesia triquetra* at the 4220-151 rd. wetland-meadow complex, Paulina Ranger District.

Field visits to fen candidate sites usually involved driving, parking, and some amount of trail and/or cross-country hiking. Upon arrival at a site, an effort was made to identify and walk through structurally differentiable plant communities within the site. Typically, the time spent at any site was directly related to the size of the site and the extent and pattern of biophysical diversity within that site. Types of information collected at a site included a plant species list, plant collections, a brief description of site character (vegetation structure, wetness and adjacent topography), soil probes, photographs and GPS coordinates of selected features. Plant species lists were never comprehensive. Known taxa were

generally always recorded. Unknown taxa, after consideration of taxon's potential significance in interpreting site conditions, were either collected to provide an opportunity for later identification, simply noted in field notebook, or left for some other, less time-sensitive visit. Field visits to fen candidate sites are best done in late summer or fall, in order to better assess the relative contributions of seasonal surface water vs. persistent, diffusely-discharging groundwater in contributing to wetness at the site. Late summer visits, however, may mean that detection and identification of some plant species will be more difficult because flowering and even fruiting periods have already passed. Typically, field seasons are crowded with obligations, and site visits are necessarily scheduled across the period from June through September.

Table 3. PEM1B site selection details for this project. "z10" and "z11" refer to portions of the main Upper Crooked HUC (that portion excluding the Maury Mountains) that fall within the UTM longitude/easting ranges of zone 10 or zone 11.

8th field HUC/project subunt	**# mapped PEM1B polys**	**# PEM1B polys examined**	**# PEM1B polys selected**
Trout	17	17	6
Lower John Day	39	11	5
Upper John Day	94	47	24
Beaver-South Fork	25	25	18
Upper Crooked (main, z11)	48	34	21
Upper Crooked (main, z10)	123	47	10
Upper Crooked (Maury Mtns)	56	15	5
Lower Crooked	159	38	16
Totals	561	234	105

Southwest up a robustly groundwater-fed slope that supports the mosses *Tomentypnum nitens*, *Meesia triquetra* and the cottongrass *Eriophorum* sp. Elev. = 6500 feet (left); large ungulate hoof pits in fen habitat supporting abundant *Tomentypnum nitens* and *Meesia triquetra*. Elev. = 6400 feet (right). Each site occurs on upper eastern flank of Lookout Mountain, Paulina Ranger District.

Results

Forty-nine sites were visited during 28 field days between 6/14/2017 and 10/4/2017. Although 105 PEM1B polygon sites were determined by pre-field analysis to warrant field visits, only a subset of this

group were visited. Accordingly, prioritization of sites was performed, based on factors such as size of mapped wetland area, accessibility, proximity to other high priority sites, and evidence of persistence and extent of groundwater-fed wetness at the site. Among the eight 8th field HUCs/project subunits included within the project area, sites visited per HUC ranged from 0-11 (Table 4).

Table 4. Numbers of field sites visited during this project.

8th field HUC/project subunit	**# of sites visited in 2017**
Trout	0
Lower John Day	3
Upper John Day	10
Beaver-South Fork	2
Upper Crooked (main, z11)	11
Upper Crooked (main, z10)	10
Upper Crooked (Maury Mtns)	2
Lower Crooked	11
Total	49

In addition to the 49 sites visited during the summer of 2017, this report also includes information collected at 8 sites previously visited in 2007 and 2013. The intent here is to centralize the bulk of the Dewey's fen fieldwork on Ochoco National Forest in this single report. The locations of these 57 sites (49+8) is mapped in Appendix A. Elevations of sites visited during the 2017 field season range from 4020-5800 feet. The highest elevation among all sites included in this report is 6600 feet on Lookout Mountain. A biophysical description of all 57 sites reported here is presented in Appendix B. One hundred forty-three plant taxa including 18 *Carex* species and 27 bryophyte taxa were detected among the sites visited. This group of plants is presented in Appendix C. Zero target species and 17 new occurrences of four notable species were detected during site visits. Summary information on these taxon detections is presented in Table 5 below.

Table 5. Pre-project and project-related detections of target and notable, fen-loving species on Ochoco National Forest. Numbers based on databases and project lead's first-hand observations. Names in bold are target species. Pre-project counts are from 2007 and 2013 surveys by Dewey.

Taxon Group	**Taxa**	**Notes :** Sites documented on OCH NF: Pre-2017 project/post-2017 project
Bryophytes		
	Calliergon richardsonii	1/1
	Hypnum pratense	1/1
	Dicranella palustris	1/1
	Helodium (*Elodium*) *blandowii*	2/2
	Meesia triquetra	4/6
	Meesia uliginosa	0/2
	Sphagnum sp.	2/2
	Tomentypnum nitens	5/5
Fungi		
	Arrhenia lobata	2/2

Vascular Plants		
	Betula glandulosa = resin birch	1/1
	Eriophorum sp. (*E. gracile* or *E. angustifolium*) = cottongrass	1/1

The fen indicator taxon cottongrass (*Eriophorum* sp., either *E. gracile* or *E. angustifolium*) at one of several patches of fen habitat at the Headwaters of Brush Creek, upper eastern flank of Lookout Mountain, Paulina Ranger District, This is currently the only known site of cottongrass on Ochoco National Forest.

Discussion

Notes on target and notable fen-loving taxa documented on Ochoco National Forest

Other than the target species *Calliergon richardsonii* (moss) and *Arrhenia lobata* (fungus), none of the taxa discussed below have either Forest Service sensitive or strategic status in Oregon, and only one (the moss *Hypnum pratense*) is possibly on track for such status. Nevertheless, from a forest management perspective, Dewey regards these as important taxa in that, with a substantial amount of potential habitat on the Forest now explored, these taxa currently appear to be *rare on Ochoco National Forest*. Perhaps just as significantly, these taxa may be regarded as occupants, and as indicators, of habitats that are themselves rare on the Forest.

Calliergon richardsonii (CARI70). This moss was first detected at the Headwaters Bridge Creek wetland/meadow complex in 2007. This became the first record of this moss in Oregon and currently remains the only known site in Oregon. It is ORBIC (2016) S1, List 2, and listed as OR-SEN in the 2018

draft FS R6 and BLM OR/WA Sensitive and Strategic Species List. There appear to be seven records of CARI70 in Washington where it was ranked S1/S2 by the Washington Natural Heritage Program in 2018. It occurs in both the upper and lower portions of the Upper Bridge Creek wetland/meadow complex and is uncommon at each of these locations. Elsewhere in fens in Oregon or Washington, more common species of *Calliergon*, such as *C. stramineum*, *C. giganteum*, *C. cordifolium* and the allied taxon, *Calliergonella cuspidata*, are routinely found. However, CARI70 is currently the only representative of this group known to occur on Ochoco National Forest.

Hypnum pratense (HYPR70). This moss was first documented at the Headwaters Bridge Creek wetland/meadow complex in 2007 and remains the only documented site on Ochoco National Forest. Elsewhere in Oregon, it is documented on Malheur and Wallowa-Whitman National Forests. It is ORBIC (2016) S1, List 3.

The 4215-150 rd. groundwater-fed wetland on Paulina Ranger District. OHV tracks in the soppy-wet upper slope of the wetland (left); large ungulate hoof pits in the soppy-wet upper NW portion of the wetland (right).

Dicranella palustris (DIPA20). On Ochoco National Forest, this moss is known only from a 2011 collection at the Upper Bridge Creek wetland/meadow complex. It has no rarity status in ORBIC (2016). Although Dewey has consistently found this species in soppy, groundwater-fed habitats (10 sites in Washington, three in Oregon), other habitats ranging from submerged riparian to upland, can be found among Oregon and Washington DIPA20 site descriptions available at the Consortium of Pacific Northwest Herbaria.

Helodium (*Elodium*) *blandowii* (HEBL2). As recent ongoing surveys continued to find this species in fens in, and east of the Cascades in Oregon, ORBIC downgraded its rarity status from S2, List 2 to S3, List 4 (2013, 2016). Nevertheless, this species is known from only two sites on Ochoco National Forest, and, as elsewhere in Oregon and Washington, is a reliable indicator of habitats wetted by diffuse, persistent, groundwater discharge.

Meesia triquetra (METR70). This moss has no current or recent rarity status with ORBIC. This moss has a wide geographic distribution in and east of the Cascades in Oregon. It is currently known from six sites on Ochoco National Forest. At its known sites in Oregon and Washington, it is a strongly reliable indicator of habitats persistently wetted by diffuse groundwater discharge.

Meesia uliginosa (MEUL70). While apparently far less well-represented in Oregon fens than HEBL2, this species was likewise downgraded in its rarity status by ORBIC in 2013 (and maintained in 2016) from S2, List 2 to S3, List 4. Until this 2017 ISSSSP project, MEUL70 was not documented on Ochoco National Forest. It is now known from soppy-wet, peaty-soiled habitats at two Forest wetland/meadow complexes. MEUL70 is an extremely small moss that it easily overlooked if not bearing its tall, distinctive sporophytes at the time of field survey.

The moss *Meesia uliginosa* at the 4220-151 groundwater-fed wetland-meadow complex on Paulina Ranger District. Close-up of gametophytes sitting at bases of tall setae of sporophytes (left); gametophytes with full sporophytes visible (right).

Sphagnum spp. (SPHAG2). Peat mosses are commonly found in fens and other wetland habitats across Oregon and the PNW. However, *Sphagnum* moss is known from only two sites on Ochoco National forest. At the Upper Bridge Creek wetland/meadow complex, it is locally abundant in both the upper and lower portions of the complex. Both Sphagnum collections from the complex have been identified by John Christy of ORBIC as *S. warnstorfii*. At its second known site on the Forest, SPHAG2 has been found in fen habitat on a single small *Abies lasiocarpa*/*Vaccinium scoparium* hummock.

Tomentypnum nitens (TONI70). Like HEBL2 and MEUL70, a recently increasing number of Oregon records caused ORBIC in 2013 (and maintained in 2016) to downgrade the rarity status of TONI70 from S2, List 2 to S3, List 4. It is especially common on Deschutes and Fremont-Winema National Forests where it is found on several dozen fens on each forest. On Ochoco National Forest, however, it is known from only five sites.

Arrhenia lobata (ARLO15). This fungus with small, handsome, chanterelle-like sporocarps is parasitic on certain fen mosses and found on federal land in Oregon only at a single site each on Fremont-Winema and Deschutes National Forests, and at two relatively proximate sites on Ochoco National Forest.

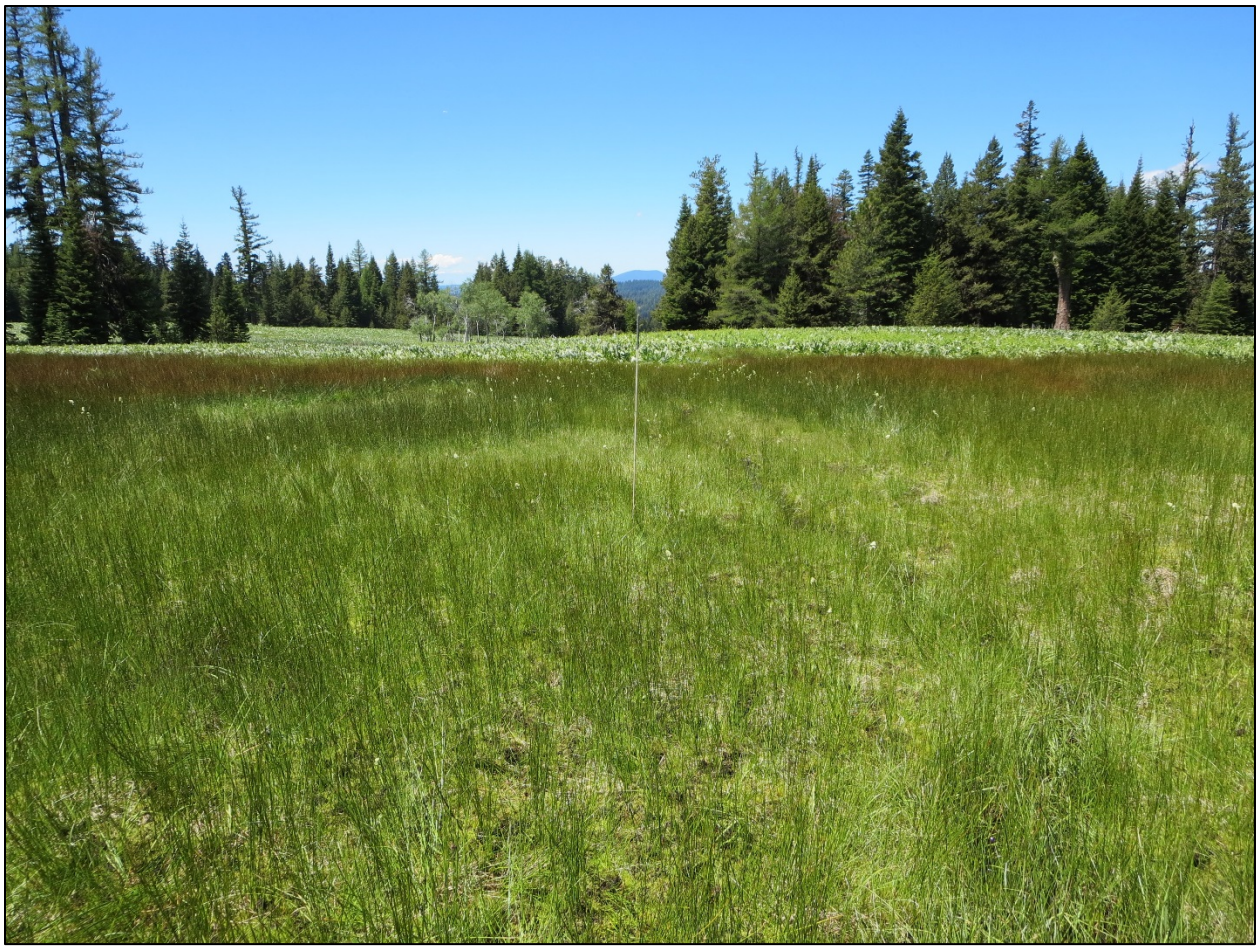
Eriophorum sp. (ERIOP; cottongrass). On Ochoco National Forest this species is known from only a single small population in fen habitat at the headwaters of Brush Creek on Lookout Mountain. This population was detected during another Ochoco National Forest ISSSSP project in 2011. The species is either *E. gracile* or *E. angustifolium*, but Dewey is not currently capable of confidently of determining which. This site is located in Crook County, approximately seven miles south of the Wheeler County line. Three sources, the USDA NRCS Plants Database, the Consortium of Pacific Northwest Herbaria,

and the Oregon Flora Project Atlas all agree that neither of these species have documented sites in either Wheeler or Crook Counties. *Eriophorum gracile* (ERGR8) has no rarity status with ORBIC (2016), and is primarily documented in the Cascades, but is also known from the Blue Mountains (Malheur and Umatilla National Forests), and the Wallowa Mountains (Wallowa-Whitman National Forest). *Eriophorum angustifolium* (ERAN6) is ORBIC (2016) S3, List 4 and is documented at Canyon Creek Meadows on Deschutes National Forest, and at sites further north in the Cascades in Willamette and Mt. Hood National Forests. When not in fruit, cottongrass is extremely difficult to detect among the sedges and rushes typically found in fens. When in fruit, cottongrass in simply impossible to miss.

A rare patch of persistently groundwater-fed wetland in southern Paulina Ranger District at the 58-560 rd. site, lower meadow. Hooves of cattle have caused very pronounced pit-and-pedestal microtopography. Elev. = 5000 feet.

Betula glandulosa (BEGL; resin birch). This species was noted at the Upper Bridge Creek wetland/meadow complex during an initial visit by Dewey in 2007. This population extends across both the upper and lower portions of the wetland/meadow complex which is located in far southern Wheeler County, approximately two miles from the northern border of Crook County. Subsequent visits to dozens of other wetlands and meadows on Ochoco National Forest, including those associated with this 2017 ISSSSP project, have resulted in no detections of this species. Three standard references, the USDA NRCS Plants Database, the Consortium of Pacific Northwest Herbaria (CPNWH) and the Oregon Flora Project Atlas (OFPA), all agree that this species is present in Crook County, but not documented in Wheeler County. The OFPA lists only a single Crook County record, a 1977 Wagner collection at Desolation Canyon in the Mill Creek Wilderness Area on Ochoco National Forest. The CPNWH lists

two Crook County records. These are the Wagner 1977 record and a 1901 Cusick record from the "banks of Squaw Creek." Assuming that this "Squaw Creek" is the same as that recently renamed as "Podo Creek," this creek is actually in southern Wheeler County, not Crook County. In any event, this species appears to be extremely rare within and near Ochoco National Forest.



West over a *Tomentypnum nitens-Meesia triquetra-Drepanocladus aduncus* moss community within a short-statured fen in upper, northeastern Indian Prairie, Paulina Ranger District. Elev. = 6200 feet.

Nearly notable fen-loving species documented on Ochoco National Forest

Carex interior (CAIN11; inland sedge). This species appears to have been first detected on Ochoco National Forest in 9/1993 (CPNWH) along Wolf Creek. A second site was documented in 7/2001 (CPNWH; OCH NRM TES) at Swamp Spring, 1-2 miles south of the Mill Creek Wilderness area. A third CAIN11 site was documented in a meadow along Gibson Creek in NW Maury Mountains in 2003 (OCH NRM TES). No further CAIN11 sites were documented on Ochoco National Forest until Dewey and David located a fourth site at the primary Jungle Creek fen on 6/2016. The Oregon Natural Heritage Program downgraded the species rarity status from S1, List 2 to S3, L4 in 2001, and in 2007, the species was removed from rarity status altogether. However, based on the few Ochoco National Forest records of CAIN11 at the beginning of this 2017 ISSSSP project, there was good reason to regard the species as at least rare on the Forest. However, in the course of this project, six new sites were located, bringing the total number of known sites on the Forest to ten. Given its short, rather cryptic habit, and its documented

presence on the Forest at a site in the lower half of the fen value spectrum, it appears likely that the actual number of sites on the Forest is somewhere in the range of 11-20.

Carex luzulina (CALU7; woodrush sedge). This sedge is common in Oregon within the Cascades and in the mountains of the state's northeast corner. It is much less common in the area between. Dewey has only recently recognized CALU7 as a fen indicator species. Only seven sites on Ochoco National Forest were documented during this 2017 ISSSSP project but for at least two reasons, regarding CALU7 as rare on the Forest appears unwarranted at this time. First, while six of these seven occurrences were within "high value" fens, one of these occurrences is at a fen in the lower half of the fen value spectrum, suggesting that its potential habitat is broader than the sites surveyed in this project. Second, sedges present in project sites visited in late spring/early summer were often too sexually immature to allow confident identification.

The 2610-104 road nicking a groundwater aquifer near Claypool Spring, Paulina Ranger District.

High value fens

Resources for managing/conserving groundwater-fed wetlands on public land will likely always be constraining. An ability to prioritize use of resources available for fen conservation is a necessity. In concept, identifying "high value" fens will be an important component, along with risk/threat assessment, of fen conservation efforts. While clearly a somewhat subjective matter, Dewey would recommend consideration of a set of apparently directly related factors such as total **amount** of groundwater-fed habitat, **volume and persistence** of groundwater discharge, and **abundance and diversity** of fen indicator taxa and rare and uncommon fen-loving plant species in identifying high value fens/groundwater-fed wetlands. With an emphasis on biodiversity and Forest-level rarity, the "high

value" fen habitats identified in this project were assessed on the sum of each site's count of fen indicator species plus count of target and otherwise notable plant species (Tables 1 and 2). Because all target and notable species are also fen indicator taxa, this ranking assessment essentially involves double counting. This is intentional, as habitat supporting these rare FIT mosses appears to be quite scarce on the Forest. Limiting the set of "high value" fens to 15 is, of course, arbitrary. The decision was based on requiring a minimum value score of 10, and the sense that a set size of 15 is reasonably inclusive, without seeming unmanageably large. Project "high value" fens are presented in Table 6, below. Value rankings of all project sites is presented in Appendix D.

Table 6. Project sites identified as including "high value" fen habitats. Values based on sum of site's count of fen indicator taxa (FIT) and count of rare FIT (target and "notable" species).

Value Rank	**Site**	**FIT Count**	**Rare FIT mosses**	**Value Score**	**8th field HUC**
1	Headwaters of Bridge Creek	20	7	27	Lower John Day, prior visit
2	4220-151 rd.	13	2	15	Upper Crooked main, UTM Zone 10
3	Headwaters of Lookout Creek	11	3	14	Upper Crooked main, UTM Zone 10, prior visit
4	Headwaters of Brush Creek	11	3	14	Upper Crooked main, UTM Zone 10
5	Upper 4215-150 rd.	12	1	13	Upper Crooked main, UTM Zone 10, prior visit
6	12-190 rd.	12	0	12	Upper John Day
7	4220 rd. (Lytle Creek)	12	0	12	Upper Crooked main, UTM Zone 10
8	Indian Prairie	10	2	12	Upper Crooked main, UTM Zone 10, prior visit
9	4270-210 rd.	11	0	11	Upper Crooked main z11
10	2700-421 rd. (Moccasin Spring and Prairie)	11	0	11	Lower Crooked
11	2630-841 rd. (Haypress Creek)	10	1	11	Upper Crooked main z11
12	30-800 rd.	10	0	10	Upper Crooked main z11
13	4254 rd., section 17	10	0	10	Upper Crooked main z11
14	5810 rd., section 13	10	0	10	Beaver-South Fork
15	Podo Meadow main, spring-mound vicinity	8	2	10	Upper John Day

Groundwater-Dependent Ecosystems

Groundwater-fed wetlands, seeps and springs are collectively referred to as groundwater-dependent ecosystems, or GDEs (USDA-USFS 2012). *Springs* are typically point sources of groundwater discharge. The behavior of the discharge, whether perennial or seasonal, and volume, can vary greatly among springs. *Groundwater-fed wetlands*, i.e., wetlands whose primary water source is groundwater, are generally associated with areas of diffuse groundwater discharge. Among groundwater-fed wetlands, groundwater discharge periods appear to represent a continuum, with periods ranging from early-season to persistent through the snow-free season. Depending on the character of the feeding aquifer, and annual precipitation variances, discharge periods can notably vary within individual groundwater-fed wetlands.

Seeps can be challenging to characterize because depending on their size and location, they can resemble either springs or small groundwater-fed wetlands.

Wetlands and meadows

Wetlands are areas where generally hydric soils are at least seasonally inundated or saturated with water so as to support a predominantly hydrophytic flora, i.e., a set of plant species that are adapted to occupying soils that are at least periodically, very wet. Commonly referenced types of wetlands include marshes, swamps, bogs and fens. While wetlands are identified based on features largely determined by hydrology, *meadows* are recognized first and foremost by vegetation. Generally, meadows are sites where, although shrubs and trees may be present, herbaceous vegetation is dominant. Hence, fens dominated by herbaceous vegetation can appropriately be referred to as a type of wetland, as well as a meadow. And of course, many meadows are absolutely not wetlands. Further complicating the process of description, fens that are meadows, and non-wetland meadows, can and commonly do, coexist as larger wetland/meadow complexes or systems.

Patches of the groundwater-loving short-beak sedge (*Carex simulata*) typically include only plants with female spikes (left, above) or male spikes (right, above). Because of this, adjacent patches of this species can initially be mistakenly regarded as different species.

Groundwater, groundwater-fed wetlands, fens, fen-like ecosystems, bogs

Groundwater, at least with reference to GDEs, is water that, through infiltration of rain and melting snow, has moved underground to a site where as a point source, or diffusely, it discharges or saturates the soil at or near the soil surface. The schedule of discharge or saturation at the soil surface ranges from seasonal

to persistent. Groundwater is typically nutrient-poor, unless it has acquired nutrients in travelling along its subsoil journey.

Groundwater-fed wetlands are generally best expressed at sites with some topographic gradient, although wetlands in basins or overtopping ponds and lake edges have been described as groundwater-fed wetlands as well. Groundwater-fed wetlands may be more commonly referred as fens, although this term can be ambiguous in its meaning, as differing definitions of "fen" are in common use. For purposes of managing and protecting biodiversity and rarity on public lands, both at the species and ecosystem scale, it seems appropriate to adopt an inclusive fen definition such as offered by Bedford and Godwin (2003) who define fens as "wetlands that develop where a relatively constant supply of ground water to the plant rooting zone maintains saturated conditions most of the time and the water chemistry reflects the minerology of the surrounding and underlying soils and geological materials." More concisely, Hájek et al. (2006) have defined fens as "groundwater-fed wetlands that host low productive nutrient-limited vegetation dominated by Cyperaceae and bryophytes." Groundwater-fed wetlands typically have peaty, organic soils, but as noted in these definitions, soils neither need, nor should, be a defining criterion.

In the realm of definitions, Dewey is currently somewhat vexed by his desire to generally use the term "groundwater-fed wetland" as synonymous with, or in lieu of "fen". The desirability of this, as noted above, is that the former term is not laden with the different definitions/expectations that currently apply to the term "fen". A problem with this desire is simply that it is common, on Ochoco National Forest and other Oregon and Washington forests, to visit meadows or shrub-meadows that appear to be primarily wetted by groundwater, and that support a moderate number of fen indicator taxa, yet appear to be only seasonally wet due to groundwater discharge, and perhaps not technically qualifying as a wetland. In fact, one of the primary observations by Dewey in a decade of fieldwork is the broad, essentially continuous range of persistence of groundwater-fed wetting among and even within many larger wetland-meadows in Oregon and Washington. Dewey has used the term "fen-like ecosystem" specifically to include those ecosystems where seasonal groundwater discharge appears to be the primary determinant of community vegetative character, but the ecosystems that include these communities may not exhibit the persistence of wetness necessary to qualify them as "wetlands".

It is commonplace to hear the term "bog" being applied to a wetland that is actually a fen. True bogs appear to be quite rare in montane settings in both Washington and Oregon. As is often the case with fens, bogs are perpetually wet peatlands. However, the primary water source for bogs is considered to be direct, on-site precipitation. Bogs are consequently extremely low-nutrient ("ombrotrophic") ecosystems because they depend on atmospheric moisture for their nutrients. Additionally, the water table associated with the saturated peat of bogs is consistently perched above the primary local water table. Bog vegetation is typically dominated by species of *Sphagnum* moss. No bogs are known to exist on Ochoco National Forest.

Groundwater-fed wetlands are particularly important biophysical features on USFS lands due to 1) the disproportionately large number of rare and uncommon plant species they may support, 2) the susceptibility of their generally very wet, peaty soils to negative physical alteration due to certain management practices, thus degrading the habitat that these wetlands provide for rare and uncommon species, and 3) the general rarity of strong expressions of this type of wetland across the forest landscape.

Recognizing fens in the field

Efforts at fen recognition in the field sometimes result in an uncertain assessment, and generally require considering multiple interrelated features including site wetness, hydrology, plant community structure and composition, geomorphology, and soil character. For Dewey, who subscribes to the Bedford & Godwin-Hajek et al. fen concepts, field recognition of fens is primarily about wetness schedule and source, and vegetation. Sites that are persistently wetted by diffusely discharging groundwater and support a flora typically dominated by sedges and/or mosses will be considered a fen. Site visits late in the growing season/snow-free season are hugely helpful in surmising both the primary water source and the seasonality of that source, for a wetland. Explanations for wet soil in the spring or early summer may include some combination of factors such as direct, on-site wetting by rain or snow-melt, surface transport and delivery of rain and melt-waters by laminar or channeled flow, or seasonal or persistent groundwater discharge. Wet soils, late in the season, in the absence of obvious, nearby surface water sources (e.g. water tables of perennial creeks and ponds), or recent heavy precipitation events, are strong circumstantial evidence that site wetness is primarily attributable to groundwater. Presence, abundance and diversity of fen indicator taxa can also be strongly indicative of fen ecosystems. Total annual precipitation varies from year to year, and a series of consecutive below normal water years can create lowered water tables in fens that are generally soppy-wet (Dewey, personal observation). Fen indicator taxa however, persist in droughty times, and speak to the typical wetness conditions for many fens.

Sphagnum sp. moss at the Headwaters Lookout Creek wetland complex.

Geomorphology – Fens are noted to occur in several basic geomorphic settings, including slopes, basins and mounds (USDA, 2011; Cooper and Wolf, 2006). Among the presumptive fens identified in this project, 14 of the 15 given high value ranks occur on slopes. One fen (in Podo Meadow) is best described

as a spring mound with some terrace-like character. A spring mound is also present at Indian Meadow, a site which ranks as a high value fen complex due to the presence of sloping fens. Several sites with somewhat lower value rankings and whose persistence of groundwater wetting will require late season visits, are all on slopes. No potential basin fens were visited in the course of this project. Many of the high value fens identified in this study are within headwater stream drainages and range from bordering actual, often seasonal drainage routes, to presence, sometimes as pronounced peaty terraces, within these topographic drainage routes. These fens may occur as relatively small inclusions within larger wetland-meadow complexes which also feature moist and dry meadows. The upper Bridge Creek wetland-meadow complex is a prime example of this.

Hydrology - In concept, sloping settings provide the least ambiguous evidence of the primary water source of wet soil. Surface water sources (snowmelt, rainwater) are unlikely to be persistent water sources on slopes unless they are moving within channels, which can be observed, and are typically either perennial or intermittent. If there are no perennial channels in the immediate vicinity of a wetland, or channels are present but are clearly intermittent, groundwater becomes a likely explanation for the wetness of local soil. Sloping fens appear to generally rely on settings where subsurface water, following a gravitational gradient, encounters a confining layer that redirects the aquifer to the soil surface. Fens can also form where the path of a shallow aquifer is excavated, as is often seen in roadside cut-bank fens. Among the 15 designated high value fens, only two have had late-season visits to confirm the persistence of groundwater discharge. Persistence of discharge is deemed likely at the other 13 sites, but this needs to be confirmed as opportunity permits. Late season visits to the next tier of higher ranked sites (e.g., ranks 16-20(25) would be very informative as well. Sites at which groundwater discharge appears to be the primary source of wetness during the growing season, yet persists, only into early August, or less, may best be referred to as “fen-like ecosystems”, or perhaps “moist, groundwater-fed meadows”. These type of ecosystems appear to be very abundant on Ochoco National Forest. The 2017 NWI mapping for the Forest includes 558 PEM1B polys, and 490 PEM1C polys. It is likely that the large majority of these sites are “fen-like” or “moist meadow” in character. Dewey is currently of the understanding, based on much fieldwork in Oregon and Washington, that the montane sloping fens or “fen-like ecosystems” in and east of the Cascade crest in these states are generally supported by local, rather than intermediate or regional groundwater flow systems. If true, it would be expected that the geologic and geomorphologic settings that support these groundwater flow systems vary, even locally, in their capacity to catch and transport annual precipitation, as groundwater, to sites of discharge. In turn, the sites of discharge – fens and “fen-like ecosystems” – will predictably vary broadly in their schedules and rates of groundwater discharge. Whatever its explanation, a broad range of schedules and rates is remarkably observable across Ochoco National Forest.

Soil character – Across much of Oregon and Washington, sites describable as fens as defined in this report, can vary greatly in thickness of their surficial organic layers (Dewey, personal observation). Peat thicknesses ranging from greater than two meters to essentially nonexistent have been encountered. Thick peat layers can reasonably be ascribed to relatively stable rates and groundwater discharge at these specific sites over very long periods of time. At the Lava Lakes fen in central Oregon, utilizing dates assigned a layer of Mazama pumice and ash originally deposited about 7700 years before present (upon which the fen peat developed) as well as a layer of ash from more local eruptions about 2200 years ago (Scott et al. 1990), Dewey was able to calculate a rate of peat deposition of 2 cm (0.8 inches) per century. Notably, Cooper and Wolf (2006) give a rate of peat accumulation in Rocky Mountain fens of about 20

cm per thousand years (0.8 inches per century). It is likely that fens with peat thin or lacking are not necessarily very young, but possible explanations for thin peat are generally not obvious. Fens with thick peat layers often have high counts of fen indicator taxa. Soil probes at all but four of 15 high value fens identified in this project indicated maximum peat depths of 51+" or 54+". Sites with lesser apparent peat depths included the 4220-151 rd. (51"), Moccasin Spring and Prairie (49"), 12-190 rd. (46") and 4254 rd. section 17 (14"). It was common at project sites, including the designated high value fens, for soil layers interpreted as peat, to be highly dense and resistant to the probe's passage. Soil probes allow a quick assessment of soil character over multiple points at project sites, but perhaps best serve as guides to where to extract soil cores (or excavate soil pits) that can be examined by a soils specialist.

Inflorescences of the inland sedge (*Carex interior*) at the Jungle Creek fen. Differentiated from the generally more common, highly similar star sedge (*Carex echinata*) by the somewhat shorter beaks of its perigynia. *Carex echinata* is not documented on Ochoco National Forest.

Vegetation – As noted above, fens by description, typically have vegetation dominated by sedges and/or mosses. Sedge relatives such as the spike rushes (*Eleocharis*), club rushes (*Scirpus*), cottongrasses (*Eriophorum*), true rushes (*Juncus*), woodrushes (*Luzula*), a relatively small number of grasses (e.g. species of *Deschampsia*, *Calamagrostis*, *Muehlenbergia* and *Agrostis*) and dicotyledonous herbs are also commonly represented. Groundwater-fed communities dominated by these taxa are appropriately referred to meadow-fens. Shrubs are also commonly present, and may have sufficient cover to warrant the community classification of shrub-fen. In Oregon and Washington, fen shrubs include *Vaccinium uliginosum*, *V. oxycoccos*, *Betula glandulosa*, *Kalmia microphylla*, and species of *Salix*, *Alnus*, *Spiraea* and *Ledum*. Although not commonly, small parcels of forested fens also occur. Most frequently represented tree species are *Pinus contorta* and *Picea engelmannii*, but other conifer species may also be

present. Perhaps the most referenced fen mosses are the so-called "brown mosses." These are largely species within the Amblystegiaceae, but the Brachytheciacious moss *Tomentypnum nitens*, is usually included in this group. Common genera of fen-loving brown mosses include *Calliergon*, *Calliergonella*, *Campylium*, *Drepanocladus*, *Hamatocaulis*, *Warnstorfia* and *Scorpidium*. Another very common, and often dominating fen moss are peat mosses (*Sphagnum*). Other moss species that serve as fen indicators are included in the genera *Elodium*, *Meesia* and *Plagiomnium*.

Fen indicator taxa

The use of fen indicator plant species in the description and classification of fens has been commonly practiced in North America (Bedford and Godwin, 2003). The utility of plant taxa as indicators of the physical conditions necessary to support fen ecosystems became evident to Dewey quite quickly as he developed an interest in, and found opportunities, to seek out fens and fen-like ecosystems in Oregon and Washington. While lists of plant species associated with fens are readily available in the literature, Dewey simply developed a list of taxa commonly encountered in the fen and fen-like habitats he visited from 2000-2018 (Appendix E). This list, which is admittedly subjective, has grown with Dewey's field experience, and includes, perhaps expectantly, species that seem to vary considerably in their fidelity to the variety of physical conditions, especially water table behavior, that support fen and fen-like habitats. For instance, the broadly geographically distributed fen mosses *Meesia triquetra*, *Calliergonella cuspidata*, *Hamatocaulis vernicosus* and *Warnstorfia exannulata*, appear to be quite demanding of groundwater-fed wetness that persists throughout the growing season. In contrast the mosses *Tomentypnum nitens* and the taxon *Sphagnum*, occur over a relative broad range of groundwater table behaviors. Likewise, the vascular plants *Juncus ensifolius*, *Hypericum anagalloides*, *Platanthera dilitata* and *Saxifraga oregana*, appear to exhibit notably broader habitat amplitudes than do *Carex limosa*, *Eriophorum gracile*/*E. angustifolium*, *Drosera rotundifolia*/*D. anglica* and *Triantha glutinosa*.

Biogeography of fen indicator taxa

The OR-WA fen indicator taxa recognized by the project lead are largely higher latitude, boreal taxa. North American distributions of 12 of these taxa that are generally representative of the group are illustrated in Appendix F (species maps from USDA NRCS Plants Database). It's evident from Appendix F that the distributions of the fen indicator taxa have one or more southward extensions into decidedly non-boreal latitudes. For the most part, these southward distributional extensions are possible due to the presence of mountains (e.g., in the western US, the Cascades, Sierra Nevada, Ochoco, Blue and Wallowa Mountains, Kettle River Range, Selkirk Mountains and the Rockies). This seems to be simply another case of the long-standing observation that, at lower latitudes, sites at higher elevations can be climatically similar to sites at higher latitudes. Hence, while at higher latitudes these OR-WA fen indicator species are components of *boreal fen communities*, in Oregon and Washington, these same species are components of *montane fen communities*. But while the presence of mountains makes the presence of the OR-WA fen communities possible, it is the presence of particular, coincident topographic, geologic and hydrologic features that seem to dictate the distribution of suitable montane fen habitats. Along the Cascade crest and east, this coincidence of fen-enabling features among R6 forests is generally uncommon at best.

Occurrence of fen indicator taxa east of the Cascades crest in Oregon

It's notable that the fen indicator taxa included in Dewey's regional FIT list are not evenly distributed across the fens visited to date in the seven national forests that manage lands along and east of the Cascade crest in Oregon. These data are summarized in Table 7 below, and presented in full in Appendix G. The highest counts of FIT by forest are currently found among the Cascadian forests (Fremont-Winema, Deschutes and Mt. Hood) and among the northern Blues (Umatilla) and Elkhorns-Wallowas (Wallowa-Whitman) in the northeastern corner of the state. The lowest forest-level FIT counts are currently associated with the two forests spread over the Ochocos (Ochoco) and southern Blues (Malheur). This is particularly evident regarding the group of FIT now documented on Ochoco National Forest. Other than a moss species whose one known site on the Forest, is the only documented site in Oregon, there are no Forest FIT that are not also present in Cascadian fens, but as many as a dozen Cascadian FIT are not yet detected on the Forest. It is not obvious (to Dewey) what factors primarily explain this observed paucity of Cascadian FIT on Ochoco National Forest.

Table 7. Fen indicator taxon (FIT) counts in forests along and east of the Cascade crest in Oregon. Counts based primarily on fieldwork by Dewey. The FIT count for Malheur National Forest is currently understated due to a focus on bryophytes and lichens during fieldwork.

Forest	**FIT count**
Deschutes	39
Fremont-Winema	38
Malheur	22
Mt. Hood	35
Ochoco	27
Umatilla	34
Wallowa-Whitman	35

Fen community structure types

Coarse classes of fen vegetation structure can be rather easily described. Dewey has found it convenient to use the categories of *short-statured, tall sedge, shrub,* and *forested* when recording field notes. Of course, these structural types can, and frequently do, intergrade. These structural types are briefly described below.

Short-statured fen communities are characterized by persistently high water tables, high diversity of graminoids, forbs and bryophytes, and low stature of the vegetation. Height of vegetation in these communities is typically 12-16" or less, even while some included graminoid, forb and shrub species are generally much taller outside of this community. This is the structural community type in which Dewey has most frequently found rare and uncommon vascular and nonvascular plant species, including sensitive species. Few-flowered spikerush (*Eleocharis quinqueflora*) is frequently either dominant or abundant among the vascular plants in this community. In Dewey's experience, this community type is typically associated with localized areas of persistent groundwater discharge in sloping fens. The short-statured fen community appears to be the type of fen community to which Bedford and Godwin (2003) refer in

noting that low nutrient availability may underlie "the low stature, distinctive flora, and high species diversity of some rich fen vegetation." This is also the basic fen community type from which most of the project lead's fen indicator species set is drawn. This type of community is present at each of the highest value Ochoco National Forest fens recognized in this report, although Dewey would note that only at a few of these sites, is the stature as strikingly short as is commonly seen in the community's expressions at other Oregon and Washington fens.

Tall sedge fen communities generally have low species diversity, little moss or forb ground cover, and are often dominated by 30-48" tall *Carex aquatilis* and/or *Carex utriculata*. It currently appears that the soil surface in tall-sedge fen communities is commonly saturated or inundated early in the growing season, but becomes damp, moist or even dry by late summer. This community type is commonly represented in the wetland-meadow systems that include the Ochoco National Forest highest value fens, but is especially common among the "fen-like," seasonally groundwater-wetted meadows visited in the course of this project. *Carex nebrascensis* appears to be the dominant, or co-dominant sedge in most instances of this tall sedge community type seen on the Forest.

The very distinctive inflorescences of the groundwater-loving Jones' sedge (*Carex jonesii*) at the 30-800 rd. groundwater-fed wetland system.

Shrub fen communities are often intermediate between short-statured and tall sedge fen communities with regard to species diversity, and likely include a patchy cover of graminoids, forbs and mosses. High early-season water tables commonly dip down towards the end of the growing season, but perhaps not so much as within tall sedge communities. Depending on geography, important fen shrubs in Oregon east of

the Cascade crest can be some combination of species of *Betula*, *Vaccinium*, *Kalmia*, *Salix* and/or *Alnus*. On Ochoco National Forest, the dominant shrubs within fens and fen-like ecosystems are species of *Alnus* and *Salix*. This project focused on groundwater-fed meadows, but the NWI has identified this project's 4220-151 rd. high value fen as a scrub-shrub wetland.

Forested fen communities appear to be uncommon within the forests visited to date by the project lead. These generally are areas that, in viewing aerial imagery, have more the character of forest than of meadow. On the ground, however, the wetland character of the site is evident. Persistent groundwater-fed wetness and a moderate level of species diversity (shrubs, graminoids, forbs and bryophytes) may be typical of forested fens. Lodgepole pine (*Pinus contorta*) and/or Engelmann spruce (*Picea engelmannii*) are most commonly present, but a variety of other conifer species may be represented as well. A small amount of forested fen is included in the largely meadow fen complex located at the headwaters of Lookout Creek on Lookout Mountain.

Fens and nutrient availability

Bog and fens are commonly differentiated from one another as ombrotrophic ("relating to the rain") vs. minerotrophic ecosystems. Being largely dependent on the nutrients dissolved in precipitation, bogs are extremely nutrient-poor ecosystems that greatly limit the diversity of plant species that can succeed in these habitats. Fens, by definition, are primarily wetted by groundwater, which of course, starts as precipitation but generally acquires some mineral content as it passes through subsurface environments in route to sites of discharge or surface proximity. Depending on geographic area, soluble Ca+ may enrich groundwater as it passes through calcareous sedimentary and/or metamorphic subsurface environments. Generally, however, other macronutrients such as N, P, and K are not readily available in subsoil environments and groundwater arriving at a fen is still quite nutrient poor (Hájek, et al. 2006; Bedford and Godwin, 2003). Regarding the relatively nutrient-poor conditions within fens, it's been found that nutrient availability, rather than presence of peaty soils, better differentiates fens and marshes, the latter being primarily wetted by nutrient-rich surface water. That the plant species typically present in moss-sedge fens are adapted to nutrient-poor conditions, and in relative competitive balance, is supported by the observations that nutrient-enrichment promotes a succession from moss-sedge fen communities towards tall-sedge (marsh-like) communities (Kotowski et al., 2006).

Fens as unique ecosystems

Some familiarity with fens and fen-like ecosystems should cause hesitation in accepting their inclusion as "riparian" landscape features. The species composition of plant communities included within fen ecosystems is largely distinct among plant communities across the R6 forests visited to date by the project lead. With some notable exceptions (e.g., overtopped ponds and lakes) this distinctness appears to be very much tied to the community water source being primarily *nutrient-poor groundwater*, near the source of its initial, diffuse, surface/near surface discharge. The project lead's current concept is that fen ecosystems may or may not contribute surface water output to riparian systems, but they do not receive significant amounts of water and nutrients from these systems. A meadow that is regularly wetted by relatively *nutrient-enriched, surface-sourced* riparian water – often by means of seasonal or episodic channel flooding - will not support the plant communities associated with fens and fen-like ecosystems

(Bedford and Godwin, 2003). With this view, the project lead would offer that fens are not just wet "riparian" habitats that may support notable numbers of rare or uncommon plant species, but are themselves biophysically distinct, variously rare or uncommon *groundwater-supported ecosystems* that in their own right, merit recognition and appropriate restorative or protective management.

North down the 1610 rd. groundwater-fed wetland-meadow system in the northwest corner of the Maury Mountains, Lookout Mountain Ranger District. This hydrologically fascinating system is highly in need of management direction review.

Wetland condition assessment

Along with protocols for inventory and for relatively rapid on-site assessment of biophysical character, condition assessment is important to the provision of appropriate management for groundwater-fed wetland resources. Weixelman and Cooper (USDA, 2009) have presented a checklist of items to note when conducting condition assessment of montane fens in California. Ochoco Forest natural resources staff may find some or all these items useful when designing a condition assessment protocol for Ochoco National Forest. Dewey's experience in visiting fens and fen-like ecosystems in Oregon and Washington indicates that livestock and unauthorized recreation use are primary causes of site degradation. Siltation from closely adjacent roads and ditching has also been noted. Fieldwork by Dewey on Ochoco National Forest from 2007-2018 indicates that livestock use is a primary source of degradation of habitats

primarily wetted by groundwater. Notably, visible impacts from recent use appear to be low to moderate at the high value fens identified during this project, although early season growth of sedges can conceal hoof impacts expressed in the soil microtopography. Within the fen habitats at the high value 30-800 rd. site, pit and pedestal microtopography was only evident upon lurching awkwardly on hidden pits and pedestals while attempting to walk through the low, but dense early growth of sedges. During a late September, 2007 visit to the upper Headwaters Bridge Creek wetland-meadow complex, it was noted that the shrub *Vaccinium* was abundant, but easy to miss because it was grazed down to such a low stature. In contrast to observations among the high value fen habitats, impacts at groundwater discharge areas within the numerous sites that include "fen-like" habitats are frequently conspicuous as extensive and intensive pit and pedestal microtopograpy on the seasonally wet soils. Multiple sites on the Forest that did not qualify based on diversity and rarity of detected fen indicator taxa, nevertheless appear to include areas of persistent groundwater-fed wetness. Some of these sites, such as Williams Prairie, Divide Spring, 58-561 rd. (Columbus Creek) and the 1610 rd. (Maury Mountains) appear likely to exhibit low levels of biodiversity largely due to biophysical alteration of the habitats due to generations of intense grazing pressure.

As Dewey's cumulative time visiting fens in Oregon and Washington has increased, so has the number of questions regarding use of fens by cattle. Existing literature partly addresses some of these questions, but as a set, they seem relevant to managers of public lands where fens are regarded as suitable for grazing.
1. To what extent does cattle grazing in fens contribute to compaction of fen soils?
2. What is the relationship between intensity of use (cattle-days per season), grazing season fen water table behavior, and fen soil composition and susceptibility to fen soil compaction?
3. How does soil compaction affect plant-soil water relations in fens?
3. Can fen soil compaction be reversed?
4. How does fen soil compaction affect competition among plant species within the fen community?
5. Does chronic consumption of above-ground plant parts (stems and leaves) promote and/or maintain fen plant community species composition unlike that in an otherwise similar fen community that is not grazed?
6. Does direct deposition of the manure and urine of cattle create measurable nutrient enrichment in fens? What nutrients are contributing to this enrichment?
7. What changes in fen plant community composition can be expected with direct, livestock-contributed nutrient enrichment?

Other notes

1. The 5254 rd. section 17 site is rather anomalous among the high value fen sites recognized in this project. It seems to be biophysically intermediate between a typical roadside seepage slope and a more fully formed sloping fen, In its smallish size, steeper slope, shallow soil, inclusion, in part, of a seepy roadside cutbank and drainage ditch, and its lack of detected rare, Forest-level fen-loving plant species, it is similar to the typical roadside seepage slope. However, the site's support of a relatively large (on Ochoco National Forest, at least) number of fen indicator species, is a feature of larger, more gently sloped, deeper soiled sloping fens on the Forest.

2. *Carex nebrascensis* is ubiquitous on the Forest in fen and fen-like habitats that elsewhere among like habitats known to Dewey in Oregon and Washington, would likely feature *Carex aquatilis*, or at higher

elevations, *Carex scopulorum*, among community dominants. This is one of the most unexpected observations resulting from this project. Possible explanations would appear to include biogeography, geology/water chemistry and/or management history. It has been noted (Wilson et al., 2014) that *C. nebrascensis* "can increase under grazing as competing vegetation is removed, and may persist by rhizomes in overgrazed wetlands."

Follow-up possibilities

1. Find opportunities to incrementally enlarge the fen inventory initiated with this project. National Wetland Inventory mapping includes a remarkable 558 PEM1B, 490 PEM1C and 138 PSSB polygons on Ochoco National Forest. This project focused on mapped PEM1B polys. Although a reasoned process was used to select the most promising among this large number of sites, the reality is that only a small percentage of all PEM1B sites could be visited. Many, especially smaller sites, are awaiting visits.

2. Solicit within PNW universities for academic interest in analysis of peat cores from Ochoco National Forest fens. Primary intents would be to determine age of selected high value fens, and detect episodic climatic events that tested the resiliency of these fens.

3. Consider implementing long-term water table monitoring in 1-3 of the robustly groundwater-fed, easily accessible, high value fens such as those at Headwaters Bridge Creek, 4220-151 rd. or Upper 4215-150 rd. Groundwater-fed wetlands are surely among the most complex, biodiverse, and water-sensitive, non-aquatic ecosystems in the PNW. They may be to the effects of ongoing climate change, as canaries are to coal mines.

4. Consider revisits to most of the sites including "high value" fen habitats. Only four of these sites have been visited later in the season than early August (Headwaters Bridge Creek, 9/27; 5810 rd., section 13, 9/27; 4270-210 rd., 9/12; 4254 section 17, 9/11). Late-season visits to the other sites would allow assessment of the presumed persistence of groundwater-fed wetness at these sites. Further, it could allow a more formalized assessment of soil character at the areas of most persistent groundwater-fed wetness at these sites. Such soil characterization at these sites would be an important augmentation of the currently existing descriptions for these sites.

5. Multiple sites on the forest include (or appear to include) habitats that feature persistent groundwater-fed wetness, but have very low counts of fen indicator taxa. These sites include Williams Prairie, Divide Spring (not included in this project) and the 1610 rd. (Maury Mountains) wetland-meadow, where it appears likely that long-term intense grazing pressure has created physical habitat alterations that have reduced the capacity of these habitats to be supported by the local groundwater aquifers. For the likes of the Divide Spring and 1610 rd. wetlands, at least, consideration should be given to field visits and assessments of revised management practices at these sites.

Recommendations for consideration

As part of a continuing effort to promote awareness and conservation of rare, high value, groundwater-fed wetlands, and the rare and uncommon plant species included within them, the Forest is invited to consider the following specific recommendations.

1. *Special botanical area*. No groundwater-fed wetland on Ochoco National Forest approaches the Headwaters of Bridge Creek wetland-meadow complex with regard to collective area of persistent groundwater discharge and diversity of plant species. This site supports Oregon's only documented population of the OR-SEN fen moss *Calliergon richardsonii*, as well as a host of fen-loving species that are rare on the Forest. It is strongly recommended that this site be considered for special management status, perhaps as a Special Botanical Area. Such a designation could be accomplished during the Forest Plan revision process, which is said to be beginning soon.

2. *Range management guideline*. Because of a) the presence of persistently wet, generally peaty soils, b) the high susceptibility of these soils to habitat damaging alteration due to livestock use, and c) the general rarity of fen ecosystems on the Forest, fens should be regarded as *unsuitable* for livestock grazing. Accordingly, livestock presence (grazing, bedding, transit) in fens should be regarded as inappropriate and unauthorized.

3. *Protocol development/implementation*. Fen management on Ochoco National Forest would benefit through the development or adoption of a protocol for the identification and condition assessment of groundwater-fed wetlands (fens). This protocol should include at least the following components:

a. A pre-field Forest-wide systematic analysis aimed at identifying potential fen sites.

b. Conduct brief visits to candidate fen sites in order to i) identify sites that actually include fen habitat and ii) economically describe the character and condition of detected fen habitats, permitting both an assessment and ranking of sites that include high value fens. It would be highly desirable to complete this initial Forest-wide inventory in a matter of years, rather than decades. This ISSSSP-funded project can be considered a good start in this direction.

c. Return visits to selected sites for more detailed data collection may be desirable to better inform site management recommendations.

d. Protection/restoration prescriptions will need to be prepared and implemented for high value fens determined to be negatively impacted by livestock use or other management activities.

References

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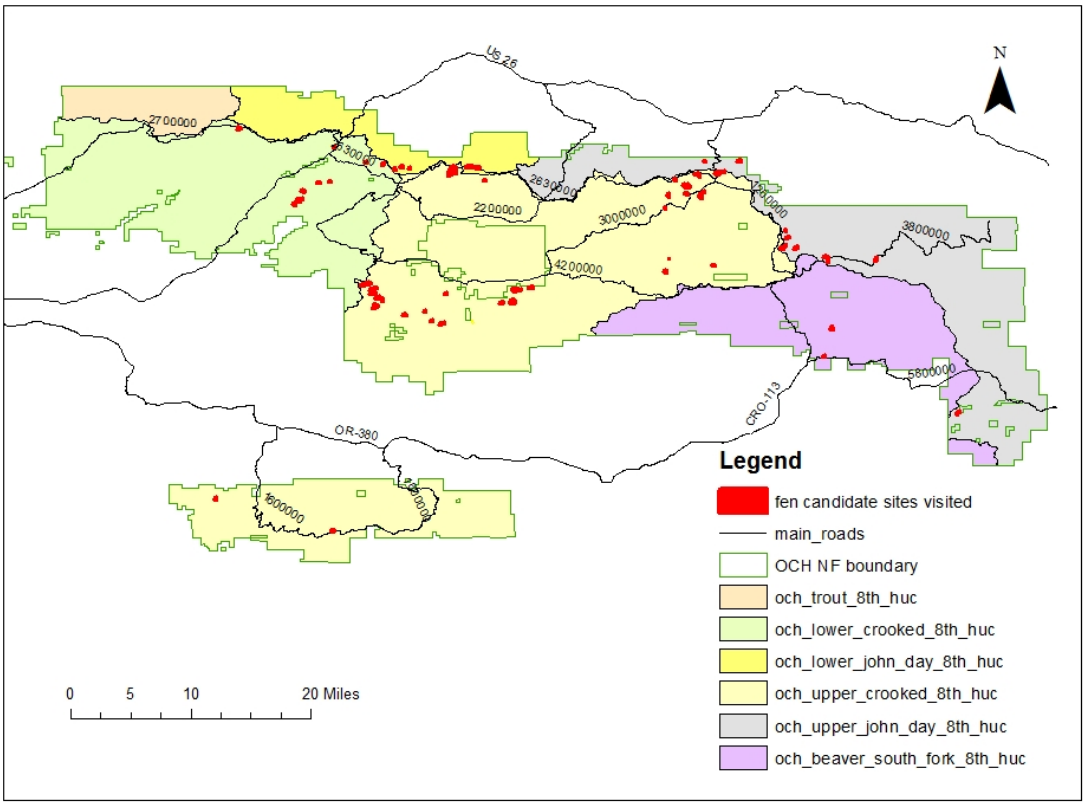
Appendix A – Ochoco National Forest wetlands/wetland-meadows described in this report.



Appendix B – Descriptions for sites visits conducted in 2017, 2013, 2011 and 2007.

Note: Soil depth measurements with a "+" symbol (e.g., 51+") indicate the soil base lay somewhere below the full reach of the soil probe.

Upper Crooked Main, UTM Zone 11

1. Blevin's Spring/Hdws Double Corral Ck.
Elevation: 5740-5800 feet
TRS: T13S, R23E, S11
Date: 6/14/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, CAPA14, CANE2, **ELQU2**
Forbs – SEDUM, LOMAT, ANTEN, SEHY, POBI6, **SAOR2**, CAQU2, TRLO, MOCH, VERON, VERAT, EPILO, TAOF, POGR9
Shrubs – ARTEM
Bryophytes – BRPS70, **DRAD2**, PHFO6, BRWE70
Soil probes: Eight probes across the site found soil depths of 4-37". Soils had very notable organic component with an inorganic, component ranging from sparsely gritty to very gritty. Deepest soils were found in the upper half of the main wetland on the eastern side of FS 12.
Notes: This site is situated in a low-gradient, gentle drainage in a scabby landscape. The site is here designated as the wetland lying relatively proximate to both the eastern and western sides of FS 12. The overall wetland had much soppy soil or shallow standing water at the time of visit, but appears to be only seasonally wet, likely becoming only moist at best later in the summer. On site snow melt may account for some amount of the site wetness at time of visit, but a shallow, local groundwater aquifer, likely recharged each year by local melting of snow pack, appears to provide for much of the spring and early summer wetness of this site. Soil wetness appears to be least persistent on the portion of the wetland that is west of FS 12. The flora of wetland west of FS 12 appears very similar to that lying east of FS 12, although neither DRAD2 nor SAOR2 not detected here. Perhaps 5-6 sedge species at this meadow complex (both sides of FS 12), but phenology mostly too early for confident identification.
Photos: #s 3319, 3320-3321, 3323, 3325, 3326, 3327.

2. 2630-850 rd.
Elevation: 5700-5720 feet
TRS: T13S, R23E, S9/10
Date: 6/19/2017
Rationale: NWI PEMB
Plants: Graminoids – ALLIU, JUBA, **ELQU2**, MUFI2, ELPA3
Forbs – POBI6, **SAOR2**, CAQU2, TRIFO, RAUN, MOCH, EPILO, SEHY, RUMEX, VERON, LOMAT, **DODEC**, POGR9, WYHE2
Bryophytes – BRPS70, PHFO6, **DRAD2**
Soil probes: Three probes in areas of soppy-wet soil in the lower NW-SE axis of this meadow found a smooth (inorganic component very fine-grained or lacking), buttery, organic-rich soil, 19-29" thick, over a thin sandy layer atop rock.
Notes: This is a very low-gradient, dog leg-shaped meadow with a relatively dry W-E oriented upper portion and a NW-SE oriented lower portion with areas of notably soppy soils, particularly in its central

region. Any substantial wetting by groundwater would need to be discharge within the central interior of the NW-SE meadow leg, as no evidence of groundwater discharge was detected along the edges of the meadow. The meadow flora, including the low count of fen indicator plant species, suggests that this meadow is only seasonally wet, and that directly overlying snowpack may be more important than groundwater as a water source.
Photo: #3335.

3. 2630-841 rd. (Haypress Creek)
Elevation: 5580-5670 feet
TRS: T13S, R23E, S16
Date: 6/19/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, **CAJO**, **ELQU2**, **CASI2**, LUZUL, CADI6
Forbs – TAOF, MOCH, TRIFO, POBI6, SEHY, VERON, ALLIU, **SAOR2**, EQAR, **HYAN2**, EPILO, ORUN, **PLDI3**, VIOLA, POOC2, VERAT, BAVU, POGR9, TRLO, GEMA4, **DODEC**, CANE2, CADI6, MIGU, CAQU2, LOMAT
Bryophytes – BRPS70, PHFO6, **PLEL2**, **DRAD2**, BRWE70, MAPO16, **MEUL70**, RIBE, AUPA70, RICA15
Soil probes: Probes were conducted at 14 distinct locations spread across the three primary portions of this site. All three primary portions included some probes detecting predominantly organic soil to depths of 51+" to 54+". Most probes encountered high soil densities, two or more strata differing in density or content of inorganic fines.
Notes: Spatially, this site is comprised of three primary portions. These are included within the site's two mapped NWI PEMB polygons. The north-central and SW portions are to two primary portions of the larger, lower, hour glass-shaped polygon; the NW portion is the entirety of the area included in the second, upper polygon. This wetland directly contributes groundwater seepage to the upper, apparently intermittent reaches of Haypress Ck. The creek channel routes along the meadow's NW portion and then through the lower half of its north-central portion. Based on topography, soil character and plant community composition, what appears likely to be persistently wet sloping fen habitat occurs in all three primary portions of this wetland. Other habitat within the two mapped NWI PEMB polygons appears to be seasonally wet meadow, a habitat type that appears to be extremely common on Ochoco NF. Where the creek passes through the north-central portion of the meadow/wetland, it receives groundwater input along each of its banks. At one section of this reach, the creek is bordered by a six foot-tall cut-bank on it west side, and a 18-20" high cut-bank on its east side. The western cut-bank exposes a very interesting, three-layered soil profile. The upper layer is four feet thick, of lighter in color, and appears to be primarily of inorganic content. This layer transitions into a very dark, apparent buried organic soil sitting atop the third layer, a thin deposit of impenetrably dense clay/ash that forms the bed of the creek at this point in the reach. The buried organic soil layer is bleeding groundwater into the low-volume creek. This meadow/wetland is quite notable in the detected presence here of 10 fen indicator taxa, and the very rare (on OCH NF and mostly, state-wide) FIT moss *Meesia uliginosa*. In fact, the Haypress Ck. site is the first OCH NF record for MEUL70. Also notable, a six-foot diameter PSME stands midway along the eastern edge of the meadow/wetland's north-central portion. Cattle manure was found in this meadow/wetland, but none appeared to be of recent origin. Because of the presence of good-quality fen habitat and the presence of a rare (OCH NF) moss species, it can be defensibly argued that livestock grazing is an inappropriate management practice in the meadow/wetland.
Photos: #s 3337-3338, 3339-3340, 3341, 3342, 3343, 3344, 3345, 3346, 3348, 3349, 3350, 3351, 3353, 3354, 3355, 3359-3360.

4. 2630 rd., sect. 8
Elevation: 5760 feet
TRS: T13S, R23E, S8
Date: 6/21/2017
Rationale: NWI PEMB
Plants: Graminoids – CAMI7, PHLEU, **CASI2**, **ELQU2**, **CAJO**, CAUT
Forbs – SEHY, TRIFO, POGR9, WYHE2, POBI6, TAOF, RAUN, EPILO, **SAOR2**
Bryophytes – PHFO6, BRPS70, BRWE70, **DRAD2**
Soil probes: Three probes found organically rich soils with minor, fine inorganic component; soils 24-31" deep.
Notes: This is a very broad, very low-gradient drainage, much of which appears to be only briefly, seasonally wet. Local topography seems to dictate very limited opportunity for existence of even moderately persistent feed from groundwater aquifer(s). Soppy soils were encountered in SW portion of meadow. This is where the FIT CASI2, ELQU2 and CAJO were detected. This soppiness was likely due to a combination of meltwater from overlying snowpack (gone at time of visit) and discharge from a very local, shallow, low capacity, seasonal groundwater aquifer. The rather shallow soils and low count of detected FIT supports an interpretation that any soppiness in this meadow is restricted to late spring and early summer.
Photos: # 3362, 3363, 3364, 3365.

5. 30-900 rd.
Elevation: 5480-5540 feet
TRS: T13S, R23E, S15/22
Date: 6/21/2017
Rationale: NWI PEMB
Plants: Graminoids – CANE2, JUBA, POA, **ELQU2**, **CASI2***, **CAJO***
Forbs – SEHY, CAQU2, POGR9, EPILO, TAOF, RAUN, POBI6, VERON, MOCH, ALLIU, **SAOR2**, GEMA4, POOC2, EQAR, **PLDI3**, **HYAN2**, FRVI, TRLO, ACMI2
Bryophytes – FONTI, BRPS70, BRWE70, PHFO6, AUPA70, **DRAD2**, MAPO16.
* Very likely, but determination not confirmable due to immature perigynia.
Soil probes: Ten probes were conducted across the three mapped PEMB polygons that comprise this site. Soil depths ranged from 26-51+", with a depth of 51+" detected at least once within each of the three mapped polygons.
Notes: This site is comprised on three mapped NWI PEMB polygons distributed in close proximity near the confluence of Double Corral and Haypress Creeks. Each mapped polygon was found to include at least one linear-shaped groundwater-fed soppy areas situated between creek and an adjacent forested slope. Vegetation within these mapped polygon is generally dominated by relatively dense sedge communities; bryophyte cover and diversity is relatively low. Detected deep soil depths within soppy strips within these mapped polygons suggests these areas may be fed by relatively persistent groundwater discharge, but only visits later in the summer would confirm this.
Photos: #s 3366, 3367, 3368-3369, 3370, 3371, 3372, 3373, 3374.

6. 30-870 rd.
Elevation: 5580-5600 feet
TRS: T13S, R23E, S16/21
Date: 6/26/2017

Rationale: NWI PEMB
Plants: Graminoids – **ELQU2**, CAMI7, CAUT, JUBA, **CASI2**, CANE2, ELPA3,
Forbs – TAOF, TRIFO, ALLIU, RAUN, EPILO, SEHY, MOCH, CAQU2, POBI6, POGR9, ACMI2, VERON, SAIN4, EQAR, **SAOR2**, IRIS, VERAT, POOC2
Bryophytes – BRPS70, **DRAD2**, PLAGI7, AUPA70, PHFO6, RIBE, MAPO16, BRWE70
Soil probes: Four probes in wet-soiled portions of this meadow found a resistant/dense, smooth/non-gritty soil layer 18-26" thick, overlying a gritty layer extending to soil base at 22-42".
Notes: At the time of visit, soppy-squishy soils wetted by active, diffuse, groundwater discharge were commonly encountered, especially in the upper (NW) half of this meadow. Wet soils were most evident along the central axis of this meadow, suggesting that the likely deeper, central meadow soils are intersecting a shallow local groundwater aquifer, but not the meadow's higher edges. It seems very likely that this is yet another seasonally groundwater-wetted meadow. Evidence for this seasonality includes the very low detected cover values, or failure to detect relatively common OCH NF fen species such as SAOR2, PLDI3, CAJO, CASI2, and ELQU2.
Photos: #s 3375, 3376, 3377-3378.

7. 30-800 rd.
Elevation: 5500-5580 feet
TRS: T13S, R23E, S20
Date: 6/26/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, SCMI2, **CAJO**, CAUT, **ELQU2**, LUCA2, JUNCU, CANE2, PHLEU, **CACU5**, **CASI2**, **CALU7**
Forbs – POBI6, **SAOR2**, **PLDI3**, POOC2, ACMI2, RAUN, VERON, POGR9, FRVI, TRLO, EQAR, TAOF, SENEC, DELPH, **HYAN2**
Bryophytes – AUPA70, BRPS70, **DRAD2**, PHFO6, BRWE70, MAPO16, **PLEL2**
Soil probes: Six probes were conducted within this meadow/wetland. Four of these, on soppy-squishy soils detected soil depths of 51+". Grit in the probe residues at these sites was either fine-textured and sparse, or lacking.
Notes: This site lies within a linear mapped PEMB polygon along the drainage of a northern, very low-volume (at time of visit) tributary to Happy Camp Creek. Active, diffuse groundwater discharge within this site is most notably evident at two groundwater-rich benches near opposite ends of the site, and on the meadow slope between the creek and western forested (PICO) edge, shortly below the lower bench. This site is notable for the presence of deep soil of apparent high organic content, and the presence of four detected FIT sedges. Two of these sedges, CACU5 and CALU7, appear to be relatively uncommon on OCH NF. This site is also notable for the heavy soil impact owing to use by cattle. Manure of cattle is abundant and widespread. Although generally visibly masked by the dense sedge community, soils in the wetter portions of the meadow/wetland are difficult to walk through due to the high density of hidden pits and pedestals, 2-4" high.
Photos: #s 3379, 3383, 3384, 3385, 3386, 3387, 3389&3391, 3392.

8. 30-747 rd.
Elevation: 5420-5450 feet
TRS: T13S, R23E, S29
Date: 6/27/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, CANE2, POA, CAMI7, **CAJO**, **CASI2**, CAUT

Forbs: - TAOF, RAUN, ACMI2, EPILO, **SAOR2**, SEHY, POGR9, **PLDI3**, GEMA4, **HYAN2**, POOC2, MIGU, VERON

Bryophytes – PHFO6, BRPS70, BRWE70, **PLEL2**, AUPA70, MAPO16

Soil probes: Two probes were conducted. A probe in the squishy-wet upper northern portion of this meadow found scratchy soil throughout the core to a firm base at 39". A probe conducted in a soppy-wet portion the lowest, southern border of the meadow detected a column of smooth soil atop 4" of scratchy soil sitting on a firm base at 36".

Notes: This meadow is situated on a moderate slope dropping down from north to south. The base of this slope joins a second, much smaller slope descending from west to east. Active, diffuse groundwater discharge at the time of this visit was located primarily in two locations within the meadow: at the upper, northern portion of the meadow's main, north-downward-to-south slope, and at the lower southern edge of the meadow, along the lower eastern portion of a lesser, west-downward-to-east slope. Much of the lower (southern) half of this meadow is sparsely vegetated and dry-soiled at the time of this visit. The low count of detected FIT supports an understanding that this is a seasonally groundwater-wetted meadow, becoming progressively drier as the summer progresses.

Photos: #s 3393, 3394, 3395, 3396, 3397, 3398, 3400.

9. 4254 rd., section 17

Elevation: 4850-4960 feet

TRS: T14S, R23E, S17

Date: 9/11/2017

Rationale: NWI PEMB

Plants: Graminoids – **CAJO**, **CACU5**, **CAIN11**, CAPE42, **JUNE**, **JUEN**, SCMI2, CAAM10,

Forbs – EQUIS, **SAOR2**, LICA2, RUMEX, ACMI2, EPILO, **HYAN2**, PAPS5, LEMNA, **PLDI3**, POOC2, FRVI, MIGU, TRLO

Shrubs - ALNUS

Bryophytes – MAPO16, PHFO6, BRPS70, **PLEL2**, **DRAD2**

Soil probes: Multiple probes in the groundwater-fed area above the 4254 road found 12-14" of soil over rock.

Notes: The mapped PEMB poly includes area both below and above the 4254 road. A short walk through the area below the road indicated little presence of groundwater-wetted habitat. Most of the time during this site visit was spent above the road, on the face of the road cut bank, and on the groundwater-fed slope above it. Perhaps most striking about this portion of the site above the road is the unexpectedly large count (10) of detected FIT in such a very small area. This large count suggests that groundwater-wetting of this site may persist through much of the growing season. This suggestion is reinforced by the relative late-summer date of this visit. Also notable is the presence here of the uncommon (OCH NF) fen-loving sedge CAIN11. Notably, six other roadside areas of groundwater discharge were noted between this site and the 4270/4254 junction to the east. Three of these, at least, appeared to warrant further examination on the ground.

Photos: #s 3679, 3680, 3682.

10. 4250-500 rd.

Elevation: 5120 feet

TRS: T14S, R23E, S22/23

Date: 9/12/2017

Rationale: NWI PEMB

Plants: Graminoids – CAPA14, PHLEU, VEDU

Forbs – ALLIU, JUOR, SEHY, EPILO, TRLO, ACMI2
Bryophytes – PHFO6
Soil probes: None attempted.
Notes: This site was accessed by walking north from the 4250 road. Soils at the site were dry at the time of visit. This very low-relief site sits at a topographic headwaters site, bordered on three sides by the same 5120' contour line. A weakly defined channel at the site suggests presence of early-season surface water output from this location, but there is no evidence that groundwater discharge makes any contribution to this output. Early season wetness at this site seems most likely due to meltwater from the local snowpack.
Photos: #s 3683, 3684, 3685.

11. 4270-210 rd.
Elevation: 4970-5020 feet
TRS: T14S, R23E, S20
Date: 9/12/2017
Rationale: NWI PEMB
Plants: Graminoids – SCMI2, PHLEU, **JUEN**, **CASI2**, **CAIN11**, **CACU5**, JUBA, CAUT, JUOR, **CAJO**, **CAAQ**, CANE2
Forbs – EQAR, EPILO, PRVU, **PLDI3**, MIGU, POOC2, **HYAN2**, PAPS5, **SAOR2**, LEMNA
Shrubs - ALNUS
Bryophytes – PHFO6, MAPO16, BRPS70, **PLEL2**, **DRAD2**
Soil probes: Two probes on squishy/soppy-wet soil in the upper, central portion of the eastern lobe of this meadow system found low-density/resistance, gritless soil to 51+". A probe on a nearby groundwater-fed slope found soil of moderate density/resistance to a gritty soft base at 36". A probe on the groundwater-fed terrace at the far upper end of the western lobe of the system found moderately low density/resistance, gritless soil to apparent rock at 50".
Notes: The large amount of late-season groundwater discharge encountered in this meadow system was unexpected, given its position just below a very broad, sparsely vegetated scabby ridge. The system itself is a N-S-oriented "Y", with a 250m-long eastern arm and a 300+m-long western arm converging into a 150m-long trunk that terminates at its junction with an unnamed E-W-flowing intermittent creek. The whole of this "Y" is mapped as NWI PEMB. The OCH NF GIS steams layer does not map even an intermittent creek draining this meadow system. The eastern arm of this meadow system has first-order soppy or squishy groundwater-wetted soils in its upper portion and along the western edge of its central portion. In the upper portion of the eastern lobe, a centrally-located, very soppy area with concave microtopography, may be wetted substantially by second-order groundwater discharge from wet meadow soils above it. Small, low-volume channels are present in the eastern arm. They originate fully within the eastern arm, and eventually, disappear by recharging back into it. At the point where the arms of the "Y" converge, an audible, active small creek was draining out of the western arm. This small creek was not followed all the way down to where it would join the larger, intermittent E-W drainage at the "Y" meadow system's base, but short travel along its route suggests that it too may recharge before reaching the larger E-W drainage. Above its junction with the eastern arm, much of the western arm is very wet-soiled, with a mixture of alder-lined riparian corridor and small meadow openings with smaller active channels. It is impossible to judge how much of this wetness is being derived from groundwater discharge from along the border of the riparian corridor and the adjacent wooded uplands, and how much is simply lateral, subsoil movement of water from the active creek channels. The collective volume of visible surface water appears to vary along the lower 2/3s of the corridor, suggesting the groundwater discharge and recharge are both active processes along here. The upper third of the western arm is

occupied by a variously groundwater-wetted, 90m-wide bench sitting atop a prominent slope break. Small active channels were draining out of the bench and down the face of the slope break at the time of visit. More than half of the FIT noted within the eastern arm of this meadow system were detected on this bench. Along with detections in the lower portion of this arm, about ¾ of the FIT noted in the eastern arm were detected in the whole of the western arm. The transition from the damp to soppy-wet soils of the bench to the dry soil of the adjacent upland woodland of PIPO and JUOC is narrow and immediate. The conifer woods very quickly transition into the broad, scabby ridge. Again, somewhat surprising that such a dry-soiled, sparsely vegetated upland could be apparently underlain with such a robust groundwater aquifer. Laying in a transect of wells up into this scabby upland to determine the depth to, and thickness of, this aquifer, would be a very interesting project. This richly groundwater-endowed meadow/wetland system is otherwise notable in its support of a goodly number (11) of FIT, including the uncommon (OCH NF) fen-loving sedge CAIN11.
Photos: #s 3686, 3687, 3688, 3689, 3690, 3691.

<u>Upper Crooked Main, UTM Zone 10</u>

1. 4220-050 rd. (Jungle Creek)
Elevation: 4920-4940 feet
TRS: T14S, R21E, S31
Date: 7/11/2017
Rationale: Recommendation by OCH NF staff (Jim David).
Plants: Graminoids – JUBA, CANE2, SCMI2, POA, CAPA14, CAAM10, **JUEN**, **CAJO**, **CASI2**, **CAIN11**, CADI6
Forbs – ALLIU, EPILO, POOC2, **PLDI3**, SIDAL, **SAOR2**, SPCA5, **HYAN2**, MIGU, GEMA4, VERON, EQAR, RAUN, LEMNA, PAPS5
Shrubs - SYAL
Bryophytes – BRPS70, CAPO17, MAPO16, **DRAD2**
Soil probes: Probes in seasonally groundwater-wetted areas above the 050 spur road, and below this road and low on both north and south slopes above Jungle Creek, found dark, generally resistant/dense sparsely gritty soils with depths of 50-51+". Multiple probes within the very soppy CAIN11 community found a firm soil base at 19-24"
Notes – This site, situated immediately east of the junction of the 050 and 052 spur roads, consists of a set of proximate, small patches of primarily groundwater-wetted soil, and dependent plant species. Modest numbers of FIT were detected in two patches of seasonally groundwater-wetted soils above the 050 spur road, but a larger cover and greater diversity of FIT, including the sedges CAJO, CASI2 and CAIN11 were detected only below this road on groundwater-fed slopes shortly above Jungle Creek. It is possible that the only persistent soil-wetting groundwater discharge at this site is associated with the very soppy-wet CAIN11 community on the western edge of this site. Much of the wet-soiled area below the 050 road examined during this visit is mapped NWI PFOB (freshwater forested/shrub wetland).
Photos: #s 3434, 3435, 3436, 3438, 3439-3444.

2. 4220-151 rd.
Elevation: 5460-5480 feet
TRS: T15S, R20E, S2/11
Date: 7/18/2017
Rationale: Field knowledge of OCH NF staff (Jim David)
Plants: Graminoids – SCMI2, CAMI7, CAUT, **CACU5**, **CAJO**, CANE2, **CALU7**, **JUEN**, PHLEU,

MUFI2, JUBA, **CASI2**, **ELQU2**

Forbs – **PLDI3**, MIGU, EQAR, POOC2, **SAOR2**, GEMA4, SAAR13, **HYAN2**, FRVI, TRLO, RUMEX, SPCA5, ACMI2, PRVU

Bryophytes – PHFO6, AUPA70, MAPO16, BRPS70, **PLEL2**, **DRAD2**, **METR70**, **MEUL70**

Soil probes: Three probes in the upper (south) meadow found 30-37" soil to rock base; no grit detected in residue of two of the three probes. Three probes in the lower, main meadow found apparently pure organic soil to rock or other firm base at 30-51"; no grit detected in residue of any of the probes.

Notes: This wetland/meadow system as recognized here consists of a upper, smaller, NE aspect meadow, separated by a band of grand fir, alder and aspen from the lower, larger meadow which itself consists of a smaller, upper, low-gradient, north aspect portion, and a larger, lower, steeper, E/NE aspect portion. Squishy-wet or soppy-wet soil was common in both upper and lower meadows at the time of visit. Among groundwater-fed wetland/meadows on OCH NF visited by the project lead, this wetland/meadow appears to rank second only to the upper Bridge Creek wetland/meadow in its count of detected FIT (13). This site is also notable for the presence of the rare (on OCH NF) fen moss METR70, and the presence of only the second OCH NF record of the fen moss MEUL70. Both of these taxa were detected only on the E/NE aspect portion of the lower wetland/meadow. The MEUL70 was found mostly along a damp-wet, moss and liverwort-rich, long very rotten down bole in a shaded, particularly soppy-soiled, robustly groundwater-fed corner of the E/NE aspect slope. Persistence of groundwater discharge within this system is uncertain due to the mid-summer date of visit, but the high FIT count, including in particular, the sedges CACU5 and CALU7, suggests that much of the system may continue wet through much or all of the summer. Manure of cattle was not seen within the wetland/meadow proper, and manure in woods on the NW edge of the system was old and dry. Soil pits due to large hooves were present in the vicinity of the MEUL70 site, but whether cattle or elk, was not evident. All of the wet-soiled area examined during this visit is mapped NWI PSSB (freshwater forested/shrub wetland).

Photos: #s 3446, 3447, 3448, 3449, 3450, 3451, 3452, 3454, 3455-3461, 3462-3264, 3466, 3467-3468, 3469.

3. 4220 rd. (Lytle Creek)

Elevation: 5550-5600 feet

TRS: T15S, R20E, S10

Date: 7/24/2017

Rationale: NWI PEMB

Plants: Graminoids – PHLEU, POPR, **JUNE**, **JUEN**, **CAJO**, **CACU5**, CANE2, **CALU7**, SCMI2, **ELQU2**, CAUT, JUBA, **CASI2**, HOBR2, JUOR

Forbs **– PLDI3**, **SAOR2**, MIGU, ALLIU, PRVU, ACMI2, GEMA4, ERPH, CIRSI, TRLO, PAPS5, POOC2, VERON, EPILO**, HYAN2**, RUMEX, LEMNA, HYPE, ACMI2, POGR9, POBI6, SAAR13

Shrubs – ALNUS

Bryophytes – BRPS70, PHFO6, **PLEL2**, **DRAD2**, MAPO16, AUPA70

Soil probes: Six probes on squishy-wet or soppy-wet soils in four of the five rather partitioned portions of this wetland/meadow system found apparent organic layers overlying sparsely gritty layers over firm bases at 42-46", or with soil bases lying beneath the reach of the probes at 51+ to 54+" (in four probes).

Notes: This wetland/meadow complex included much soppy-wet, groundwater-fed habitat at the time of visit. Because of partitioning by alder strands, and topography, five meadow subunits within this system are recognizable both in the NAIP imagery and on the ground. Soppy-wet areas are typically associated with forest-edge toeslopes, other slope breaks, and in the case of the largest subunit at the far, upper NW end of the system, a channel-like broad swath of groundwater discharge which in NAIP-view at least, has

a linear/dendritic pattern. The persistence of the groundwater-fed wetness witnessed during this visit is uncertain, but it presence in the last week of July, and the relative high count of FIT, including presence of the sedges CACU5 and CALU7 in two of the system's lower subunits, suggests that locally, at least, this wetness may persist through the summer.
Photos: #s 3470, 3473, 3477, 3475, 3476, 3477.

4. Upper 4215-150 rd.
Elevation: 5190-5200 feet
TRS: T15S, R20E, S12
Date: 7/25/2017; 9/11/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, **ELQU2**, SCMI2, CANE2, **CAJO**, **JUEN**, PHLEU, POPR, JUOR, **CASI2**, CAUT, **CACU5**, MUFI2, DECE
Forbs – TRLO, ERPH, **PLDI3**, MIGU, ACMI2, PAPS5, **SAOR2**, **HYAN2**, **MIPR**, **SPRO**, ORUN, ALLIU, EPILO, POOC2, EQUIS
Bryophytes – **DRAD2**, PHFO6, **METR70**, MAPO16
Soil probes: Four probes were conducted along a N-S axis in the upper portion of the wetland/meadow. All probes encountered high soil densities either in upper soil layers or throughout, with firm bases reached at 31-42" (3 probes) or not yet reached at 51". Probe residue mostly with sparse, fine grit.
Notes: This gently-sloping, mid-sized, 3+ acre wetland/meadow is particularly notable in the predominance of short-statured fen community – as expressed on OCH NF – on the soppy-wet/squishy-wet soils accounting for most of the wetland/meadow's surface area. Short-statured fen communities generally feature codominance of shorter-statured sedges and sedge relatives, and mosses. This system appears to be primarily, if not exclusively, wetted by groundwater discharging along the full extent of meadow/forest interface along the meadow's upper western edge. At the time of the initial, mid-summer visit to this meadow on 7/25/2017, the extensive presence of soppy-wet/squishy-wet soils, and the relatively high count of detected FIT (12) suggested that this wetness might well persist well into the summer. This suggestion was greatly supported by the return visit on 9/11/2017 in which little change in upper meadow wetness was noted. Minor seasonally active channels exist within the meadow, but even at the mid-summer visit, none of these carried persistent surface output from the system. This meadow is also very notable in the presence of the rare (on OCH NF) fen-loving moss METR70. Cattle manure observed within this meadow was scant, although it was abundant in the woods immediately adjacent to the western edge of the system. Hoof pits and hoof-sized areas of bare peat were observed in the northern half of the meadow, and major hoof pits and pedestals were present in the lower, seasonally wet eastern portion of the meadow's northern, NW-SE oriented lobe. Overall, physical evidence of grazing impact to this meadow is relatively slight.
Photos: #s 3478, 3479, 3480-3482, 3483-3484, 3485-3486, 3487-3491, 3492, 3493, 3494, 3678.

5. Lower 4215-150 rd. (w) (Spring Creek hdws)
Elevation: 4980 feet
TRS: T15S, R20E, S12/13
Date: 7/25/2017
Rationale: NWI PEMB
Plants: Graminoids – SCMI2, JUBA, **JUEN**, CANE, PHLEU, **CASI2**, DECE, **ELQU2**, **CACU5**, JUOR
Forbs – **SAOR2**, TRLO, MIGU, EPILO, PAPS5, ALLIU, LEMNA, **HYAN2**, RANU, POOC2, POGR9, CIRSI, PRVU
Bryophytes – PHFO6, BRPS70, MAPO16, **DRAD2**

Soil probes: Two probes in the soppy-wet upper half of the N-S portion of the meadow found very resistant/dense soil to firm bases at 35-38". Soil residue on extracted probes has sparse to abundant fine grit.
Notes: This is a dog-leg shaped meadow that initially extends downslope along a N-S axis for approximately 125m and then bends to a NNW-SSE axis, following Spring Creek for about 125m. The steeper, upper half of the N-S portion of this meadow included nearly all of the instances groundwater-fed soppy-wet soil detected during this visit. No groundwater-fed surface output from the meadow's N-S axis, into Spring Creek was detected. Spring Creek itself was flowing at a very low volume. The creek along its NNW-SSE axis is initially narrow and incised, with audible headcuts, before widening and disappearing into a tall sedge community. Large gouges in the creek bank exist where large ungulates have accessed the creek water.
Photos: #s 3496, 3497.

6. Lower 4215-150 rd. (e) (Spring Creek hdws)
Elevation: 4980 feet
TRS: T15S, R20E, S12
Date: 7/25/2017
Rationale: NWI PEMB
Plants: Graminoids – **CASI2**, **ELQU2**, DECE, JUOR
Forbs – ALLIU, MADIA, EPGL, **SPRO**, POBI6, **MIPR**, MIGU, ARCH3
Bryophytes – **DRAD2**, BRPS70
Soil probe: Single probe in squishy-wet DRAD2-CASI2-ELQU2 community found soil so extremely resistant/dense that probing effort terminated at 16".
Notes: This is a triangular-shaped meadow gently sloping downward along a NE-SW axis, from its upslope broad base to its downslope tapering SW tip. At the time of visit, the western half of the meadow was moist/dry-soiled while much of the eastern half was occupied by a groundwater-fed swath that was damp on its edges and squishy-wet to soppy-wet toward its interior. This swath is visible in NAIP imagery and easily enough traced on the ground by soil moisture content and presence of associated local indicator species, particularly SPRO and JUOR. The upslope origin of the groundwater swath is traceable to the vicinity of a spring-well of upwelling water arising from a sandy/gravelly base 40" below the water surface. Local distribution soil wetness suggests that the spring-well is not the sole source of groundwater feeding the large swath, but that it is also associated with diffuse groundwater discharge over a broader, adjacent area. Surface discharge from this well, and likely, contribution from local diffuse discharge, provides very low volume, sometimes interrupted flow within a mostly shallow and narrow channel that extends slightly beyond the far SW tip of the meadow. The low count of detected FIT suggests that the wetness seen here in mid-summer may be seasonal and become only weakly expressed in a month's time or less. The low count of FIT is almost a bit surprising given that soppiness in the swath is clearly not briefly seasonal, but apparently extending well past mid-summer. A return visit in mid-August would be informative, as would accessing local data on the relative wetness of the 2017 water year.
Photos: 3498, 3499.

7. 4230 rd. (Hickey Meadow)
Elevation: 4710-4740 feet
TRS: T14S, R21E, R35
Date: 7/26/2017
Rationale: NWI PEMB

Plants: Graminoids – JUBA, DECE, JUOR
Forbs – ACMI2, POGR9, TRLO, DELPH, ASTER, MICRO6, EPILO, POBI6
Bryophytes – RICA15, **DRAD2**
Soil probes: None conducted.
Notes: There is no evidence of the influence of even seasonal groundwater discharge in any portion of this very large meadow. Curious deep erosional features exist in the meadow's lower far eastern end. Although OCH FS GIS shows a perennial stream entering the meadow at its central southern border and then coursing toward the meadow's eastern end, not even a seasonal channel was detected along this route or anywhere else within the meadow. A well-developed dry channel comes out of a drainage heading up into the woods on the south side of the meadow, but it broadens and then dissipates before actually reaching the fencing bordering the meadow. Absence of evidence of groundwater contribution, and failure to detect even dry channels that would provide seasonal, upland input, it seems likely that spring meltwater from the directly overlying winter snowpack is the primary source of seasonally available water for this meadow.
Photos: #3500, 3501, 3502, 3503.

8. 4230-900 rd. (Hickey Creek)
Elevation: 4600 feet
TRS: T14S, R21E, S36
Date: 7/26/2017
Rationale: NWI PEMB
Plants: Graminoids – JUOR, JUBA, DECE, CANE2
Forbs – ACMI2, POGR9, ALLIU, EPILO, **SAOR2**, POOC2, RUMEX
Shrubs - SALIX
Bryophytes – BRPS70, PHFO6, **DRAD2**, **PLEL2**, FONTI, AUPA70, BRFR70
Soil probes: Relatively dry, shallow or impenetrable soils were found in the lower eastern half of terrace flat mapped as PEMB. Two probes were conducted on the southern edge of the eastern half of the mapped PEMB in soils evidently wetted by groundwater discharge. These probes found soil depths of 36" and 51+". Residue on probes was sparsely gritty.
Notes: Evidently and notably groundwater-wetted soils were found within the mapped PEMB primarily along ~ 100m of the slope break at its southern edge, ending just before the E-W drainage associated with seasonal outflow from the culvert passing under the 4230-900 rd. The very low count of detected FIT is likely associated with the small aerial extent of groundwater-wetted soil, but may also be associated with seasonality of groundwater discharge. It may also be that some of this groundwater discharging at this site is fed by secondary infiltration of surface water being delivered by the seasonal flow from the culvert.
Photos: #s 3504, 3505, 3506, 3507, 3508, 3509.

9. 4230 rd. (Round Prairie)
Elevation: 4810 feet
TRS: T15S, R21E, S3
Date: 7/26/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, JUOR, CANE2
Bryophytes – FONTI
Soil probes: None conducted. Except at lower, far western end, meadow soils were hard and mostly dry.
Notes: This large, very gently sloping meadow appears to have essentially zero wetting due to groundwater discharge. Only at the far northern end where all seasonal drainage exits the meadow into a

small reservoir, were wet soil and channels with shallow standing water observed. It was not evident whether this wetness represented remnants of seasonal surface drainage from the meadow, or discharge of groundwater lying under the meadow and originating from infiltration of meltwater from snow directly overlying the meadow. Many erosional features within the meadow, such as dry channels and deep potholes, suggest active, seasonal surface water drainage across the meadow. This is puzzling in that these erosional features suggest a larger volume of water than meltwater of overlying snow could provide, yet seasonal channels entering the meadow appeared to be weakly developed.
Photos: 3511, 3512, 3513, 3514, 3515-3516, 3517.

10. 4230-850 rd. (Little Round Prairie)
Elevation: 4940 feet
TRS: T15S, R21E, S3
Date: 7/27/2017
Rationale: NWI PEMB
Plants: Graminoids – DECE, JUBA, VEDU
Forbs – ARCH3, MICRO6, ALLIU, ACMI2, EPILO, **SPRO**, SAIN4, POBI6, TRLO
Soil probes: None conducted.
Notes: Zero evidence of groundwater contribution to seasonal wetting within this meadow was detected. Soil surfaces at the time of visit were dry and hard. No seasonal input channels were detected, although the location of very weakly developed channels within the meadow suggests that there may be low volume seasonal output from the meadow's tapering NE corner. Meadow gradient is essentially flat, although perhaps very weakly bowl-shaped. Meltwater from directly overlying snowpack may be the primary source of soil-wetting water for this meadow.
Photos: 3514, 3515-3516, 3517.

<u>Upper Crooked – Maury Mountains</u>

1. 1610 rd., section 26
Elevation: 4430-4500 feet
TRS: T17S, R18E, S26
Date: 10/3/2017
Rationale: NWI PEMB
Plants: Graminoids – CAUT, JUBA
Forbs – CIRSI, LEMNA, POOC2, **SAOR2**, RUMEX, MIGU, EPILO, GEMA4, EQUIS
Shrubs – ALNUS, BEOC2
Bryophytes – MAPO, BRPS70, **DRAD2**, **PLEL2**
Soil probes: Probe in extremely soppy-wet groundwater discharge area at lower eastern edge of meadow found very low resistance to 51+"; residue on probe thin, mucky, without grit. Probe in extended seepage area along eastern edge of meadow found moderately low resistance soil to 51+"; residue on probe a thin muck with very sparse grit. Probe on soppy-wet soil in upper mid-meadow found did not reach base at 51+"; upper two feet of soil offered moderate resistance, but then probe sank rest of its length with a single push.
Notes: This is a N-S oriented meadow/wetland with a steep-slope at its lower, far northern end and an otherwise gently sloping main body. Groundwater discharge is clearly primarily responsible for the squishy/soppy soils observed along much of the meadow's eastern edge and along a broad midline down much of its main body. Given the lateness of the visit, it appears that this groundwater discharge may typically persist through the full growing season. From a wetland management perspective, this is a very

sad, late-season sight to behold. Impacts of the hooves of cattle are extensive and intensive. Low stubble height made vascular plant identification dependent on incidental finds of individual shoots in protected nooks. A very heavy thistle infestation is in progress. This site has the size and persistent wetness to support a respectable diversity of plant species, but little evidence of diversity was available at the time of visit. Intense grazing impacts are likely a factor here.
Photos: #s 3815, 3816, 3818, 3821, 3822.

2. 1600 rd., section 11
Elevation: 5260-5340 feet
TRS: T18S, R19E, S11
Date: 10/3/2017
Rationale: NWI PEMB
Plants: Graminoids – **JUEN**, JUBA, SCMI2, PHLEU, CANE2
Forbs – EPILO, SIOR, MIGU, SEHY, VERAT, TRLO, LEMNA
Bryophytes – BRPS70, **DRAD2**, POWA70
Soil probe: A probe in a squishy-wet green swath within the area of the mapped PEMB found highly resistant/dense to a firm base at 38"; soil residue on prove lightly gritty and very pale in color. Sense of resistance may have been in large part due to vacuum created with every effort to raise probe during the usual repeated up and down motion usually needed to sink the probe.
Notes: This visit included a rather extensive walk-about both above and below the 16 road. It was found that the area above the 16 road and the very broad meadow below the 16 road was mostly dry-soiled. The only damp to squishy-wet soil was found in a roadside ditch on the upslope side of the 16 road and in a green swath extending down into the meadow from the culvert draining the wet ditch. The volume of water exiting this culvert was little more than robust dripping, but the overgrown (sedges) channel extending from this culvert was occupied by shallow pools and sometimes very slowly moving water will into the meadow. Notably, the green swath and extent of damp to squishy-wet soils associated with this channel broadened with distance down the gentle slope. Plant dominants within the green swath included CANE2 and EPILO. The amount of wetness in this swath clearly appeared to exceed the volume of water present in the channel. This in turn suggested that diffuse groundwater discharge may be occurring within the area of the green swath. The last of squishy-wet soil detected within the green was found approximately 80m below the 16 road. The green swath itself extended another 50m with underlying soils transitioning from wet to damp and then dry. At least two other culverts collect seasonal surface water from above the 16 road and send it down into the large meadow. Source of this surface water appears most likely to be meltwater from local annual snowpack. Above and below-road well transects would appear to be necessary to determine the character of any shallow groundwater aquifer underlying the meadow, and the possible extent to which diffuse seasonal discharge from such an aquifer contributes to the meadow's annual water budget.
Photos: #s 3823, 3824, 3825, 3826, 3827.

<u>Lower Crooked</u>

1. 2610-150 rd. (s)
Elevation: 4560 feet
TRS: T13S, R19E, S22/27

Date: 7/27/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, POPR, **ELQU2**, JUBA, HOBR2, PAPS5, **JUEN**, SCMI2, CAUT, **CAIN11**, **CAJO**, **JUNE**, AGROS2
Forbs – ALLIU, POGR9, EPILO, SIOR, MIGU, TRLO, TRIFO, EQUIS, CASTI, **PLDI3**, POOC2, ASOC, CIRSI
Shrubs – SALIX
Bryophytes – **DRAD2**, **PLEL2**, BRPS70
Soil probes: Two probes on damp and on squishy-wet/soppy-wet soil found a very resistant/dense upper layer becoming progressively less resistant in route to a depth of 51+''.
Notes: This small site features a very confined area of diffuse groundwater discharge that supports a small willow patch and generates very low volume surface output to the drainage ditch along the 2610-150 rd. very shortly below. This site is notable for the relatively large number of FIT (8) detected within such a very small area. It is also notable in the presence of the uncommon fen-loving sedge *Carex interior*.
Photos: #s 3518, 3519, 3520.

2. 2610-150 rd. (w)
Elevation: 4560 feet
TRS: T1S, R19E, S22
Date: 7/27/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, JUBA, **JUEN**, CAPA14, AGROS2, DECE, POPR, **ELQU2**, CANE2
Forbs – DELPH, POGR9, EPILO, ARCH3, MIGU, **PLDI3**, TRLO, EQUIS, LEMNA
Bryophytes – MAPO16, **DRAD2**, **PLEL2**
Soil probes: One probe found resistant/dense soil to 51+"; probe residue gritty.
Notes: This "Y"-shaped PEMB poly includes two broad, gently-sloped valley bottoms at and just above the point of confluence of their associated seasonal water courses. JUBA and CANE2 are frequent dominants in the plant communities. Levels of soil moisture encountered within this poly ranged from damp to soppy-wet. Source of this water not clearly evident, but there was little evidence of groundwater discharge along valley edges.
Photos: None.

3. 2610-150 rd. (ne)
Elevation: 4580-4600 feet
TRS: T13S, R19E, S22
Date: 7/27/2017
Rationale: NWI PEMB
Plants: Graminoids – POPR, PHLEU, JUBA, AGROS2, JUOR, CAPA14, **JUEN**, **ELQU2**
Forbs – DELPH, POGR9, EPILO, ACMI2, LEMNA, PAPS5, **SAOR2**, **PLDI3**, POOC2, ALLIU,
Bryophytes – BRPS70, **DRAD2**
Soil probe: One probe at west edge of meadow in squishy/soppy-wet groundwater discharge area found resistant/dense soil to 51+". Soil residue on probe very dark and sparsely gritty.
Notes: This site is mapped by OCH NF GIS as a headwaters to an intermittent creek. Multiple shallow, damp channels course along the long axis of the meadow, but wet soils were primarily restricted to a squishy/soppy-wet area on the meadow's western edge. The water source here is clearly first-order groundwater discharge at a slope break at the meadow/forest interface. The only active, low-volume

channel noted within this meadow originates at this squishy/soppy-soiled area. Three of the five FIT detected at this site were found only in this western-edge actively groundwater-fed area. Manure of cattle and hoof gouges and pits are abundant within this meadow, but curiously, impacts of visiting cattle seems to be relatively light within the wet-soiled community at the meadow's western edge.
Photos: #s 3522, 3523, 3524.

4. 2610-104 rd. (Claypool Spring)
Elevation: 4560 feet
TRS: T13S, R19E, S27
Date: 7/31/2017
Rationale: NWI PEMB
Plants: Graminoids – **JUEN**, JUBA, PHLEU, CAUT, SCMI2, CASU6, CAPE42, AGROS2, POA
Forbs – TRLO, ASOC, CIRSI, POGR9, ACMI2, EPILO, DELPH, MIGU
Bryophytes – **DRAD2**
Soil probe: Probe in soppy-wet lower corner of exclosure found resistant/dense soil to 51+". Soil residue on probe was dark and somewhat gritty.
Notes: Mapped PEMB poly is in the upper part of a drainage-meadow for an intermittent creek. The mapped poly is slightly misplaced and included only dry soil surfaces at the time of visit. Two areas of groundwater-fed soppy-wet soils were noted during this visit. The lower is on the eastern edge of the drainage on a relatively steep slope. The entire wet and damp-soiled portions of this were densely and heavily pitted by hooves of cattle. The closely proximate pedestals in this pit & pedestal microtopography were 8-12" tall. This site is clearly wetted predominantly by groundwater discharging as it moves, subsurface, down the wooded, adjacent, western slope. The second groundwater-fed area is approximately 75m up the drainage, occupying much of the western 2/3s of the meadow's width. This area is bounded by a pole fence and is likely the area meant to be designated by the mapped PEMB poly. The exclosed area includes both soppy and dry-soiled portions. The wetter portions of the exclosed area are dominated by taller graminoids including SCMI2, JUBA, CAUT and CAPE42. The vegetation within the exclosed area is more characteristic of that of a wet valley bottom than of a sloping fen. The exclosure's pole fence is broken down in a spot or two, and cattle have been inside this season, but in low numbers. The exclosure was apparently intended to protect the "spring" within. This is not the expected habitat of rare or uncommon plants, nor were any seen. The 104 spur road immediately upslope to the east of this meadow has nicked a groundwater aquifer feeding portions of the meadow below. This water bleeding from this nick travels down the roadbed for about 50m before disappearing due to infiltration and evaporation.
Photos: #s 3525, 3526, 3527, 3528, 3529.

5. 2610-150 rd. (Deadman Creek)
Elevation: 4480-4520 feet
TRS: T13S, R19E, S15
Date: 7/31/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, PHLEU, AGROS2, **ELQU2**, **JUEN**, SCMI2, **CAJO**, CAUT
Forbs – TRLO, ALLIU, ACMI2, **PLDI3**, DELPH, PAPS5, LEMNA, MIGU, EQUIS, POOC2, **SAOR2**, GEMA4, CASTI2, ASOC, POGR9, EPILO
Shrubs - SALIX
Bryophytes – **PLEL2**, **DRAD2**, BRPS70, PHFO6

Soil probes: Two probes on damp soil on a large, dark green (NAIP) convex slope in the upper half of the meadow found high density (mid-slope) or low density soil to 51+". Soil residue on probes either very sparse or lacking. A single probe on soppy soil in the dark green (NAIP) lower portion of the meadow found low density soil to 51+". Probe residue with sparse grit.
Notes: The two principal areas of evident groundwater discharge within this broad, moderately sloping valley bottom are a broad, dark green (NAIP) area of topographic convexity in the upper half of the meadow, and a broad, dark green area in the meadow's lower half. Except for along very low volume minor channels draining the lower portion of the convex slope, this meadow feature was mostly never more than damp, or borderline squishy-wet at the time of visit. The minor but active channels on the lower part of this slope merged to provide an active input channel to the main meadow drainage channel developing along the far northern edge of the meadow. It was not evident the extent to which the convex slope was being fed by groundwater moving down the valley corridor vs. from the adjacent wooded slope to its south. The lower, dark green portion of the meadow was also largely damp at the time of visit, but was soppy-wet in its upslope extension along its southern border. This soppy-soiled area was clearly receiving groundwater discharge from an aquifer underlying the sparsely wooded slope to its south. The level of soil moisture at the time of visit as well as the modest number of detected FIT, suggest that this meadow may lack any areas of persistently groundwater-wetted soil.
Photos: #s 3530, 3531, 3532.

6. 2620 rd. (roadside)
Elevation: 4600 feet
TRS: T13S, R19E, S14
Date: 7/31/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, PHLEU, DECE, **JUEN**, **JUNE**, **ELQU2**, AGROS2, CAUT, SCMI2, CAPA14, CAAU3
Forbs – MIGU, ASOC, TRLO, EPILO, **DODEC**, **PLDI3**, POGR9, RAUN, SIOR, PAPS5, EQUIS, RUMEX, POOC2, SISYR, SEHY, PRVU
Shrubs - SALIX
Bryophytes – PHFO6, BRPS70, **DRAD2**, **PLEL2**
Soil probes: A single probe each in soppy-wet soil above and below the 2620 road found very resistant/dense (above) and moderately resistant (below) soil to 51+". Soil residue on probes was dark, with fine grit or grit lacking.
Notes: This is an area of groundwater discharge that has been dissected by the 2620 road. Soppiness above the road is associated with groundwater discharge along a broad slope break. Much soppy-wet was present in the southern half of the E-W oriented lower meadow. The persistence of groundwater discharge at this dissected wetland/meadow would be interesting to assess with a late summer visit. Was the 2620 road constructed through this wetland during a period of less wet soils in late summer when the ample groundwater discharge was somehow overlooked?
Photos: #s 3533-3535, 3536.

7. 2620-025 rd.
Elevation: 4880-4920 feet
TRS: T13S, R19E, S13
Date: 8/1/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, AGROS2, JUOR, JUBA, **JUEN**, **CAJO**, CANE2, **CAIN11**, CAPE42,

ELQU2, SCMI2, CAUT
Forbs – ASOC, PRVU, **HYAN2**, TRLO, MIGU, **SAOR2**, PAPS5, **PLDI3**, LEMNA, ALLIU, GEMA4, EPILO, POOC2, EQUIS, EQAR, SIOR, VERAT
Bryophytes – BRPS70, PHFO6, **DRAD2**, **PLEL2**

Soil probes: A probe at the soppy-wet flat at the west, lower end of this meadow, and another on top of the highest slope break at the far eastern end of the meadow, found soils of very high density (lower end) or low density (upper end) with bases below the reach of the probe (51+"). Soil residue on extracted probes with (lower) or without (upper) grit. Probes between the two ends of the meadow found gritty soils lying over rock at depths of 20-48".

Notes: From its upper eastern end to its lower western end, the roller coaster-like major topography of this meadow is bench-slope break-gentle slope (with fenced aspen grove)-slope break-gentle slope (with concave slope off its northern edge)-slope break-steep slope-flat. The flat at the lower western end includes much soppy-wet soil and sparse CAIN11. A concave N/NW-aspect slope off the northern edge of the gentle slope at mid-meadow was contributing discharge to a small, low-volume channel running down the northern edge lower half of the meadow. A larger count of CAIN11 plants was present on this concave slope. The upper portion of the gentle slope has areas of squishy/soppy-wet soils supporting sedge communities dominated by intermixed SCMI2 and CAUT. Other areas of soppy-wet soils were encountered at the slope break below the aspen grove and on the bench at the very top of the meadow. As in other moderate-sized groundwater-fed meadows with moderate numbers of detected FIT, an assessment of the persistence of groundwater-fed wetness at this meadow will require re-visits toward the end of summer. A water trough with piped in groundwater is located at the northern edge of the meadow's lower western end. The trough was empty at the time of visit and was not receiving piped water input. The trough does not have any sort of full-mark shut-off valve. Cattle had apparently not visited this meadow in 2017 prior to the time of this visit.

Photos: #s 3537, 3538, 3539, 3540, 3541, 3542, 3544, 3545, 3546-3647.

8. 2630-302 rd.
Elevation: 4840 feet
TRS: T13S, R20E, S5
Date: 8/1/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, DECE, PHLEU, AGROS2, CANE2, CAAT3**, CASI2**, **CACU5**, **JUEN**, SCMI2, CAUT
Forbs – SIOR, POGR9, RAUN, ACMI2, TRLO, ASOC, EPILO, **PLDI3**, **SAOR2**, MIGU, POOC2, LEMNA, SPCA5
Shrubs – SALIX
Bryophytes – PHFO6, **DRAD2**

Soil probes: Probe on squish/soppy-wet soil on short, +/- bench immediately above very abrupt slope break found sparsely gritty soil to 51+". Probe on quaking peat mat at western edge of slope break found low density soil to 36", then higher density soil to 51+".

Notes: This mapped PEMB poly centers about a sharp slope break on a long (350m) seasonally wet meadow sloping along a gentle and constant slope. The slope surface shortly above this slope break is dry-soiled, and transitions quickly to damp and then squishy/soppy-wet on the short bench at the upper edge of the slope break. Two primary channels with low volume flow originate immediately below the slope break. These eventually converge into a single, densely vegetated corridor continuing downslope. The graminoids CASI2, JUBA and DECE are co-dominants in and transitioning into the bench. Within the bench, abundance of PLDI3 transitioning into an abundance of SAOR2 corresponds to a transition

from damp soil to squishy/soppy-wet soil. The groundwater discharge at the slope break represents a common experience with groundwater aquifers, that is, moving, shallowly subsurface down a slope, but giving no evidence of its presence, until some factor(s) allows the aquifer to meet the soil surface. And this site is another example of the common situation of a mid-summer visit, especially in combination with a relatively low count of FIT, providing little ability to confidently predict persistence of groundwater discharge through the full summer.
Photos: #s 3548, 3551, 3552, 3553-3555.

9. 2630-350 rd. (Cole Spring)
Elevation: 5200-5240 feet
TRS: T13S, R20E, S4
Date: 8/1/2017
Rationale: NWI PEMB
Plants: Graminoids – CAUT, SCMI2, **JUEN**, JUBA, CAPE42, AGROS2, **CACU5**, **CAJO**, JUOR, **ELQU2**, **CASI2**, DECE, CANE2, CAAT3
Forbs – EPILO, LEMNA, MIGU, RUMEX, TRLO, GEMA4, VERAT, POGR9, CIRSI, ACMI2, **HYAN2**, EQAR, LEVU, ASFO, MIGU, RAUN
Bryophytes - BRPS70, PHFO6, **PLEL2**, **DRAD2**
Soil probes: Probe in soppy-wet CAUT community in upper SE corner of meadow moderately resistant/dense to low resistance/density soil to 51+"; probe residue with very minor fine grit. Probe in lower part of squishy/soppy-wet swath down middle of upper half of meadow found moderately resistant/dense soil with gritty layers to 51+". Probe in center of isolated soppy-wet patch on eastern side of upper meadow found moderately resistant soil without notable strata or grit to a firm base at 47".
Notes: At the time of visit, the two notably wet-soiled areas within this meadow system were in the far SE lobe and in the upper, NE end of the main meadow. The soppy wet, upper SE lobe of the meadow has a low-volume drainage into the lower portion of the main meadow. Wetness in this lobe appears to be primarily due to surface input from a spring-fed channel arising well up the forested slope to the east. Damp to squishy/soppy wet soils in the upper half of the main meadow are initially restricted to banks of the one or more likely intermittently flowing, low-volume channels draining the upper meadow. Further north in the main meadow, damp and wet soils become more diffuse, apparently associated with a diffusely distributed discharge of groundwater. This damp/wet-soiled groundwater-fed swath is then pretty much continuous to the far upper end of the main meadow. An isolated soppy-wet patch of soil and associated fen-loving vegetation occurs on the eastern side of the upper main meadow. It is most likely that all wetness observed in the upper main meadow is associated with discharge from a groundwater aquifer shallowly underlying the upslope woods on all three sides of the upper main meadow. Assessment of persistence of groundwater-fed wetness in the upper main meadow would require a return visit later in the summer.
Photos: #s 3556, 3557, 3558, 3559.

10. 2600-400 rd. (Bandit Spring Rest Area)
Elevation: 4540 feet
TRS: T12S, R19E, S36
Date: 8/3/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, CAAT3, PHLEU, DECE, **CAIN11**, **CACU5**,
Forbs – **PLDI3**, **SAOR2**, SPCA5, CASTI2, EQUIS, SIOR, POOC2, POGR9, PAPS5, RUMEX, MADIA,

Shrubs - SALIX
Bryophytes – BRPS70, PHFO6, **DRAD2**, **PLEL2**

Soil probe: Probe in squishy-wet soil in eastern 1/3 of meadow found moderately resistant/dense, multi-layered soil to 51+"; probe residue dark, without notable grit.

Notes: This N-S oriented meadow gently slopes along a broad, seasonal drainage route. The meadow approaches 200m in length, but only the central 50m of it included wet soils at the time of visit. Wetness was concentrated within and near the edges of two, parallel, low volume primary channels and multiple smaller wet channels/trenches. Walking about in the wet portions of this meadow is made difficult by the combination of wandering, 4-6" deep trenches and the generally dense graminoid cover, particularly JUBA, that conceals them from view. These trenches appear clearly not a result of erosional processes, seemingly forming borders around/defining soil polygons measureable in feet or meters. This microtopography is perhaps a product of freeze-thaw cycles in wet, organically-rich soils? The wetness in this meadow at the time of visit seems clearly to be associated with diffuse groundwater discharge in the central portion of this meadow. Assessment of the persistence of this discharge would require visits toward the end of one or more summers. A very modest number of FIT were detected at this site, but notably, CAIN11 is included among them.

Photos: #s 3565, 3566, 3567-3568, 3569, 3570.

11. 2700-421 rd. (Moccasin Spring and Prairie)

Elevation: 5550 feet

TRS: T12S, R18E, S24

Date: 8/3/2017

Rationale: NWI PEMB

Plants: Graminoids – AGROS2, DECE, **JUEN, CASI2**, PHLEU, **JUNE**, **CAJO**, JUBA, **CALU7**, **CAAQ**, **ELQU2**, JUOR
Forbs – TRLO, **PLDI3**, ASFO, SEHY, **HYAN2**, ALLIU, POBI6, GEMA4, ACMI2, **SPRO**, EPILO, **SAOR2**, POOC2, RAUN, ARCH3
Shrubs - SALIX
Bryophytes – AUPA70, PHFO6, MAPO16, BRPS70

Soil probes: Six probes across this system at sites ranging from damp to soppy-wet at the time of visit found soil depths of 26-49". Five of the probes reached bases at $\leq$ 35". Grit was detected on none of the probe residues.

Notes: This is a large, shallowly crescent-shaped meadow, arcing gently downslope from NW to SE in its upper NW end, continuing N-S in its central portion, and then arcing rather sharply to the SW, forming a SW lobe, at its southern end. Among OCH NF meadows with significant groundwater input, this meadow supports a better-than-typical count (11) of detected FIT. Notably however, FIT are largely restricted to only three small areas within the larger meadow system: 1) the central, NW end of the system, 2) a short (60-70m) section of forest/meadow interface along the western edge of the meadow, and 3) two small sites in the lower-central and the upper, northern corner of the SW lobe at the meadow's southern end. Each of these areas includes sites of soppy-wet, first order groundwater discharge. Although the central NW end of the meadow had a small soppy-wet patch at the time of visit, multiple FIT were noted here on dry, hard soils. Given presence of these FIT, and the topographic setting in the upper portion of drainage within the meadow, it is likely that these dry, hard soils were wet earlier in the season due to diffuse, first-order groundwater discharge. A wet swath extends from Moccasin Spring and associated diffuse groundwater discharge at the northern end of the 60-70m section referenced above, down into the lower portion of the central meadow, which at the time of visit featured a rather sharply delimited large green patch. Soil within this large patch was mostly dry and cracking. The FIT CASI2

was perhaps the dominant species within this patch, with ELQU2 and CAAQ also well-represented. This patch likely receives seasonal surface water from snowmelt as well as input from the wet channel originating at Moccasin Spring. It is quite unexpected that the 11 FIT detected at this meadow system include zero bryophyte species.
Photos: #s 3571, 3572, 3574.

Upper John Day

1. 12-975 rd.
Elevation: 4760-4920 feet
TRS: T13S, R23E, S1
Date: 6/15/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, CAHO5, CAMI7, SCMI2, CANE2, **ELQU2**
Forbs – RAUN, TAOF, VIAM, COLLI, GALIU, ANTEN, TRIFO, IRIS, GEMA4, EQAR, POOC2, **PLDI3**, MIGU, TRAGO
Bryophytes – BRWE70, CAPO17, RICA15, RIBE, BRFR70, BRPS70, PHFO6, MAPO16, **DRAD2**
Soil probes: Three probes along the southern side of the upper, western portion of this site found a dark soil with a fine-grained inorganic component extending to a depth of 48-51+". Soil was very resistant to passage of probe, perhaps primarily due to vacuum created with each upward movement of the probe. Single prove on northern side of upper portion of site reached a resistant sandy layer at 24" that continued to a firm base at 38".
Notes: This site appears to be a seasonally wet meadow occupying a gentle, eastern aspect drainage that includes two mapped NWI PEMB polygons. The upper, west-most of these two mapped polygon areas exhibits the strongest seasonal fen character and was mostly very squishy-wet at the time of visit. Topographic position suggest that the southern side of the upper meadow has strong seasonal groundwater feed from the north-aspect slope meeting the southern edge of the meadow. This understanding is supported by the deep, organic-rich soil along this edge, and the high percentage of moss cover along the southern side of the upper meadow. In the upper, lower-gradient portion of the meadow, JUBA, RAUN and TAOF appeared to be plant community dominants. Small active channels of collected groundwater seepage were present at the far eastern edge of the polygon. These converge and drain into the area of the east-most polygon. Less squishy-wet soil, which was independent of active channels, was present in the area of east-most polygon. Even though very wet at the time of the visit, the very low count of fen indicator taxa, and the presence of multiple non-wetland species, strongly suggests that this meadow system is only seasonally wet.
Photos: # 3328.

2. 1280 rd.
Elevation: 5100-5140 feet
TRS: T13S, R23E, S3
Date: 6/15/2017
Rationale: NWI PEMB
Plants: Graminoids – JUBA, **ELQU2**, SCMI2, CAPE42, CAPA14, ALPR3
Forbs – RAUN, SEHY, EPILO, COLLI, TAOF, MOCH, TRLO, POOC2, GEMA4, **PLDI3**

Shrubs – RIBES
Bryophytes – PHFO6, **DRAD2**, **PLEL2**, RIBE, RICA15, BRPS70, BRWE70
Soil probes: Four probes conducted, two within and two outside of groundwater seepage corridors. Soil depths of 24-36" with three of the probes reaching underlying rock. Soil with high organic content and mildly gritty with inorganic content. Three of the probes in resistant soil that forms vacuum when pulling probe upward.
Notes: Site is a meadow occupying a mildly sloping, bench-like portion of an otherwise steeper, north-aspect forested slope. Groundwater-fed wetness at the time of visit was principally along a longer diagonal corridor running SE to NW across the slope, and a shorter, N to S corridor down the western end of the slope. These two corridors converge at the lower NW corner of the meadow. The paucity of fen indicator taxa and restriction of notable groundwater-fed wetness to linear corridors, suggest that this site is a seasonally wet meadow with only weakly developed fen character.
Photos: #s3329, 331-3333, 3334.

3. 12-200 rd.
Elevation: 5720 feet
TRS: T14S, R24E, S4
Date: 6/27/2017
Rationale: NWI PEMB
Plants: Graminoids – CAUT, **JUEN**, CAPE42, POA, HOBR2, **ELQU2**
Forbs – SEHY, POBI6, TRIFO, MOCH, TRLO, MIGU, RAUN, RUMEX, EPILO, VERON, SIDAL
Bryophytes – BRWE70, BRPS70, PHFO6, **DRAD2**
Soil probes: Two probes in soppy-wet soil in upper, NW corner of site encountered smooth, easy passage to 24-34", then a resistant, gritty layer to a firm base at 31-45".
Notes: This is a smallish, elliptically-shaped, groundwater-fed wetland/meadow very gently sloping downward from NW to SE. Diffuse groundwater discharge appears to be occurring principally at the far, upper NW corner of the site. The influence of this discharge wains rapidly with distance from the NW corner, with soils being no more than damp less than halfway along the NW-SE axis of the meadow. The very low count of detected FIT supports a supposition that groundwater-wetting here is seasonal only.
Photos: #s 3401, 3402.

4. 12-190 rd.
Elevation: 5700-5720 feet
TRS: T14S, R24E, S9
Date: 6/28/2017
Rationale: NWI PEMB
Plants: Graminoids – **JUNE**, CAUT, LUCA2, **CALU7**, **CACU5**, SCMI2, **ELQU2**, ALOPE, **JUEN**, JUBA, **CASI2**, **CAJO**, CALEL3, JUOR
Forbs – **PLDI3**, **SAOR2**, RAUN, SEHY, TAOF, TRLO, EQAR, VERAT, EPILO, ACMI2, POOC2, GEMA4, ORUN, **HYAN2**, MIGU, TRIFO, POBI6
Bryophytes – BRPS70, BRWE70, **PLEL2**, MAPO16, POWA70, PHFO6, **DRAD2**
Soil probes: Four probes along the moderately steep, soppy-wet, richly groundwater-fed slope at the south end of the wetland/meadow found a moderately resistant layer 19-36" thick, overlying a generally much more resistant/dense layer extending to the soil base at 38-46". Grit in the residue on the extracted probe was either fine and sparse or lacking. Two probes in different plant communities in the lower,

larger northern portion of this wetland/meadow system found moderately resistant, finely gritty soil over a firm base at 30-36".
Notes: This SW-NE oriented wetland/meadow is comprised of two very distinct portions. The smaller southern portion features a moderately steep, short, north-aspect slope with very soppy soil and active, robust groundwater discharge. Quaking soil in the eastern portion of this slope allows passage only by walking along fallen boles and limbs. The persistence of groundwater discharge along this slope can be known only by visits later in the summer, but the presence of the uncommon OCH NF FIT sedges *Carex luzulina* and *C. cusickii* suggests that groundwater may be more than briefly available here. The other 75% of the wetland/meadow is relatively low-gradient slope where the hydrology responsible for soil moisture levels appears to be somewhat complex, but clearly includes very local, apparently mostly seasonal, groundwater discharge. Soil moisture levels at the time of visit transitioned generally from dry to increasing moist with a corresponding transition in indicator species of VERAT-SEHY-PLDI3 & SAOR2 with northward progression. This site is particularly notable for its relatively large count of 12 detected FIT.
Photos: #s 3403, 3405, 3406, 3407, 3408.

5. 1250-020 rd.
Elevation: 5680-5720 feet
TRS: T14S, R24E, S9
Date: 6/28/2017
Rationale: NWI PEMB
Plants: Graminoids – CANE2, CAMI7, JUBA, **ELQU2**, **JUNE**, POA, DECE, CAUT, **CASI2**, CAPE42
Forbs – SEHY, **SAOR2**, POBI6, DELPH, TRLO, EPILO, MOCH, WYHE2, RAUN, POGR9, GEMA4, TAOF, **PLDI3**, POOC, CAQU2
Bryophytes – PHFO6, BRPS70, BRWE70, AUPA70, **DRAD2**, RIBE, RICA15
Soil probes: Six probes were conducted along the length of the meadow, in soils ranging from damp to squishy-wet. At one upper meadow location, the damp soil was too resistant/dense to allow passage of the probe. A five other probe sites, soil thicknesses ranged from 12-30". Grit content of residue on the probe varied from slight to lacking.
Notes: This site is a half mile-long meadow associated with the headwaters of a seasonal tributary to Bear Creek. The meadow is drained along a gentle SW-NE gradient by a complex of variously sized channels that were mostly dry at the time of visit. Dry soils were commonplace and moss cover was scant. Only two locations of squishy-wet soils were detected, a small area on the eastern side of the meadow immediately south of where it is strongly constricted by PICO woods to the east, and a larger, less easily definable area near the meadow's far northern end. Most of the detected FIT were located in or adjacent to these two areas. There is little evidence of groundwater from adjacent forested slopes discharging into this meadow, especially along the meadow edges. It appears most likely, that the primary water sources for this meadow are meltwater from each season's directly overlying snowpack, and any shallow aquifers within the meadow itself, which derive their water from overlying snowmelt. In-cutting of some of the larger channels suggests the occurrence of seasonal high volume flow, which is not a behavior of primarily groundwater-fed channels. The low count of detected FIT appears to be a feature of meadows only seasonally wetted by snowmelt and groundwater discharge.
Photos: # 3411.

6. 1250-030 rd.
Elevation: 5530-5560 feet

TRS: T14S, R24E, S9
Date: 6/29/2017; 9/13/2017
Rationale: NWI PEMB
Plants: Graminoids – **JUNE**, CANE, JUBA, POA, **ELQU2**, MUFI2, CAMI7, CAUT, SCMI2, **CAJO**, **CACU5**
Forbs – VERAT, RAUN, DELPH, TRLO, SEHY, MOCH, POBI6, ACMI2, PERY, EPGL4, CAQU2, EPILO, **SAOR2**, GEMA4, POOC2, **PLDI3**, MIGU
Shrubs – SALIX, VACCI
Bryophytes – BRWE70, BRPS70, PHFO6, AUPA70, **DRAD2**, **PLEL2**
Soil probes: Three probes on soppy/shallowly inundated surfaces in central portion of main, very low gradient meadow found low to moderate resistance though very finely gritty soil to 54+". Probes in wet soil along the eastern and western edges of the meadow encountered moderate resistance to rock at 44-46".
Notes: The hydrology of this quarter-mile long, mostly gently sloping meadow/wetland is both surprising and puzzling. At the time of the 6/29 visit, much of the broad, nearly flat upper portion of this system was either soppy-wet or shallowly inundated. The far southern end of the system was dry-soiled, and given no perceptible change in slope gradient was evident in looking north out into the visible remainder of the meadow, there was little reason to expect other than a continuation of dry soil. It was quite surprising to venture further north into the meadow and soon enough transition into damp and then soppy/inundated soils. The source of all this water soon became a source of puzzlement as the eastern and western sides of the meadows were then examined and no evidence of groundwater discharge from the adjacent lightly forested slopes could be found. There is a six foot high slope break at about mid-meadow, and below this to the north, the average gradient of the slope increases, becoming notably steeper at another slope break at the meadow's narrowing, far northern end. A very active output channel at the meadow's far northern end gathers water from channels collecting groundwater discharge along both the eastern and western edges of the lower half of the meadow. A soppy/shallowly inundated northeastern lobe of the meadow was discharging groundwater along a moderate, west-aspect slope and this drainage was finding its way to the meadow's main drainage channel at the meadow's far northern end. Soil probes in the soppy/inundated central portion of the meadow above the slope break found very low resistance as they were push down to the full extent of the rod's length. On the return visit on 9/13, and very surprisingly, the central portion of the meadow above the slope break was dry-soiled and now so resistant/dense that the soil probe could be pushed no more than 4" below the soil surface. Flow persisted in the lateral channels below the slope break, but at much reduced volume; soil in the NE lobe was wet to the touch, but not even squishy under foot; the meadow's main exit channel was still active, at reduced flow, and the slope break above this channel was still soppy wet. At the time of the second visit, it was apparent the lower half of the meadow, particularly the still-soppy wet central part shortly above and below the lower slope break, was still receiving groundwater discharge, presumably from the now dry-surfaced upper half of the meadow. The soppy-wet area described above is the only portion of the 1250-030 wetland/meadow system in which CACU5 was detected. But the puzzlement concerning the source of the meadow's soil water remained as great as ever. As with the 6/29 visit, cattle manure was everywhere within the meadow at the 9/13 visit. A pattern of patchy grazing was evident, with areas of heavily grazed meadow adjacent to lightly grazed areas. Recent OHV tracks were present, running the length of the eastern half of the meadow.
Photos: #s 3412, 3413, 3414, 3415, 3692.

7. Podo Meadow area, south of 38 rd.
Elevation: 5540 feet

TRS: T14S, R24E, S14/23
Date: 6/30/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, CAUT, **CASI2**, JUBA, POA, CANE2, **JUEN**, MUFI2, **CAJO**
Forbs – S**AOR2**, **PLDI3**, GEMA4, TRLO, RAUN, FRVI, POBI6, ACMI2, TAOF, POOC2, SEHY, CIRSI, RUMEX, MIGU, DELPH, BAVU, EPWA3, **HYAN2**, VERAT, MOCH, PERY
Bryophytes – BRPS70, PHFO6, AUPA70, BRWE70, **PLEL2**, **DRAD2**, MAPO16
Soil probes: Three probes in two to the more biodiverse areas on soppy soils on both the eastern and western sides of this meadow found moderately resistant soil to 51+". Probe residue from each probe had sparse, fine-grained grit.
Notes: This meadow occupies a relative steep, north-aspect slope. Active, but low-volume drainage was occurring centrally at its base at the time of visit. Soil moisture conditions within the meadow ranged from dry to very soppy-wet. Two relatively biodiverse soppy-soiled areas were located near the western and eastern edges about mid-way along the meadow's length. The soppy-wet area on the meadow's western edge extended about 30m N-S, and featured mostly short-statured, moss-dominated vegetation. Only the usual OCH NF seasonal groundwater-fed wetland moss species were detected here. A third soppy-wet area in the lower NE corner of the meadow featured a tall, dense sedge and forb mix that included relatively few plant species.
Photos: #s 3417, 3418, 3419.

8. Podo Meadow main, spring-mound vicinity
Elevation: 5490 feet
TRS: T14S, R24E, S14
Date: 6/30/2017
Rationale: NWI PEMB
Plants: Graminoids – LUCA2, JUBA, **ELQU2**, **CASI2**
Forbs – POOC2, **PLDI3**, GEMA4, **HYAN2**, **SAOR2**
Shrubs – SALIX
Bryophytes – **HEBL2**, **TONI70**, AUPA70, PHFO6, BRPS70, **DRAD2**
Soil probe: Extremely resistant/dense to 51+"; no grit and essentially no residue on probe.
Notes: This visit was not meant to be a full walk-through of potential habitat at this site, but rather, a revisit to check on status of the populations of two rare (OCH NF) fen mosses previously documented at this site. The project lead had make two previous informal visits to this site, but neither of those were full walk-throughs either. Only a full walk-through would determine this, but this and the previous visits suggest a likelihood that the only persistent, soppy-wet habitat within this large mapped PEMB polygon is a small area immediately downslope from a large spring-mound/terrace at the far western edge of the meadow's main body and, according to notes from the 2009 visit, adjacent and immediately north of the spring-mound. There are two discharge wells atop the bench, each of which was feeding low-volume discharge through separate channels over the edge of the bench and down its steep east-aspect slope. Other than along the shallow banks of these discharge channels, the east-aspect slope was dry at the time of visit. In contrast, the area at the base of this slope has a very soppy-wet community of the mosses PHFO6, BRPS70, DRAD2 and HEBL2 thickly intermixed in the thatch lying under a canopy of sedges and forbs. It was not evident the extent to which the soppiness of this community was due to surface flow from the channels fed by the discharge wells vs. by subsurface groundwater-feed. Moving east from this community, soil rather quickly transitions to less wet and then dry. In this transition zone, where seemingly dry, thick thatch overlies wet soil, HEBL2 continues to be well-represented. Full W-E extent

of detected HEBL2 was 25m. About midway along this W-E extent of HEBL2, a single four square meter occurrence of TONI70 was detected. This was the only TONI70 detected during this brief visit. NRM EO polygons based on 2009 and 2010 visits indicate that both TONI70 and HEBL2 were detected on wet peat along the northern edge of the spring-mound. This area was not visited during the 2017 visit.
Photos: #s 3423-3424, 3425-3428, 3429, 3430, 3432.

9. 38-130 rd.
Elevation: 5840-5900 feet
TRS: T14S, R25E, S17
Date: 9/13/2017
Rationale: NWI PEMB
Plants: Graminoids – SCMI2, CAUT, DECE, **JUEN**, **CAJO**, **SAOR2**, ACMI2, **HYAN2**, PHLEU, **CALU7**, JUBA, CALEL3, CANE2
Forbs – EPILO, GEMA4, ASFO, **PLDI3**, POOC, TRLO,
Bryophytes – BRPS70, PHFO6
Soil probes: Three probes within the localized area with apparent strongest groundwater influence found gritty, dense/resistant soils to firm bases at 21-34".
Notes: Notable groundwater influence was largely restricted to an approximately 60m-long, downslope swath from the central to the lower portion of the area included in this N-S oriented PEMB polygon. Presence of groundwater-fed soil wetness at the relatively late date of this visit indicates that groundwater discharge at this site may well be persistent through the full growing season. Perhaps the very low count of detected FIT relates strongly to the very limited area of that groundwater influence. A second mapped PEMB poly is located approximately 250m downslope from the primary site described above. This lower site, also fairly closely proximate to the 38 road, features a small, very wet groundwater-discharge bench and a bit of short-lived surface drainage from the base of this bench. As with the primary site described above, the flora is simple in composition, with heavy on the cover of sedges and light on that of bryophytes. FIT detected at this lower included JUEN, CACU5, SAOR2, PLDI3, HYAN2 and PLEL2.
Photos: #s 3693, 3694, 3695, 3696, 3697, 3698.

10. 5800-560 rd. (Columbus Creek)
Elevation: 5000 feet
TRS: T16S, R26E, S19
Date: 9/26/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, JUBA, CAREX
Forbs – ACMI2, SEHY, POGR9, EQUIS, POOC2, EQUIS
Shrubs - SALIX
Bryophytes – BRPS70, PHFO6, MAPO16, BRAL70, **DRAD2**, **PLEL2**
Photos: #s 3779, 3780, 3781, 3782, 3783.

<u>Lower John Day</u>

1. 2630-353 rd. (Butterfield Spring)
Elevation: 5500-5560 feet
TRS: T13S, R20E, S9/10
Date: 8/2/2017

Rationale: NWI PEMB
Plants: Graminoids – **ELQU2**, **JUEN**, JUBA, AGROS2, CAPE42, SCMI2, CANE2, CAUT, **CAJO**
Forbs – MIGU, TRLO, GEMA4, RUMEX, ASFO, CIRSI, **PLDI3**, RAUN, VERAT, EQAR, SEHY
Shrubs - ALNUS
Bryophytes – BRPS70, PHFO6, MAPO16, RICA15
Soil probe: On squishy/soppy-wet soil along western edge of alder grove in upper SE corner of meadow, found very resistant/dense, gritty soil to firm sandy base at 48"; low organic content evident in residue on probe.
Notes: At time of visit, wet soils were found along a channel originating at spring at meadow/woods interface at upper SW end of meadow. Channel was wet continuing down center of meadow to alder clump in mid-meadow, and a short way beyond. Much of the wetness along this channel may be traced to discharge at the spring. Seasonally active channels were found all way down meadow to passage under 2630-350 road. Lower reach of this channel system with points of standing water. A second wet-soiled area was a wet swath running along the western edge of an alder grove tucked into the upper SE corner of the meadow. This swath continued downslope only shortly beyond the alder grove. Wetness in the upper portion of this swath is fairly clearly due to diffuse groundwater discharge along the swath. Assessment of persistence of discharge at the spring, and especially, adjacent and above the alder grove, would require a return visit later in the summer.
Photos: #s 3560, 3561.

2. 2630-350 rd., sections 3/10
Elevation: 5360 feet
TRS: T13S, R20E, S3/10
Date: 8/2/2017
Rationale: NWI PEMB
Plants: Graminoids – PHLEU, HOBR2, CAUT, JUBA, SCMI2, **JUEN**
Forbs – ASFO, SEHY, SIOR, GEMA4, CIRSI, POBI6, ALLIU, EQAR, RUMEX, MIGU, ORTHO, TRLO, POOC2, EPILO
Bryophytes – BRPS70
Soil probes: Probe attempt in damp patch of JUBA on upper SW meadow slope (outside of mapped PEMB poly) found soil too resistant for useful probe. Probe in apparently seasonally wet CAUT stand in SE corner of meadow found resistant/dense soil to firm base at 45"; no grit in residue on probe.
Notes: This appears to be a seasonally wet meadow, with zero evidence of a significant contribution from groundwater discharge. Primary pockets of apparent seasonal wetness, which were damp-soiled at the time of visit, include a JUBA patch in the upper SW corner of the meadow, a tall CAUT stand in the meadow's SE corner, and the lower NE end of the meadow, all appear to be primarily wetted by some combination of meltwater from overlying snowpack and seasonal surface drainage from adjacent wooded slopes.
Photo: # 3562.

3. 2630-360 rd. (Lost Lake Spring)
Elevation: 5500 feet
TRS: T13S, R20E, S10/11
Date: 8/2/2017
Rationale: NWI PEMB
Plants: Graminoids – SCMI2, **JUEN**, **ELQU2**, **CAJO**

Forbs – ASFO, ALLIU, GEMA4, EPILO, SEHY, MIGU, **HYAN2**, POOC2, ACMI2, **PLDI3**, RUMEX
Bryophytes – **DRAD2**

Soil probe: Probe on soppy-wet soil at western end of meadow/wetland found moderately resistant/dense layer to 18", then highly resistant/dense to firm base at 30"; residue on probe gritty.
Notes: An interesting site. Western end of meadow/wetland with E-W oriented wet channel, 2-4 feet wide, with standing water. A damp to soppy-wet soil swath runs along the edges of this channel, suggesting wetting by lateral movement groundwater through the banks of the channel. This swath supports (except CAJO) the modest number of FIT detected at this site. Approximately 1/3 way east into meadow, meadow transitions into shallowly inundated wetland, becoming too soft and wet for further exploration in 12" bog boots. The meadow/wetland occupies apparently very flat terrain, and the source of all the water gathered here is not immediately evident. Meltwater from overlying snowpack seemingly could scarcely account for this much water, and although the visit was rather hasty, surface input channels were not noted. This site is referred to as a spring, and a possible combination of point source and diffuse discharge from groundwater moving down the forested slope to the meadow's south, appears if not evident during this visit, perhaps the most plausible water source.
Photos: #s 3563-3564.

<u>Beaver-South Fork</u>

1. 5800/5810 rd. junction
Elevation: 4020 feet
TRS: T15S, R24E, S26
Date: 9/26/2017
Rationale: Good fen site potential noted during drive-byes on other business. This site is mapped as NWI PSSA and would not have been included in this project if not for the good potential seen during the drive-byes.
Plants: Graminoids – **CAIN11**, **ELQU2**, **JUNE**, **JUEN**, **CASI2**, SCMI2, CANE2, **CACU5**
Forbs – **SAOR2**, POOC2, PRVU, EQAR, MIGU, **HYAN2**, LEMNA,
Shrubs - SALIX
Bryophytes – BRPS70, PHFO6, **DRAD2**
Soil probes: Two probes on soppy-wet soils in the northern half of the actively groundwater-wetted NE lobe of this meadow found moderately low to low density, gritless soil to a dense sandy layer at 36". Probe residue a thin, watery muck.
Notes: The main body of this meadow lies along a 120m-long riparian corridor that is seasonally wetted by both surface drainage and groundwater discharge. The only persistently groundwater-wetted portion of this meadow is the far upper 30m of its NE lobe. The combination of d*iffuse* and *persistent* groundwater discharge such as occurs here, is rare on OCH NF. This very small wetland had been grazed by cattle in 2017, with the soppiest, upper portion less intensely so. This small wetland is one of only two documented sites on OCH NF of the rare, ORBIC S1 fungus *Arrhenia lobata*. ARLO15 is understood to be parasitic on certain species of fen-loving mosses. The fungus was not detected during this visit.
Photos: #s 3785, 3786, 3787.

2. 5810 rd., section 13
Elevation: 4360-4420 feet
TRS: T15S, R24E, S13
Date: 9/27/2017

Rationale: Good fen site potential noted during drive-by on other business.
Plants: Graminoids – **CACU5**, CANE2, **CAIN11**, **CAJO**, SCMI2, CAUT, **JUEN**, **ELQU2**, JUBA, PHLEU, CAPE42, JUOR,
Forbs – PRVU, EQLA, POOC2, EPILO, MIGU, **HYAN2**, ACMI2, **PLDI3**, **SAOR2**, EQHY
Shrubs- SALIX
Bryophytes – MAPO16, **PLEL2**, **DRAD2**, BRPS70, POWA70, PHFO6, BRFR70
Soil probes: Multiple probes on the west-aspect slope at the southern end of this wetland/meadow system found moderately resistant/dense, variously gritty soils to bases at 23-39". One probe found no base at 54+". Multiple probes on the south-aspect slope in the northern portion of the system found moderately resistant, variously gritty soils to bases at 20-21". Two probes founds no bases at 51+".
Notes: This rather large, slightly longer than ¼ mile-long, wetland/meadow system features a broad, mostly steep west-aspect slope, a much longer N-S oriented, gently sloped, relatively narrow portion that follows the corridor of an intermittent stream and a smaller, linear meadow associated with a minor E-W oriented tributary drainage joins the corridor of the larger intermittent stream about `1/3 of the way up its reach in the system's northern portion. Squishy/soppy-wet, apparently *persistently* wet shorter-statured fen plant communities were found in all three of these portions of the larger wetland/meadow system. Dominant species within these shorter-statured communities consistently included the moss DRAD2 and the vascular plants ELQU2 and HYAN2. Cattle were in all parts of this system in 2017, leaving multiple areas with conspicuous soil pitting. This system includes the second of only two OCH NF records of the rare, ORBIC S1 fungus *Arrhenia lobata*. ARLO15 is understood to be parasitic on certain species of fen-loving mosses. The fungus was not detected during this visit.
Photos: #s 3788, 3789, 3790, 3791, 3793.

<u>Sites visited prior to this 2017 project: Upper Crooked Main, UTM Zone 10</u>

1. Chev Springs
Elevation: 5940-6040 feet
TRS: T15S, R20E, S5
Date: 6/12/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – SCMI2**, ELQU2**, JUBA**, CASI2,** CAREX
Forbs – VERAT, **SAOR2**, **HYAN2**, **PLDI3**, TAOF, POBI6, EPILO, ALLIU, **MIPR**, TRIFO, VERON, POOC2, GEMA4
Shrubs - ALNUS
Bryophytes – PHFO6, BRWE70, **DRAD2**, BRPS70, **PLEL2**, AUPA70
Soil probes: Three probes in finely gritty soil were stopped due to resistance at 34". Two probes found gritless or nearly gritless soil to 51+".
Notes: This site features a somewhat compartmentalized system of meadows that include various amounts of shrub cover, on a moderately steep, south-aspect slope. Four areas of active, diffuse groundwater discharge were noted at the time of visit. A good assessment of the persistence of groundwater discharge at these areas would require visiting in mid-late summer, as would a desire to use mature perigynia during the process of sedge species identification.
Photos: #s 883, 884, 885, 887, 888, 889, 890, 893.

2. Headwaters of Lytle Creek
Elevation: 6180 feet
TRS: T14S, R20E, S33/T15N, R20E, S4

Date: 6/13/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – **CAJO**, JUBA, **CASI2**, CAREX
Forbs – TAOF, VERON, POBI6, **SAOR2**, PAPS5, **HYAN2**, **PLDI3**, VERAT, MIGU, TRIFO
Bryophytes – PHFO6, BRPS70, AUPA70, BRWE70, **DRAD2**
Soil probes: Probes found a sandy, organics-rich soil with bases as deep as 48".
Notes: This site occupies a N-S oriented bench at the edge of a slope break midway in a long, nearly 550m-long, E-W oriented shrub-meadow terminating at its lower end in the upper-most reach of Lytle Creek. The essentially flat bench is approximately 110m in width, and in NAIP view, the steep slope break slope below it features a dense, dendritic network of channels converging into two primary channels feeding into Lytle Creek. A good assessment of the persistence of groundwater discharge at this site would require visiting in mid-late summer, as would a desire to use mature perigynia during the process of sedge species identification.
Photos: #905.

3. Headwaters of Lookout Creek
Elevation: 6280-6440 feet
TRS: T14S, R20E, S32
Date: 6/13-6/14/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – **ELQU2**, **CAJO**, CAREX
Forbs – **SAOR2**, **PLDI3**, VERAT, **HYAN2**, **MIPR**, POOC2
Shrubs – ALNUS, SALIX
Bryophytes – BRWE70, **DRAD2**, **TONI70**, **METR70**, MAPO16, PHFO6, BRPS70, AUPA70, RORO5, **SPHAG2, PLEL2**
Soil probes: 10+ probes in wet soil across this site found organics-rich soil to depths of 12-51+".
Notes: This site features four discrete areas of diffuse groundwater discharge with a total area of approximately 2.4 acres. These areas are mostly meadow but one is a mix of meadow and forest. All areas are on the south side of the very upper, E-W oriented portion of the Lookout Creek drainage. Distance from the upper-most to lower-most discharge area is nearly 600m. The south slope of this drainage is forested, and apparently supports the groundwater aquifer feeding the discharge areas. The north side of this drainage has some forested patches, but is largely sparsely vegetated and dry-soiled. Cow manure as well as elk scat is present in and among the discharge areas. Hoof pits were present in the discharge areas, but not identifiable as elk, cattle, or both. A goodly number of FIT were detected within the discharge areas, but most notable were detections of the rare OCH NF fen-loving mosses TONI70, METR70 and SPHAG2.
Photos: #s 906, 907, 909-914, 915, 916, 917, 919, 920, 921, 922, 923, 924, 925, 926.

4. Headwaters of Brush Creek
Elevation: 6380-6600 feet
TRS: T14S, R20E, S29
Date: 6/21/2013; 8/9/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – JUBA, **ELQU2**, **CAJO, ERIOP**, CAREX
Forbs – **PLDI3**, POBI6, **SAOR2**, **HYAN2**, POOC2, ORUN, **MIPR**, VERAT
Shrubs – SALIX, ALNUS
Bryophytes – PHFO6, BRPS70, BRPS70, BRWE70, **PLEL2**, **TONI70**, **METR70**, AUPA70,

MAPO16, **DRAD2**

Soil probes: Three probes found apparent organic soil over rock at 24-26"; a single probe found organics-rich soil to 51+". Quaking soils were found twice in the upper portion of the site area as defined by presence of wet, groundwater-fed communities. A re-visit to this site on 8/9/2013 found a cottongrass species (ERIOP, either *E. gracile* or *E. angustifolium*) in one of the site's TONI70 communities. This is apparently the first record of a cottongrass species on OCH NF.

Notes: This site features four discrete areas of diffuse groundwater discharge with a total area of approximately 3.2 acres. These areas include some trees and shrubs, but are mostly meadow, and are located in the highest portion of the main, E-W oriented Brush Creek headwaters drainage. Two discharge areas are low on the drainage's south-aspect slope, one is low on the north-aspect slope, and the fourth, and highest, is more or less centered in the drainage. The discharge areas span a distance of slightly more than 600m. The north aspect slope is largely forested while the south-aspect slope, although supporting some patches of trees, is mostly sparsely vegetated and dry-soiled, particularly the mid- and upper portion of the slope. Relative to other sites on OCH NF that include groundwater-fed habitats, this site supports a relatively large number of detected FIT. More notably three rare OCH NF fen-loving taxa were found here, the mosses TONI70 and METR70, and the sedge relative, cottongrass (ERIOP, either *E. gracile* or *E. angustifolium*). This is apparently the first record of a cottongrass species on OCH NF. The vegetative cottongrass was undetected during the spring visit on 6/21, but was easily spotted when fully in fruit during a return visit on 8/9/2013. During the late summer return visit, cottongrass was detected only in the single groundwater discharge area on the north-aspect slope, where along with TONI70 and METR70, it was very abundant on still squishy-wet and soppy-wet soils. A single cow was present among the groundwater-discharge areas during the visit on 8/9/2013.

Photos: #s 933-934, 935, 936, 937, 938, 939, 940, 941, 942, 943-944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 956, 957, 1176,1177.

5. Williams Prairie

Elevation: 4720-4780 feet

TRS: T15S, R21E, S8

Date: 7/11/2008

Rationale: Occasionally mentioned in conversations with OCH NF staff; in area due to Forest project work.

Plants: Graminoids – CAREX, JUNCU, CANE2, **JUEN**, JUBA
Forbs – POGR9, CASTI2, **SAOR2**, ACMI2
Shrubs – SALIX
Bryophytes – BRPS70, DREPA3

Soil probes: Multiple probes on the groundwater-wetted convex surface with caged SALIX at the lower, northern end of the meadow/prairie found gritless soil with no base reached at 48".

Notes: This visit was a fairly quick walk-through of as much prairie as possible. The only notable area of soils wet with groundwater discharge were at the northern end of the meadow, largely coinciding with the area occupied by a *Salix wolfii* look-alike. NAIP imagery shows this area to lie at the foot of an evident seasonal drainage area originating upslope to the east, near the edge of the 4225-141 road. The drainage presents itself as an area of late/winter-early spring groundwater discharge but was no more than damp-soiled at the time of visit. It seems likely that surface wetness stops as the water table height of the groundwater aquifer drops in early summer, but water movement within this aquifer continues shortly below the ground surface. With movement further downslope, the top of this aquifer again becomes within reach of the soil surface in the area of the SALIX community. Notably, the SALIX community is present on top of, and around, the edges of a convex microtopographic feature, which is commonly

associated with areas of persistent groundwater discharge, presumably due to the volume of peat deposition. Soil surfaces within the SALIX community were a patchwork of damp vs. soppy-wet, with a corresponding patchwork of CAREX-JUNCU-dominated plant community vs. moss-dominated community. It's interesting that NWI mapping appears show a reverse-interpretation, with the drainage itself mapped as PEMB, and the SALIX community lying within a PEMC polygon. The plant list presented here is embarrassingly sparse. This is likely due in part to the brevity of the visit. However, even the brief visit gave a strong sense that plant species diversity here is quite unexpectedly low. A history of intense livestock grazing at this site might be reasonably proposed as at least a factor contributing to this perceived sparsity. A primary reason to include this site in this report is simply to note that this site appears to be a relatively rare instance of robust and likely, persistent diffuse groundwater discharge over a substantial, contiguous surface area. It almost certainly does not exist, but a plant list for this site that predates intensive livestock grazing would be extremely interesting and valuable. As it stands, the rare underlying resource, the groundwater resource, is still here, and allows good potential for creative and committed site restoration.
Photos: #s 1463, 1464, 1465, 1466, 1467, 1468, 1469, 1470, 1471, 1472, 1473, 1474.

6. Indian Prairie
Elevation: 6100-6200 feet
TRS: T13S, R21E, S7
Date: 6/28/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – **ELQU2**, **CAJO**, PHLEU, JUBA, **CASI2**, CAREX
Forbs – **HYAN2**, **MIPR**, TRIFO, POBI6, ACMI2, VERAT, DELPH, TRLO, POGR9, FRVI, TAOF, ALLIU, **SAOR2**, **PLDI3**
Bryophytes – PHFO6, **METR70**, BRPS70, BRWE70, **TONI70**, **DRAD2**
Soil probes: A probe atop the quaking spring-mound/terrace found apparent organic soil to 51+". Six probes distributed among the three other areas wet with active groundwater discharge found soils with an upper gritless layer, or not layered and all gritless or all mildly gritty, sitting atop rock or firm bases at 28-50".
Notes: Six NWI PEMB polys are mapped in Indian Prairie. Five of these are along northern, northeastern and southeastern edges of the prairie at a meadow/forest interface. A sixth PEMB poly is mapped in the NW corner of the Prairie, very shortly below the 2630 road. This visit involved exploring only the areas within and between the five polys mapped along the Prairie's northern, northeastern and southeastern edges. Four rather localized areas wet with active groundwater discharge were detected. Two of these were within or partially included within mapped PEMB polys. The mapped PEMB poly at the northern end of the Prairie was found to include a spring-mound/groundwater terrace feature approximately 6m wide and 4 feet high. Quite notably, the upper mound/terrace included an area of quaking peat. Four FIT were found on this mound/terrace groundwater discharge feature. Moving south, the next area of active groundwater discharge was partially included with the PEMB poly mapped within the far-upper NE corner of the Prairie. Of the four active groundwater discharge areas noted during this visit, this area includes the greatest surface area and the largest number of detected FIT (8), including the rare OCH NF fen-loving moss METR70. The lower, western edge of this area features an abrupt slope break, creating a terraced edge to the wet groundwater-fed area above it. This is a common feature of the lower edges of sloping fens. South from here, jagged forest intrusion extends westward, downslope into the meadow. A PEMB poly is mapped at the tip of this intrusion, but soils within the area of this poly appeared only seasonally wetted and appeared to support no FIT. Moving upslope along the southern edge of this forest intrusion, and approaching where it merges into the main forested eastern boundary of

the Prairie, the other two, closely proximate areas of active groundwater discharge were encountered. These areas are not within or near any mapped PEMB polys, or any other NWI mapped wetland feature. The upper-most of these two areas included 5 FIT, including METR70 and another rare OCH NF fen-loving moss, TONI70. Notably, the actively groundwater-wetted areas just noted in the upper NE corner of the Prairie, and here along the eastern edge, supported plant communities that were both compositionally and structurally relatively distinct: 1) CAREX dominated, 2) JUBA dominated and 3) ELQU2-CASI2 dominated. FIT appear most likely to be encountered within the low-statured ELQU2-CASI2 communities. Note: A glaucous-leaved, *Phacocystis*-type CAREX species, likely either CAAQ or CANE2, was common at these sites. Early in the growing season it is difficult to distinguish between these two species. Further exploration down the Prairie's eastern side included visits to the areas included within two remaining mapped east-side PEMB polys. No further areas of active groundwater discharge were noted along this final leg of the visit. Although soppy soils were commonly encountered in the broad valley draining the southeastern corner of the Prairie, the community dominance of dense, tallish sedges, the valley-bottom location and the low count of FIT suggests that the wetness here is largely due to recycled or second-order groundwater with altered, nutrient-enriched chemistry.
Photos: #s 1034, 1038, 1040, 1042, 1044, 1046, 1048, 1050, 1052, 1054.

7. Allen Creek (upper tributary)
Elevation: 6340 feet
TRS: T13S, R21E, R16
Date: 6/27/2013
Rationale: Included in 2013 ISSSSP special status mosses project on OCH NF.
Plants: Graminoids – JUBA, **CAJO**, **ELQU2**, CAREX
Forbs – **MIPR**, **SAOR2**, **PLDI3**, **PLEL2**, POOC2, **HYAN2**, EQAR, EPILO, TAOF, VERON, POTEN, TRIFO
Shrubs - SALIX
Bryophytes – BRWE70, PHFO6, BRPS70, AUPA70, **DRAD2**
Soil probes: None conducted.
Notes: This site is located in a band of steep, largely south-aspect, sparsely vegetated, dry soils extending about three miles along the upper south face of Mt. Pisgah between the elevations of 6300-6600 feet. This site is one of three small wetland areas included within mapped NWI polys within this band. Two of these are classified as PEMB. This site, which falls remarkably well within the mapped NWI poly, was selected for a visit because NAIP imagery indicated that it was the most promising of the three areas. Although the NWI poly associated with this site is classified as PSSB, the site visit found that herbaceous species are the site dominants. Much of this site was robustly wetted by groundwater discharge at the time of visit, and an impressive 8 FIT were detected in spite of the site's rather small size (approximately 50x70m). Portions of the site were too soft and wet to be traversed with 12" high bog boots. The site included quaking soil as well as seepage pools. Two small output channels were active at the site's southeastern corner. A glaucous-leaved, *Phacocystis*-type CAREX species, likely either CAAQ or CANE2, was common at this site. Although ELQU2 is included in the plant list for this site, only a single shoot was detected. A return visit later in the summer would be very helpful in making a confident assessment of the persistence of the groundwater discharge observed during this visit.
Photos: #s 1002, 1004, 1006, 1008.

<u>Sites visited prior to this 2017 project: Lower John Day</u>

1. Headwaters of Bridge Creek

Elevation: 6180-6260 feet
TRS: T13S, R21E, S8/9
Dates: 9/27/2007; 10/4/2011
Rationale: Information shared by OCH NF staff.

Plants: Graminoids – DECE, **JUNE**, PHLEU, CAREX, **ELQU2**, **CASI2**, **CAJO**, **JUEN**, **CALU7**, CAUT, JUBA, AGID

Forbs – EQAR, **HYAN2**, VIOLA, GEMA4, EPILO, **SAOR2**, TRLO, **MIPR**, POOC2, GALIU, SPCA5, **PLDI3**, **SPRO**, DELPH

Shrubs – SALIX, **BEGL**

Bryophytes – MAPO16, BRWE70, **TONI70**, **CARI70**, **HYPR70**, **METR70**, **SPWA70**, AUPA70, PHFO6, **HEBL2**, **DIPA20,** BRPS70, **DRAD2**, TEPE70, SAUN8

Soil probes: Probes were conducted only in the immediate vicinity of "the bulge", the most conspicuous area of groundwater discharge on western side of the point where the 2630 road crossed Bridge Creek. One probe here contacted a first, evident inorganic layer a few inches above a firm base at 51". Multiple other probes, however, appeared to pass through variably dense organic soil, not reaching the soil base lying somewhere below 52+".

Notes: This is a very long (approximately 1350m), narrow, meadow that runs along the upper-most reach of Bridge Creek. The meadow slopes gently downward from west to east and is bisected by the 2630 road, creating what arbitrarily but conveniently can be referred to as an "upper meadow", approximately 975m long, and a "lower meadow", approximately 370m long. By its hydrology, and in turn vegetation, the upper meadow can be divided into eastern, central and western portions. The eastern portion extends up-meadow from the road crossing about 220m. Its primary features are a lower 2/3s dominated by taller sedges over wet to inundated soils, and little to no evidence of active groundwater discharge. Much of the wetness seen here is quite possibly due to recycled/second-order, chemically enriched water making its way down valley from its origins as first-order groundwater discharge in the central portion of the upper meadow. The central portion of the upper meadow features a dominance of mosses and lower statured sedges, sedge-relatives and forbs on soils that are damp to soppy-wet due to groundwater discharging along the meadow/forest interface on the meadow's southern edge. The large majority of FIT detected within the upper meadow, were detected in its central portion. Notably, this central portion exhibits a sharp distinction between soil moisture levels and plant community types. Because surface and near-surface groundwater discharge from the upper, southern edge of the meadow appears to be largely intercepted by the Bridge Creek channel, the upper northern side of the meadow is much drier-soiled and supports few FIT. The primary feature of the western portion of the upper meadow is the seasonal, not persistent, discharge of groundwater. At the time of the late-summer/early-fall visits to this site, isolated pockets of damp soil were found within the matrix of drier soils, but only a small subset of the FIT detected at this Bridge Creek headwaters site were seen within this western portion of the western meadow. In the lower meadow – that portion lying east of and below the crossing of 2630 road – areas of squishy-wet to soppy-wet soil are abundant and widespread. This wetness is clearly attributable to groundwater discharge occurring at the upper meadow/forest interface, and often continuing well down the meadow slope toward Bridge Creek. These groundwater-wetted soils support numerous FIT, including the rare, OCH NF fen-loving mosses CARI70, TONI70, HEBL2, SPWA70, and DIPA20. In contrast to the early summer visits made to many of the sites included in this project, the many areas of squishy-wet to soppy-wet soils observed during these late-summer/early-fall visits to Bridge Creek headwaters meadow systems is de facto evidence that groundwater discharge at these areas is persistent through the growing season. It is very notable that the number of detected FIT at the Bridge Creek headwaters meadow/wetland system far exceeds that documented at any other OCH NF meadow/wetland visited by the project lead. Further, multiple rare OCH NF FIT mosses are documented on OCH NF only

at the Bridge Creek headwaters meadow/wetland. These include *Calliergon richardsonii* (CARI70, ORBIC S1 and documented in Oregon only from this Bridge Creek headwaters site), *Hypnum pratense* (HYPR70; ORBIC S1) and *Dicranella palustris* (DIPA20). *Sphagnum*, which is abundant here on persistently groundwater-wetted soils, appears to be documented at only one other site on OCH NF. Grazed sedge/graminoid communities, browsed shrubs (willows, huckleberries), and common presence of hoof pits indicates substantial visitation by large ungulates.
Photos: #s (2007 visit): 1417, 1418, 1419, 1420, 1421, 1422, 1423, 1424, 1425, 1426, 1427, 1428, 1429, 1430, 1431, 1432, 1433, 1434, 1435, 1436-1437, 1439, 1440, 1441, 1442, 1443, 1444, 1445, 1446; (2011 visit): 769, 770, 771, 772, 773, 774-775, 776, 777-778, 779, 780, 781, 782, 783, 785, 786.

Appendix C – Plant taxa detected at project-related sites

Graminoids		
	Agrostis idahoensis	AGID
	Agrostis sp.	AGROS2
	Alopecurus sp.	ALOPE
	Carex amplifolia	CAAM10
	Carex aquatilis	CAAQ
	Carex athrostachya	CAAT3
	Carex aurea	CAAU3
	Carex cusickii	CACU5
	Carex disperma	CADI6
	Carex hoodii	CAHO5
	Carex interior	CAIN11
	Carex jonesii	CAJO
	Carex lenticularis var. *lipocarpa*	CALEL3
	Carex luzulina	CALU7
	Carex microptera	CAMI7
	Carex nebrascensis	CANE2
	Carex pachystachya	CAPA14
	Carex pellita	CAPE42
	Carex simulata	CASI2
	Carex sp.	CAREX
	Carex subfusca	CAFU6
	Carex utriculata	CAUT
	Deschampsia cespitosa	DECE
	Eleocharis palustris	ELPA3
	Eleocharis quinqueflora	ELQU2
	Eriophorum sp.	ERIOP
	Hordeum brachyantherum	HOBR2
	Juncus balticus	JUBA
	Juncus ensifolius	JUEN
	Juncus nevadensis	JUNE
	Juncus orthophyllus	JUOR
	Luzula campestris	LUCA2
	Muhlenbergia filiformis	MUFI2
	Phleum sp.	PHLEU
	Poa pratensis	POPR
	Poa sp.	POA
	Scirpus microcarpus	SCMI2
	Ventenata dubia	VEDU
Forbs		
	Achillea millefolium	ACMI2
	Allium sp.	ALLIU
	Antennaria sp.	ANTEN

	Arnica chamissonis	ARCH3
	Aster foliaceus	ASFO
	Aster occidentalis	ASOC
	Barbarea vulgaris	BAVU
	Camassia quamash	CAQU2
	Castilleja sp.	CASTI2
	Cirsium sp.	CIRSI
	Collinsia sp.	COLLI
	Delphinium sp.	DELPH
	Dodecatheon sp.	DODEC
	Epilobium glaberrimum	EPGL
	Epilobium glandulosum	EPGL4
	Epilobium sp.	EPILO
	Epilobium watsonii	EPWA3
	Equisetum arvensis	EQAR
	Equisetum hyemale	EQHY
	Equisetum laevigatum	EQLA
	Equisetum sp.	EQUIS
	Erigeron philadelphicus	ERPH
	Fragaria virginiana	FRVI
	Galium sp.	GALIU
	Geum macrophyllum	GEMA4
	Hypericum anagalloides	HYAN2
	Hypericum perforatum	HYPE
	Iris sp.	IRIS
	Lemna sp.	LEMNA
	Leucanthemum vulgare	LEVU
	Ligusticum canbyi	LICA2
	Lomatium sp.	LOMAT
	Lupinus sp.	LUPIN
	Madia sp.	MADIA
	Mimulus guttatus	MIGU
	Mimulus primuloides	MIPR
	Mimulus sp.	MIMUL
	Microseris sp.	MICRO6
	Montia chamissoi	MOCH
	Orobanche uniflora	ORUN
	Orthocarpus sp.	ORTHO
	Packera pseudaurea	PAPS5
	Penstemon rydbergii	PERY
	Platanthera dilitata	PLDI3
	Polygonum bistortoides	POBI6
	Potentilla gracillis	POGR9
	Potentilla sp.	POTEN
	Polemonium occidentale	POOC2
	Potamogeton sp.	POTAM
	Prunella vulgaris	PRVU
	Ranunculus uncinatus	RAUN
	Rumex sp.	RUMEX

	Saxifraga arguta	SAAR13
	Saxifraga integrifolia	SAIN4
	Saxifraga oregana	SAOR2
	Sedum sp.	SEDUM
	Senecio sp.	SENEC
	Senecio hydrophiloides	SEHY
	Sidalcea oregana	SIOR
	Sidalcea sp.	SIDAL
	Sisyrinchium sp.	SISYR
	Sphenosciadium capitellatum	SPCA5
	Spiranthes romanzoffiana	SPRO
	Taraxacum officinale	TAOF
	Tragopogon sp.	TRAGO
	Trifolium sp.	TRIFO
	Trifolium longipes	TRLO
	Veratrum sp.	VERAT
	Veronica sp.	VERON
	Vicia americana	VIAM
	Vicia sp.	VICIA
	Viola sp.	VIOLA
	Wyethia helianthoides	WYHE2
Shrubs		
	Alnus sp.	ALNUS
	Betula glandulosa	BEGL
	Betula occidentalis	BEOC2
	Salix sp.	SALIX
	Symphoricarpos albus	SYAL
Bryophytes		
	Aulacomnium palustre	AUPA70
	Brachythecium frigidum	BRFR70
	Bryum pseudotriquetrum	BRPS70
	Bryum weigelii	BRWE70
	Calliergon richardsonii	CARI70
	Campylium polygamum	CAPO17
	Dicranella palustris	DIPA20
	Drepanocladus aduncus	DRAD2
	Drepanocladus sp.	DREPA3
	Fontinalis sp.	FONTI
	Helodium (*Elodium*) *blandowii*	HEBL2
	Hypnum pratense	HYPR70
	Marchantia polymorpha	MAPO16
	Meesia triquetra	METR70
	Meesia uliginosa	MEUL70
	Philonotis fontana	PHFO6

	Plagiomnium sp.	PLAGI7
	Plagiomnium ellipticum	PLEL2
	Pohlia wahlenbergii	POWA70
	Riccia beyrichiana	RIBE
	Riccia cavernosa	RICA15
	Roellia roellii	RORO5
	Sanionia uncinata	SAUN8
	Sphagnum sp.	SPHAG2
	Sphagnum warnstorfii	SPWA70
	Tetraphis pelucida	TEPE70
	Tomentypnum nitens	TONI70

Appendix D – Value rankings of Ochoco National Forest wetland/wetland-meadow sites included in this report. See page 16 for description of ranking process.

Value Rank	Site	FIT Count	Rare FIT mosses		Value Rank	Site	Fit Count	Rare FIT mosses
1	Headwaters of Bridge Creek	20	7		26	2610-150 rd. (Deadman Creek)	7	0
2	4220-151 rd.	13	2		27	2620 rd. (roadside)	7	0
3	Headwaters of Lookout Creek	11	3		28	Podo Meadow area, south of 38 rd.	7	0
4	Upper 4215-150 rd.	12	1		29	30-747 rd.	6	0
5	Headwaters of Brush Creek	11	2		30	2630-302 rd.	6	0
6	12-190 rd.	12	0		31	2600-400 rd. (Bandit Spring Rest Area)	6	0
7	4220 rd. (Lytle Creek)	12	0		32	1250-020 rd.	6	0
8	Indian Prairie	10	2		33	38-130 rd.	6	0
9	4270-210 rd.	11	0		34	2630-360 rd. (Lost Lake Spring)	6	0
10	2700-421 rd. (Moccasin Spring and Prairie)	11	0		35	Headwaters of Lytle Creek	6	0
11	2630-841 rd. (Haypress Creek)	10	1		36	2630 rd., sect. 8	5	0
12	30-800 rd.	10	0		37	Lower 4215-150 rd. (Spring Creek hdws - e)	5	0
13	4254 rd., section 17	10	0		38	2610-150 rd. (w)	5	0
14	5810 rd., section 13	10	0		39	2610-150 rd. (ne)	5	0
15	Podo Meadow main, spring-mound vicinity	8	2		40	2630-850 rd.	4	0
16	2620-025 rd.	9	0		41	30-870 rd.	4	0
17	5800/5810 rd. junction	9	0		42	1280 rd.	4	0
18	2610-150 rd. (s)	8	0		43	2630-353 rd. (Butterfield Spring)	4	0
19	4220-050 rd, (Jungle Creek)	8	0		44	Blevin's Spring/Hdws Double Corral Ck.	3	0
20	2630-350 rd. (Cole Spring)	8	0		45	4230-900 rd. (Hickey Creek)	3	0
21	1250-030 rd.	8	0		46	1610 rd., section 26	3	0
22	Chev Springs	8	0		47	12-200 rd.	3	0
23	Allen Creek (upper tributary)	8	0		48	12-975 rd.	3	0
24	30-900 rd.	7	0		49	1600 rd., section 11	2	0
25	Lower 4215-150 rd. (Spring Creek hdws - w)	7	0		50	2610-104 rd. (Claypool Spring)	2	0
51	5800-560 rd. (Columbus Creek)	2	0					
52	Williams Prairie	2	0					

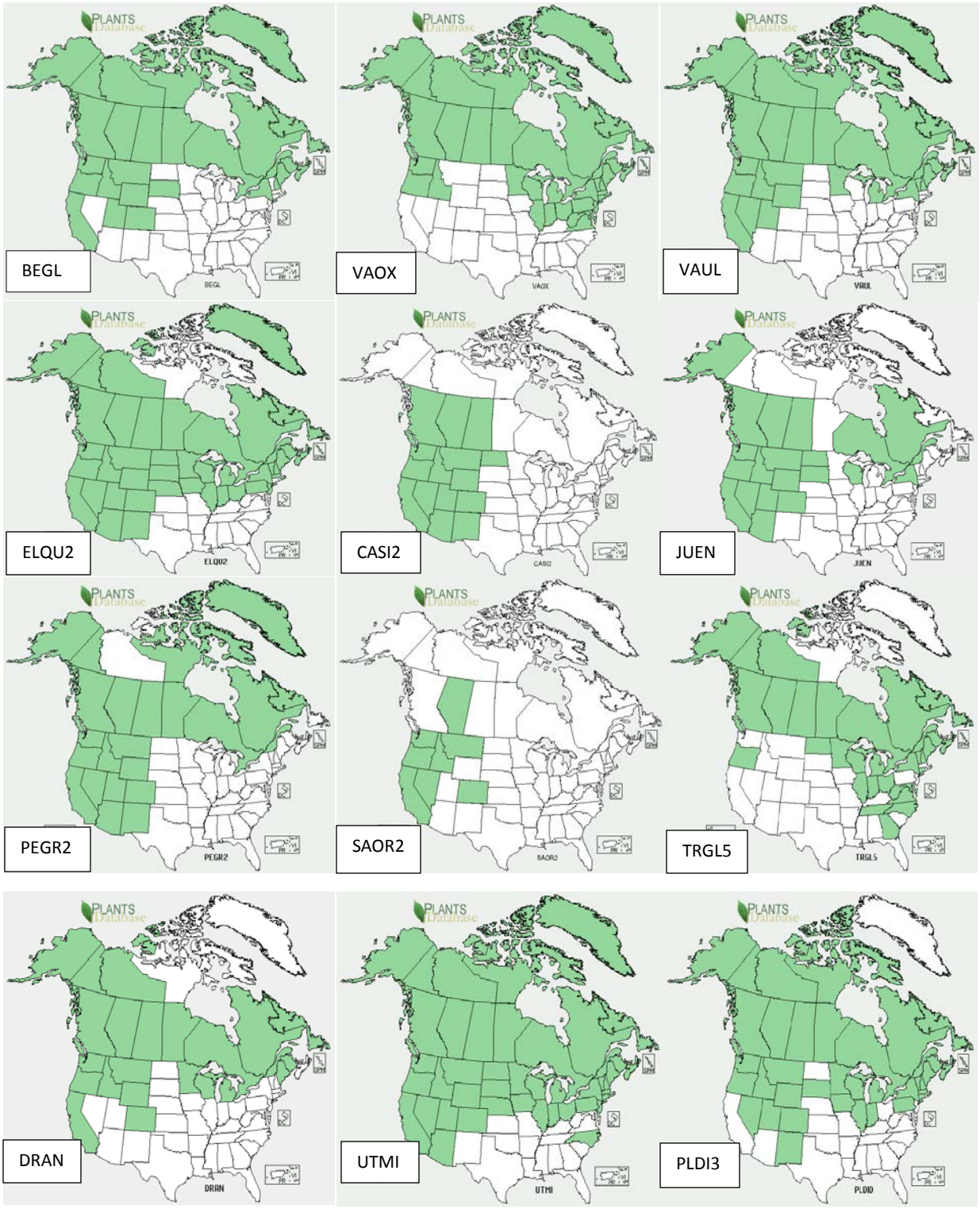
Value Rank	Site	FIT Count	Rare FIT mosses		Value Rank	Site	Fit Count	Rare FIT mosses
53	4230 rd. (Hickey Meadow)	1	0					
54	4230-850 rd. (Little Round Prairie)	1	0					
55	2630-350 rd., sections 3/10	1	0					
56	4250-500 rd.	0	0					
57	4230 rd. (Round Prairie)	0	0					

Appendix E – Current list of fen indicator taxa for Oregon and Washington developed by Dewey.

Taxon Group	Taxon Code	Scientific Name
Graminoids	CAAQ	*Carex aquatilis*
	CACU5	*Carex cusickii*
	CAEC	*Carex echinata*
	CAGY2	*Carex gynocrates*
	CAIN11	*Carex interior*
	CAJO	*Carex jonesii*
	CALI7	*Carex limosa*
	CALU7	*Carex luzulina*
	CAMA12	*Carex magellanica ssp. irrigua*
	CASI2	*Carex simulata*
	CATE5	*Carex tenuiflora*
	ELQU2	*Eleocharis quinqueflora*
	ERIOP	*Eriophorum* spp.(*E. gracile* or *E. polystachion*)
	JUEN	*Juncus ensifolius*
	JUNE	*Juncus nevadensis*
Forbs	DODEC	*Dodecatheon* spp. (especially *D. jeffreyi*)
	DROSE	*Drosera* spp. (*D. anglica* or *D. rotundifolia*)
	HYAN2	*Hypericum anagalloides*
	METR3	*Menyanthes trifoliata*
	MIPR	*Mimulus primuloides*
	PEGR2	*Pedicularis groenlandica*
	PLATA2	*Platanthera* spp. (*P. dilatata* or *P. saccata*)
	SAOR2	*Saxifraga oregana*
	SCPAA3	*Scheuchzeria palustris* ssp. *americana*
	SPRO	*Spiranthes romanzoffiana*
	TRGL5	*Triantha glutinosa*
	UTRIC	*Utricularia* spp. (*U. minor* or *U. intermedia*)
Shrubs	BEGL	*Betula glandulosa*
	KAMI	*Kalmia microphylla*
	VAOX	*Vaccinium oxycoccos*
	VAUL	*Vaccinium uliginosum*
Bryophytes	CACO70	*Calliergon cordifolium*
	CAGI70	*Calliergon giganteum*
	CARI70	*Calliergon richardsonii*
	CAST70	*Calliergon stramineum*
	CACU18	*Calliergonella cuspidata*
	CAST51	*Campylium stellatum*
	CATR27	*Calliergon trifarium*

	DIPA20	*Dicranella palustris*
	DRAD2	*Drepanocladus aduncus*
	HAVE70	*Hamatocaulis vernicosus*
	HAFL9	*Harpanthus flotovianus*
	HEBL2	*Helodium blandowii*
	HYPR70	*Hypnum pratense*
	METR70	*Meesia triquetra*
	MEUL70	*Meesia uliginosa*
	PASQ70	*Paludella squarrosa*
	PLEL2	*Plagiomnium ellipticum*
	SCCO18	*Scorpidium cossonii*
	SCSC70	*Scorpidium scorpioides*
	SPAM5	*Splachum ampullaceum*
	SPSP70	*Splachnum sphaericum*
	SPHAG2	*Sphagnum* spp.
	TONI70	*Tomentypnum nitens*
	WAEX	*Warnstorfia exannulata*

Appendix F – Biogeography of selected fen indicator taxa.



Appendix G - Fen indicator taxon (FIT) counts in forests along and east of the Cascades crest in Oregon. Counts based primarily on fieldwork by Dewey. The FIT count for Malheur National Forest is currently understated due to a focus on bryophytes and lichens during fieldwork. FIT list used here developed for use in Oregon and Washington by Dewey. Field observations by Dewey supplemented by Smith and Rausch (2015) on Malheur NF and Saager (2018) on Umatilla NF. Supplemental information indicated with "●" symbol.

Taxon Group	Taxon Code	DES	FWI	MAL	MTH	OCH	UMA	WAW
Graminoids	CAAQ	X	X	X	X	X	X	
	CACU5	X			X	X	●	
	CAEC	X	X		X		X	X
	CAGY2							
	CAIN11					X		
	CAJO	X	X		X	X	X	X
	CALI7	X	X		X		●	X
	CALU7	X	X		X	X	X	X
	CAMA12							
	CASI2	X	X		X	X	X	X
	CATE5							
	ELQU2	X	X	X	X	X	X	X
	ERIOP	X	X	X	X	X	X	X
	JUEN	X	X	X	X	X	X	X
	JUNE	X	X	X	X	X	●	X
Forbs	DODEC	X	X		X	X	X	X
	DROSE	X	X		X			X
	HYAN2	X	X	X	X	X	X	X
	METR3	X	X	X	X		●	X
	MIPR	X	X		X	X	X	X
	PEGR2	X	X	X	X		X	X
	PLATA2	X	X		X	X	X	X
	SAOR2	X	X	X	X	X	X	
	SCPAA3	X	X					
	SPRO	X	X		X	X	X	X
	TRGL5	X	X		X			
	UTRIC	X	X		X		●	X
Shrubs	BEGL	X	X	X	X	X	X	
	KAMI	X	X		X		●	X
	VAOX	X			X			
	VAUL	X	X		X			X
Bryophytes	CACO70							
	CAGI70				X		X	X

Taxon Group	Taxon Code	DES	FWI	MAL	MTH	OCH	UMA	WAW
	CARI70					X		
	CAST70	X			X		X	X
	CACU18	X	X	●	X			
	CAST51			X				X
	CATR27	X	X					
	DIPA20					X	X	X
	DRAD2	X	X	X	X	X	X	X
	HAVE70	X	X	X	X		X	X
	HAFL9	X					●	
	HEBL2	X	X	X		X	X	X
	HYPR70		X	●		X		X
	METR70	X	X	X	X	X	X	X
	MEUL70		X	X		X		X
	PASQ70							
	PLEL2	X	X	●		X	X	X
	SCCO18							
	SCSC70							
	SPAM5		X					
	SPSP70							X
	SPHAG2	X	X	●	X	X	X	X
	TONI70	X	X	X	X	X	X	X
	WAEX	X	X	●	X		X	X
Total		39	38	22	35	27	34	35