Bryophyte Inventory of Fens and Fen-like Ecosystems on Klamath Falls Resource Area, Lakeview District BLM

ENE up central portion of Section 27 fen, Surveyor Mtn.

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March 2015

Dense linear array of *Meesia uliginosa* with maturing sporophytes at the Section 27 fen, Surveyor Mtn.

Acknowledgements

This project was funded by a FY 2014-2015 grant from the USFS R6/OR-WA BLM ISSSSP program. Thanks to Johanna Blanchard (formerly the Klamath Falls Resource Area botanist) for developing the initial proposal for this project.

Introduction

This project was an effort to better document the presence, distribution, habitats and habitat condition of groundwater-loving rare bryophytes on the Klamath Falls Resource Area (KFRA) of the Lakeview BLM District. Impetus for this project included the recent documentation of multiple rare bryophytes within groundwater dependent ecosystems on adjacent Fremont-Winema National Forest, as well as the incidental, 2009 detection on KFRA of the groundwater-loving moss *Tomentypnum nitens,* which was thought to be rare. The basic types of groundwater dependent ecosystems on federal lands in and east of the Cascades of Oregon and Washington are springs, fens, and fen-like ecosystems. In the experience of the project lead, fens and fen-like ecosystems differ from springs primarily in being supported by diffusely-discharging, rather than more point-sourced, groundwater. Secondarily, and apparently, rather consequently, fens and fen-like ecosystems also notably differ from springs in their floristic composition. Again, according to the project lead's experience, fens are supported by groundwater discharge that persists, or nearly persists, through the full growing season. Fen-like ecosystems are supported by groundwater discharge that is seasonal, resulting in reduced availability beginning as early as July. In the project lead's experience, rare and uncommon bryophytes (and vascular plants) are much more likely to be encountered within fens and fen-like ecosystems, than in association with springs.

Tomentypnum nitens at the SW Buck Lake fen-including wetland, Surveyor Mtn.

Objectives

The objectives of this project were essentially two-fold. First to better document the number and distribution of fens and fen-like ecosystems on the Klamath Falls Resource Area and second, to look within these ecosystems for variously rare or uncommon bryophytes. Rare bryophytes associated with fens and fen-like ecosystems that were sought during this project are included in Table 1 below.

Table 1. Rare bryophytes sought during Klamath Falls Resource Area inventory for fen and fen-like ecosystems.

Species	**Global and State Rank**	**ORBIC List**	**BLM Status** (2013 list)
Cephaloziella spinigera	G4S1	ORBIC List 2	BLM Sensitive
Harpanthus flotovianus	G5S1	ORBIC List 2	BLM Sensitive
Meesia uliginosa	G4S1	ORBIC List 2	BLM Sensitive
Pseudocalliergon trifarium	G4S1	ORBIC List 2	BLM Sensitive
Tomentypnum nitens	G5S2	ORBIC List 2	BLM Sensitive
Tritomaria exsectiformis	G5S2	ORBIC List 2	BLM Sensitive

Patch of short-statured fen community at SW Buck Lake fen-including wetland, Surveyor Mtn.

Methods

This project was initially planned and proposed by Johanna Fichenscher Blanchard, botanist for the Klamath Falls Resource Area. Johanna selected about a dozen sites where groundwater discharge was known to occur. Johanna subsequently accepted a position with the Roseburg BLM District, and the current project lead accepted the opportunity to conduct a small amount of additional planning, as well as to conduct the fieldwork. The additional planning conducted by the current project lead involved simply examining the wetland sites GIS layer generated by the US Fish and Wildlife Service (USF&WS) National Wetland Inventory (NWI). In particular, an effort was made to note all the polygons within the Klamath Falls Resource Area that are coded PEMB. The project lead has noted in previous projects, that this code, most frequently among the dozens of NWI codes, corresponds to field sites that include fens and fen-like ecosystems. However, other codes known to identify field sites with fens and fen-like ecosystems include PEMC, PSSB, PSSC, PFOB and PFOC.

The fen-loving moss *Meesia triquetra* at Section 27 fen, Surveyor Mtn.

A more detailed explanation of these codes is available at http://www.fws.gov/wetlands/, but briefly, "P" = palustrine, "EM" = emergent, and "B" = substrate saturated to surface for extended periods during the growing season. "C" = seasonally flooded, "SS" = scrub-shrub and "FO" = forested. The extent to which USF&WS has been able to field-truth these codes in the Klamath Basin is unknown, and elsewhere in

Oregon and Washington, experience has shown that these codes can be misleading. Overall, however, the NWI wetland mapping is a highly valuable resource when looking for fens and fen-like ecosystems on federal lands. In this project, the ability to place appropriately coded NWI polygons over NAIP aerial imagery allowed the selection of a set of more than a dozen additional sites with potential to include fens or fen-like ecosystems. Nearly all of these sites occurred within the immediate vicinity of Surveyor Mountain. During site visits, information collection included a plant species list (bryophytes and vascular plants), basic description of vegetative structure, amount and distribution of wetness, soil probes and site condition. Skill of the project lead was insufficient to identify all plants encountered. Special emphasis was placed on noting the presence of fen indicator taxa. Plants of uncertain identity were routinely collected to allow further examination back at the field station. At sites were rare or otherwise notable plants were detected, collections were made for inclusion in the Klamath Falls Resource Area herbarium. GPS readings and photos were taken at most sites.

Results

Eighteen survey areas with potential to include fens or fen-like ecosystems were visited between 6/11/2014 and 7/9/2014. One fen, one fen-wetland complex, and eight fen-like ecosystems were documented. Two Table 1 mosses and one incidental rare vascular plant were found during these surveys. Sites surveyed and relevant associated information is summarized in Table 2 below. More detailed information regarding these sites is presented in Appendix A. A map showing the location of survey areas at Surveyor Mountain is presented in Appendix B. Plant taxa encountered during surveys, including fen indicator taxa, are listed in Appendix C. Thirty-two fen indicator taxa were detected among the fen and fen-like ecosystems visited during this project.

Table 2. Features of survey areas visited during Klamath Falls Resource Area inventory for fen and fen-like ecosystem. If not included in the original proposal, survey areas were selected because of potential to include fens and fen-like ecosystems based on the types of NWI polys mapped within the defined survey area. "FIT" refers to fen indicator taxa.

	Survey area	**Township, Range Section**	**Rationale**	**Fen (f) or fen-like ecosystem (fle)?**	**Target taxa detected**	**FIT detected**
1	SW Buck Lake	T38S, R3W, S23	In original proposal; PSSC poly	Yes (f)	*Meesia uliginosa* *Tomentynum nitens* (*Utricularia minor*, an incidental vp)	28
2	Section 27 (n sect line) srv	T38S, R5E, S27	PEMB, PFOB polys	Yes (f)	*Meesia uliginosa*	18
3	Section 13 (main)	T39S, R5E, S13	In original proposal; PFOC poly	Yes (fle)	None	14
4	Section 3/34/35	T39S, R5E, S3/34	In original proposal, in part; PEMB, PSSB polys	Yes (fle)	None	13
5	Section 21 srv	T38S, R5E, S21	4 PSSC polys, 1 PFOC poly, 2 PEMB polys	Yes (fle)	None	12
6	Cherry Glade srv	T39S, S5E, S1	In original proposal; no NWI polys here	Yes (fle)	None	8
7	Fourmile wetland	T34S, R6E, S1/12/13	In original proposal; PEMC poly	Yes (fle); marsh	*Utricularia minor*, an incidental vp)	7
8	Section 13 (far ne)	T39S, R5E, S13	PSSC poly	Yes (fle)	None	7
9	Section 7 srv	T39S, R6E, S1	PSSC poly	Yes (fle)	None	7
10	Schnipps Valley srv	T39S, R14E, S25	PEMB, PEMC polys	Yes (fle)	None	2
11	Section 27 srv	T38S, R5E, S27	5 PSSB polys, 1 PFOB poly	No	None	5
12	Section 23 SE ¼	T38S, R5E, S23	PSSB poly	No	None	0
13	Section 23 NE ¼	T38S, R5E, S23	PSSC poly	No	None	1
14	Section line 23/26	T38S, R5E, S23/26	PSSB poly	No	None	0
15	Section 25 NE 1/4	T38S, R5E, S25	In original proposal; PSSC, PFOC polys	No	None	1
16	Section 25 SE ¼	T38S, R5E, S25	In original proposal; 3 PSSB polys, 1 PFOB poly	No	None	0
17	Section 36	T38S, R5E, S36	In original proposal; PFOB poly	No	None	0
18	Horsetail Springs	T40S, R6E, S23	In original proposal; no NWI polys here	No	None	0

Discussion

1. Fen indicator taxa. These are taxa that the project lead has consistently detected within fens, especially short-statured fen communities, during his visits to fen candidate sites across multiple national forests within the Pacific Northwest. This list, which is admittedly subjective and always open to edits, seems to be largely applicable across the Cascadian national forests visited to date, although the incidence of certain species can change geographically. The primary geographic range of the majority of these fen indicator taxa is at higher, boreal latitudes. North American distributions of 12 of these taxa (NRCS Plants Database at http://plants.usda.gov/java/) that are generally representative of the group are illustrated in Appendix D. It's evident from Appendix D 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 these include the Cascades, Sierra Nevada, Ochoco, Blue and Wallowa 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 fen indicator species are components of *boreal fen communities*, in Oregon and Washington, these same species are components of *montane fen communities*.

The insectivorous *Drosera anglica* at SW Buck Lake fen-including wetland, Surveyor Mtn.

But while the presence of mountains makes the presence of the Oregon and Washington 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 USFS forests is generally uncommon and among BLM districts, which lie at lower elevations, presumably altogether rare.

2. Fens. There is much reference in fen literature to the importance of peat as one of the defining characters of a fen. Some authors, however, perceive a latitudinal bias in in such a definition. Beford and Godwin (2003) have noted that "most literature on fens originates from boreal regions where peatlands dominate the landscape." In their review of fens and fen literature of the United States, Bedford and Godwin (2003) cite multiple authors in noting that fens at more temperate latitudes occur on mineral and carbonate substrates, as well as on peat. Bedford and Godwin (2003) suggest that, regardless of latitude, *water source* (groundwater) and *vegetation* (typically a mix of mosses, graminoids and dicot herbs), rather than soil type, are more useful, applicable characters with which to define and differentiate fens.

Few-flowered spikerush (*Eleocharis quenqueflora*) at the Section 27 fen, Surveyor Mt.

This view is essentially exactly mirrored by the authors of large review of fens and fen literature of Central Europe (Hájek, et al. 2006). With their reviews, both sets of authors referenced above have proposed their own definitions of fens, definitions better able to work across the broad range of latitudes

and landscapes across which fens occur. Bedford and Godwin (2003) propose that fens are "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."

Two unequivocal fens, or fen-including sites, were visited during this project. Each of these sites is at Surveyor Mountain.

a) SW Buck Lake. This large wetland is very notable both for what is here, as well as what is apparently not here. The 28 FIT detected here is among the largest number detected at any wetland known to the project lead within Oregon or Washington. On the other hand, the failure to detect any *Sphagnum* amidst the extensive, apparently highly suitable habitat within this wetland, is very puzzling. Sphagnum occurs in another large, strongly groundwater-influenced wetland in the Cherry Creek drainage approximately 2.5 miles due north of SW Buck Lake basin, although admittedly, it is uncommon at this site. This same wetland in the Cherry Creek drainage includes abundant *Pseudocalliergon trifarium*, and this species, in spite of apparent extensive suitable habitat, was also not detected at within the SW Buck Lake wetland.

SSE over portion of fen on far western edge of SW Buck Lake fen-including wetland; Surveyor Mtn. in background.

The water sources for the SW Buck Lake wetland are in part obscure. Much of the far western, moss/Cyperaceae-dominated portion of the wetland is clearly primarily fed by diffuse, eastward flowing groundwater discharge, and is clearly a fen ecosystem. A return visit to this western portion of the wetland in October 2014 found the volume of groundwater discharge generally reduced, with the water table now often somewhat below the soil surface, but still within the rooting zone of the vascular plants; in turn, capillarity within the organic soil column was still commonly wicking moisture to the surface-dwelling mosses. In contrast, even in October, the eastern/main lobe of the wetland was still generally very soppy-wet. Particularly along the eastern edge of this lobe, small patches of short-statured fen community provide evidence of a north and northwest-flowing groundwater contribution to the wetness of this main wetland lobe. However, the abundant cover of Cyperaceae in this lobe suggests that moderate nutrient-enrichment, perhaps through seasonal surface water input, or just marsh-like standing water conditions, is occurring in this lobe as well. While apparently not exclusively wetted by groundwater, the SW Buck Lake wetland, based on its large size and biodiversity, is very arguably the most notable strongly groundwater-influenced, fen-including wetland within the Klamath Falls Resource Area.

b) Section 27 fen. This wetland is very notable in that it appears to represent only the second fen, or fen-including wetland, known to exist within the Klamath Falls Resource Area. This wetland is much smaller than the SW Buck Lake wetland, but, perhaps in large part due to its smaller size, appears to be wetted throughout by diffusely discharging groundwater. As with the SW Buck Lake wetland, this fen was revisited in October 2014 and found to be still soppy-wet throughout. Its biodiversity, including the detection of 18 fen indicator taxa, is notable for a wetland of its size. Other than the biophysical rarity of such a site as this on the Klamath Falls Resource Area, the site is also notable as supporting far and away the largest population of the fen moss *Meesia uliginosa* that the project lead has ever encountered in his several years of fen inventory in Oregon. In a 2015 list update, this species was removed from BLM/USFS sensitive species status in Oregon, due to the Oregon Biodiversity Information Center (ORBIC) downgrading the state status from S1 to S2 and List 2 to List 4. However, in the project lead's experience and according to BLM/USFS rare plant databases, it is rare outside of Grant and Jackson Counties in Oregon.

Lower portion Section 27 fen, Surveyor Mtn.

3. Fen-like ecosystems. This is a classification given by the project lead to ecosystems whose character is largely shaped by *seasonal* (not persistent) diffuse groundwater discharge. Floristically, these ecosystems clearly resemble fen ecosystems, but typically with a smaller number of fen indicator taxa. Whereas the two Klamath Falls Resource Area fen ecosystems recognized in this project included at least 28 and 18 fen indicator taxa, the number of fen indicator taxa detected at the 8 recognized fen-like ecosystems visited during this project ranged from 2-14 (7-14, excluding Schnipps Valley). Paralleling the incidence of true fens, fen-like ecosystems also appear to be a quite uncommon resource on the Klamath Falls Resource Area. Some of the more notable of these ecosystems are briefly discussed below (see Appendix A for detailed information on all the project's fen-like ecosystems).

a) Section 13 (main). This ecosystem occupies a section of the slope break at the interface of upslope woods and intermittent stream terrace, as well as the adjacent, higher portion of that terrace. The detection of 14 fen indicator taxa at this site suggests a relatively protracted, if seasonal, period of groundwater discharge. A revisit to this site in October 2014 found a markedly reduced volume of groundwater flow reflected in ecosystem soil surfaces being generally no more than damp or moist. Intense, extensive fresh soil pitting by the hooves of cattle, observed at the October visit, indicated the expected presence of soft, groundwater-wetted soil during the 2014 period of use by cattle.

A portion of the Section 13 (main) fen-like ecosystem, Surveyor Mtn.

b) Section 3 (main). This ecosystem is notable both for its relatively large number of detected fen indicator taxa (13) and its patchy presence along a steep slope, outside of any well-defined drainage corridor. This was the only fen-like ecosystems in which the insectivorous sundew (*Drosera rotundifolia*) was detected. A smaller, similarly steep-sloped fen-like ecosystem is located about 200 m north of here, and yet another about 100 m north of that. Collectively, these steep-sloped fen-like ecosystems form a very notable biophysical complex within the Surveyor Mountain area. Evidence of cattle use in this complex is slight.

A portion of Section 3/34 fen-like ecosystem, Surveyor Mtn.

c) Schnipps Valley. The groundwater discharge area here, shortly above a large earthen dam, and mapped in the NWI system as PEMB is noted here because of the restoration potential it promises. At the date of visit, 7/7/2014, multiple patches of very wet muck and pooled water were present. Even though this was a relatively early-season visit, the presence of the fen indicator species few-flowered spikerush (*Eleocharis quinqueflora)* and analog sedge (*Carex simulata*), both very faithful to fen site conditions, suggest that this site has, at least, a protracted annual period of seasonal groundwater discharge. The site has been so intensively damaged by cattle use (extensively pitted/churned bare soil/peaty muck and corresponding loss of vegetative cover) that there is little ability to assess what plant community may have occupied this site prior to the introduction of livestock. Exclosing this site would be a necessary step in allowing its initial recovery. Examination of NAIP imagery overlaid with NWI polys indicates that very little of this fen-like potential habitat exists on the Resource Area outside of the montane, mixed conifer ecosystems associated with Surveyor Mountain.

North over largest of groundwater discharge areas in *Eleocharis quinqueflora* community above dam (background), Schipps Valley.

4. Revised OR-WA BLM/R6 USFS Sensitive Species List update. An update of this list was issued in draft form in December 2014 for a 2015 revision. The two target mosses detected in this project, *Meesia uliginosa* and *Tomentypnum nitens*, had sensitive species status on the old list, but have no status on the new draft list. It is evident from recent exploration of fens at or east of the Cascade Crest in Oregon that *Tomentypnum nitens* is well represented in the fens of Deschutes and Fremont-Winema NFs. In contrast, *Meesia uliginosa*, currently appears to be rare outside of Malheur NF. Regardless of the recent status changes for these mosses, or perhaps even particularly because of them, the project lead would strongly encourage staff at the Klamath Falls Resource Area to view its fens and fen-like ecosystems as variously rare or uncommon biophysical landscapes features *unto themselves*, and certainly not simply as wet places where one or more rare plants species may occur.

5. Old growth. In the process of surveying NWI mapped PSSB and PSSC in the SE ¼ of section 21 on Surveyor Mountain, the project lead was highly impressed by the quality of mixed conifer old growth structure in this area. The abundance of large diameter trees (*Pseudotsuga menziesii* and *Pinus monticola* with DBH in excess of 60”), large snags and large down woody debris in this area is truly remarkable.

Large *Pinus monticola* in old growth stand, SE ¼ section 21, Surveyor Mtn. White rod is 5 feet long.

6. Follow-up. Actions, at varying levels of priority, that in the opinion of the project lead, would be appropriate based on the information acquired in this project, would include the following.

a) Map and otherwise make note of the newly detected section 27 (n section line) fen. This is a very special biophysical resource on the Klamath Falls Resource Area, and should be protected from forest management actions that could threaten its integrity. Such actions could include timber harvest and other types of fuels reduction activities, fire suppression actions, especially those involving heavy equipment, and any sort of temporary road construction. Exclusion, or allowance of only limited access by cattle, is highly recommended.

b) Actively explore the opportunity to conduct site restoration at the Schnipps Valley fen-like ecosystem.

c) Use transects with laser-leveled, schedule 40, 1" PVC wells to determine the sources, direction of flow and volume of groundwater contributing to the SW Buck Lake basin wetland. Regular monitoring of water table heights along these transects would also allow monitoring over time for possible hydrologic impacts on the wetland due to 21st century global climate change.

References

Bedford, Barbara and Kevin Godwin. 2003. Fens of the United States: Distribution, Characteristics and Scientific Connection versus Legal Isolation. Wetlands 23(3), pp. 608-629.

Hajek, Michal, Michal Horsák, Petra Hajkova and Daniel Dítě. 2006. Habitat diversity of central European fens in relation to environmental gradients and an effort to standardize fen terminology in ecological studies. Perspectives in Plant Ecology, Evolution and Systematics 8 (2006), pp. 97-114.

Appendix A – Site descriptions, Klamath Falls Resource Area 2014 ISSSSP project. Species codes are defined in Appendix C and are from the USDA NRCS Plants Database (http://plants.usda.gov).

Note: Taxon codes in **bold** indicate fen indicator taxa.

1. Fen and fen-like ecosystems

a) SW Buck Lake (fen-including ecosystem)

TRS: T38S, R3W, S23

Elevation: 4940 feet

Date: 6/17-6/18/2014; 7/2/2014; 7/9/2014

Rationale: Included within original Klamath Falls RA proposal; NWI PSSC and PEMCb.

Plants: Graminoids – CALU7, **CAJO**, **CAEC**, **ELQU2**, CACU5, **CALI7**, MUFI2, **CASI2**, **CAUT**, CALE10**, CAAQ**, **JUNE**, DECE, AGROS2, **ERGR8**

Forbs – **PLDI3**, **MIPR**, **SPRO**, POBI6, RAGO, GEMA4, **SAOR2**, **HYAN2**, EQAR, **DODEC**, **PEGR2**, **UTIN2**, **UTMI**, **METR3**, **TRGL5**, **DRAN**, COPA28, DRRO(?), EPILO, SPCA5, ASFO, GESI3, NUPHA

Shrubs – SALIX, ALNUS, RHAL, **VAUL**, **BEGL**, LONIC, **KAMI**

Bryophytes – AUPA70, **METR70**, **TONI70**, **HAVE70**, **MEUL70**, CAPO, PHFO6

Soil probes: A dozen or so soil probes were made throughout this wetland system. Deep (50+") organic soils were detected throughout the wetland, with such soils appearing to be best represented in the eastern half of the wetland. Soils with a notable inorganic component and firm, inorganic bases reached at 32-48" were mostly noted in the western half of the wetland, especially in the upper NW portion of the wetland.

Notes: Wetland accessed directly by short, north-bearing walks from the Keno Access Road. This is an exceptional wetland, largely due to 1) the manifestation of groundwater influence over a very large area, 2) the local variance in strength and persistence of groundwater influence (as is often associated with large, groundwater-fed wetlands) and 3) the large number of fen indicator taxa detected here. The sources/directional flow of groundwater feeding this wetland is not especially obvious. There is clearly an important easterly movement of groundwater along the western edge of the wetland. The strength of this flow appears to lessen as the summer progresses, with free water at the peat surface disappearing. However, the prevalence of short-statured fen vegetation in this portion of the wetland indicates that the water table remains in the graminoid rooting zone throughout the growing season, and high enough that capillarity is able to maintain wetness within the brown moss communities that are abundantly represented here. Much of the eastern half of the wetland appears to be perpetually soppy wet. The source of water responsible for this wetness is not obvious, but it may be a combination of subsurface flow from the source feeding the western half of the wetland, as well as subsurface flow from the south (i.e., flowing north from the slope break at the northern base of Surveyor Mountain. It is highly surprising that *Sphagnum* moss was detected nowhere within this wetland, even though evidently highly suitable habitat was extensively present.

Photos: 1826, 1827-1828, 1830-1832, 1834, 1835, 1836, 1837, 1839, 1840, 1841, 1843-1845, 1846, 1847, 1848, 1849, 1850, 1851, 1866, 1867, 1868, 1869.

b) Section 27 (fen)
TRS: T38S, R5E, S27
Elevation: 5340 feet
Date: 6/13//2014; 7/8/2014
Rationale: NWI PEMB.
Plants: Graminoids – **CAEC**, **CAJO**, CACU5, **ELQU2**, CADI6, SCMI2, CALU7, LUCA2, **CAAQ**, **JUEN**, AGROS2, MUFI2, **JUNE**, JUOR
Forbs – **SAOR2**, **PEGR2**, **DODEC**, POBI6, **HYAN2**, VERAT, **TRGL5**, **MIPR**, **PLDI3**, **DRAN**, EQHY, SYFOF, DELPH, MIGU, SPCA5, RAGO, EPILO
Shrubs – SPDO, **VAUL**, ALNUS
Bryophytes – PHFO6, AUPA70, **DRAD2**, **METR70**, RIPA6, **MEUL70**, BRPS70
Soil probes: Multiple probes within soils persistently wetted by groundwater indicated consistent presence of organic soil with notable component fine-grained inorganic material. Thickness of this organic soil layer ranges from 12-32".
Notes: The western half of the survey area ("Section 27 (n sect line) srv") is mapped as NWI PEMB and is occupied by a riparian alder community, where wet soils are largely restricted to the immediate edge of the creek. The upper, eastern half of the survey area is also mapped as NWI PEMB and is occupied by a mosaic of herbaceous and woody fen with soils throughout persistently wetted by groundwater ("Section 27 fen"). The slope within this fen ranges from gentle in its western portion, to notably steep in its far eastern portion. Micro-topography within the fen is highly varied due to its inclusion of local depressions, shrub/sapling hummocks, and logs in various stages of decay. This complexity of micro-topography likely underlies the relatively large number of fen indicator taxa detected within this fen. This fen's population of the moss *Meesia uliginosa* (rare outside of Malheur NF) is likely the largest documented anywhere in Oregon or Washington. Lots of large ungulate hoof pits in peat throughout the fen, but cow manure noticed only in lower portion of fen.
Photos: 1776, 1777-1778, 1779, 1782-1783, 1784, 1785-1786, 1786, 1789-1790, 1791, 1792, 1793, 1794-1795, 1796-1797, 1798-1800, 1801, 1802, 1804, 1805, 1811, 1812, 1813, 1814, 1815-1816, 1817, 1818, 1819-1820, 1821, 1889, 1890, 1891.

c) Section 13 main (fen-like ecosystem)
TRS: T39S, R5E, S13
Elevation: 5330 feet
Date: 7/1/2014; 7/8/2014
Rationale: Included within original Klamath Falls RA proposal; NWI PFOC.
Plants: Graminoids – **CAAQ**, CALU7, LUCA2, **CAEC**, **CAJO**, SCMI2, CAAP3, AGROS2, **ELQU2**, PHAL2, CADI6, **JUEN**, JUBA, JUOR
Forbs - **SAOR2**, **PEGR2**, POBI6, SETR, **PLDI3**, SISYR, **HYAN2**, SPCA5, **MIPR**, **TRGL5**, RAGO, CASTI, DELPH, VALER, GALIU, FRVI, EPILO, VERAT, SYFOF
Shrubs – **VAUL**, SPDO, SALIX
Bryophytes – MAPO16, PHFO6, AUPA70, BRPS70, RHIZO2, **PLEL2**, **DRAD2**
Soil probes: Greatest detected thickness of organic soil layer = 43" in NW portion of wetland, where soil still soppy wet due to groundwater discharge in early July.

Notes: While soppy-wet, groundwater-wetted soils were commonly observed within this wetland in early July, no wetter than damp soils were observed during a site revisit in early October. These observations suggest that this site is best regarded as a seasonally wet, groundwater dependent ecosystem (not technically a fen), albeit one with groundwater discharge wetting soil at or very near the soil surface for much of the growing season. Evidence of a protracted annual period of groundwater-caused soil saturation at this site is not by direct observation (no visits were made in August-September), but by the unexpectedly large number of fen indicator taxa, for a site without persistently groundwater saturated soils, detected here (n = 14). Groundwater discharge appears to be most protracted in the NW portion of this site where it is most evident at, and near, the south-aspect slope break at the interface between forested upslope and lower gradient, lightly wooded meadow. The protracted wetness of soils at this site has allowed them to be intensively damaged – especially in the NW portion of the site - by the hooves of cattle. Hoof pits here are so densely placed that walking involves much lurching in an attempt to maintain balance. The down-channel remainder of this riparian corridor included within Section 13 was not explored; no NWI wetland polys were mapped along this reach, and NAIP imagery indicated the presence of unpromising habitat.
Photos: 1862, 1863, 1864, 1865, 1887.

d) Section 3/34 (fen-like ecosystem)
TRS: T39S, R5E, S3/34
Elevation: 5730 feet
Date: 6/19/2014; 7/9/2014
Rationale: NWI PEMB.
Plants: Graminoids – CACU5, CALU7, JUNCU, **CAJO**, **CAEC**, **ELQU2**, LUCA2, MUFI, JUBA, AGROS2, PHLEU, **JUEN**, SCMI2, JUOR, **CAAQ**
Forbs – **DODEC, PEGR2**, **SAOR2**, RAGO, **HYAN2**, SETR, POBI6, LUPIN**, PLDI3**, SISYR, **TRGL5**, MIGU, **DRRO**, SPCA5, VALER, HYFO7, CASTI, SIDAL, DELPH, SYFOF, EQHY, BOTRY
Bryophytes – **DRAD2**, CHPO14, MAPO16, PHFO6
Soil probes: Deepest, organic-rich soil detected = 24”; generally, organically-rich layer not thicker than 12”, over a base of sand, gravel and rock.
Notes: This site, which is included within the “Section 3/34/35” survey area, is comprised of three sub-sites. The largest, most species-rich sub-site site, located in section 3, is composed of a series of smallish, irregularly shaped, interconnected meadows positioned in a rather linear fashion on a mostly steep, west-aspect slope. A second sub-site is situated about 200 m north of here, still in section 3, and the third sub-site is about 100 m north of the second sub-site, in section 34. Each of these sub-sites is classified as NWI PEMB, and each occurs on relatively steep, west aspect slopes. The seasonal nature of groundwater-wetted soils within these site is not based on a late season visit, but rather, on a evident reduction in general soil wetness between the two visit dates, and upon the moderate number of fen indicator taxa detected (n = 13, 8 and 11 respectively). Particularly when these three sub-sotes are considered collectively, they constitute a very notable biophysical feature within the Surveyor Mountain project area. Elsewhere within the survey area, the ENE/WSW-oriented, broad riparian corridor in S ½ of Section 35, and the lower portion of the survey area in section 3, have weak or no groundwater influence; this is inconsistent with the mapping of these areas as NWI PEMB.

Photos: 1852, 1853.

e) Section 21
TRS: T38S, R5E, S21
Elevation: 5150 feet
Date: 6/12/2014
Rationale: NWI PSSC.
Plants: Graminoids – **CAAQ**, **CAEC**, **CAJO**, LUCA2, CACU5, **ELQU2**
Forbs – **HYAN2**, **PEGR2**, **PLDI3**, RAGO, **SAOR2**, VALER, POBI6, SETR, **DODEC**
Bryophytes – AUPA70, BRPS70, **DRAD2**, PHFO6, **PLEL2**, **METR70**
Soil probes: All probes detected inorganic soils with thickness of 12-35".
Notes: Three small (≤ 100 m sq) fen-like ecosystems ("Section 21") were detected within the NW portion of the "Section 21 srv" survey area. Each of these three sites, along with much of the rest of the survey area, is included within mapped NWI PSSC polys. Each of these sites had some combination of eight of the 12 fen indicator taxa listed above. Two small NWI mapped PSSB features within the survey area were found to be small spring-fed alder communities on inorganic soil; no fen indicator taxa detected. A total of three fen indicator taxa were detected within the survey area, outside of the three small fen-like ecosystems. Hiking within the E ½ of Section 21 afforded the opportunity to document the presence here of an old growth mixed conifer community of remarkable quality, with an abundance of large old trees (an individual PSME with a DBH in excess of five feet, and very large PIMO were observed), as well as large snags and large down woody debris was noted here.
Photos: 1769, 1770, 1771, 1772, 1773.

f) Cherry Glade
TRS: T39S, S5E, S1
Elevation: 6140 feet
Date: 6/20/2014
Rationale: included in initial Klamath Falls RA proposal; no NWI wetland status.
Plants: Graminoids – **CAEC**, CALU7, **ELQU2**, JUBA, LUCA2, PHAL2
Forbs **– DODEC**, **HYAN2**, **MIPR**, **PLDI3**, POBI6, RAGO, SETR, **TRGL5**, VERAT
Shrubs – **VAUL**, RIBES, RHAL
Bryophytes – AUPA70, BRPS70, PHFO6, BRWE70
Soil probes: Within primary groundwater wetted community, a 1-2" thick organically rich layer over sand and gravel.
Notes: The primary groundwater wetted community ("Cherry Glade") within this system of interconnected meadows is located at the far southern end of the survey area ("Cherry Glade srv"). It is this community that is reflected in the plant list above. It was evident at the time of visit that most of the meadow area within this meadow system will have dry soil surfaces by August, if not sooner. Soil damage due to hoof pits of cattle exceeds 10% in much of this community.
Photos: 1855-1856, 1858, 1859, 1860.

g) Fourmile wetland (including fen-like ecosystems as well as marsh-like ecosystems)
TRS: T34S, R6E, S1/12/13
Elevation: 4160 feet
Date: 6/11/2014
Rationale: Included in original Klamath Falls RA proposal; complex mosaic of NWI wetland categories, but primarily PSSC and PEMC.
Plants: Graminoids – **CAAQ**, **CAUT**, **CASI2**, JUBA, **ELQU2**, CAVE6, MUFI2
Forbs – UTMA, **MIPR**, VIOLA, VERON, **SAOR2**, EPILO, POBI6, NUPHA, TYPHA, **UTMI**, LEMNA
Shrubs – SPDO, SALIX
Bryophytes – AUPA70, BRPS70, AMBLY4
Soil probes: Probes in soppy-wet sites consistently detected pure organic soil to a depth of 50+".
Notes: Soft, peaty soil beneath standing, or slowly moving water restricted inspection to the NW 20% of the site. Within this portion of the wetland, the biophysical character ranged from dry-soiled, grass-dominated ecosystems to CAUT-dominated, inundated, marsh-like ecosystem. The hydrologic character of this wetland is too complex for the project lead to comfortably interpret. Hence, while there is much wetness here in early June, the source(s) of water (i.e. groundwater, surface water, high water table associated with proximity to North Klamath Lake), and persistence of wetness, were not at all obvious at the time of visit. The paucity of detected fen indicator species suggests that groundwater is a lesser component of the wetland's hydrology. This assessment is further supported by the extent of inundation observed at the time of visit (the project lead has observed that sites that are primarily groundwater-fed appear to be rarely inundated). It is also possible that the paucity of detected fen indicator taxa may be linked to agriculturally-related nutrient enrichment of wetland waters and/or seasonal drying of the wetland.
Photos: 1767, 1768.

h) Section 13 far NE
TRS: T39, R5E, S13
Elevation: 5420 feet
Date: 7/1/2014
Rationale: NWI PSSC.
Plants: Graminoids – SCMI2, PHLEU, JUBA, LUCA2, CALU7, **CAEC**, **CAJO**
Forbs – **PLDI3**, GEMA4, SETR, SISYR, SPCA5, **HYAN2**, **SAOR2**, **MIPR**, POBI6, **PEGR2**, SYFOF
Bryophytes – PHFO6, AUPA70, MAPO16
Soil probes: None taken.
Notes: Site includes an apparent groundwater-fed creeklet that crosses under road via culvert. Shortly up creeklet, its channel broadens substantially, with areas of wet soil no longer restricted to immediate edges of creeklet, and local landscape assuming character of patchy meadow. Much cow manure and soil pitting due to hooves of cattle.
Photos: 1861.

i) Section 7.
TRS: T39S, R6E, S7

Elevation: 5540 feet
Date: 7/1/2014
Rationale: NWI PEMB.
Plants: Graminoids – PHLEU, LUCA2, CALU7, **CAJO**
Forbs – POBI6, **PLDI3**, **SPRO**, **DODEC**, RAGO, SYFOF, **SAOR2**, **PEGR2**, **MIPR**
Shrubs – SPDO
Bryophytes – AUPA70
Soil probes: None attempted.
Notes: This is a linear, short (+/- 25 m) area of seasonally groundwater-supported vegetation within a long reach of a dry, weakly channeled riparian corridor (survey area = "Section 7 srv"). Soil within this small, groundwater dependent ecosystem was already mostly dry at the time of visit. Intensive presence of soil pits and pedestals due to impacts of cattle hooves; much cow manure present.
Photos: None taken.

j) Schnipps Valley (fen-like ecosystem)
TRS: T39S, R14E, S25
Elevation: 4860 feet
Date: 7/7/2014
Rationale: NWI PEMB.
Plants: Graminoids – JUBA, **ELQU2, CASI2**
Forbs – **MIPR**, SISYR
Bryophytes – DREPA3, BRPS70
Soil probes: At primary groundwater discharge area S of dam, apparent pure organic soil to 48+". Probe stopped due extreme drag on rod due to stickiness of soil.
Notes: Primary groundwater discharge areas are shortly S of dam ("Schnipps Valley"), and shortly E of dam within the larger survey area ("Schipps Valley srv"). No fen indicator taxa detected at area E of dam (Cyperaceae species were present, but only as low stubble, and not identifiable). *Intense* soil damage due to hooves of cattle is prevalent in areas of groundwater discharge, especially in the discharge area S of dam, where large patches of de-vegetated, churned muck often mark specific discharge sites. Cow manure is ubiquitous. The presence and depth of organic soil, and the presence of ELQU2 and CASI2 at the discharge area S of the dam suggest that this area may have either persistent, or very protracted seasonal, groundwater discharge. Now obscured by intensive use by cattle, it is likely that this small portion of the Schnipps Valley has an underlying robust biophysical character that existed over many centuries before cattle were introduced to North America. The project lead suggests that this site be considered as a geographically compact, low cost, high priority habitat restoration project for the Klamath Falls Resource Area.
Photos: 1881, 1882, 1883, 1884, 1885.

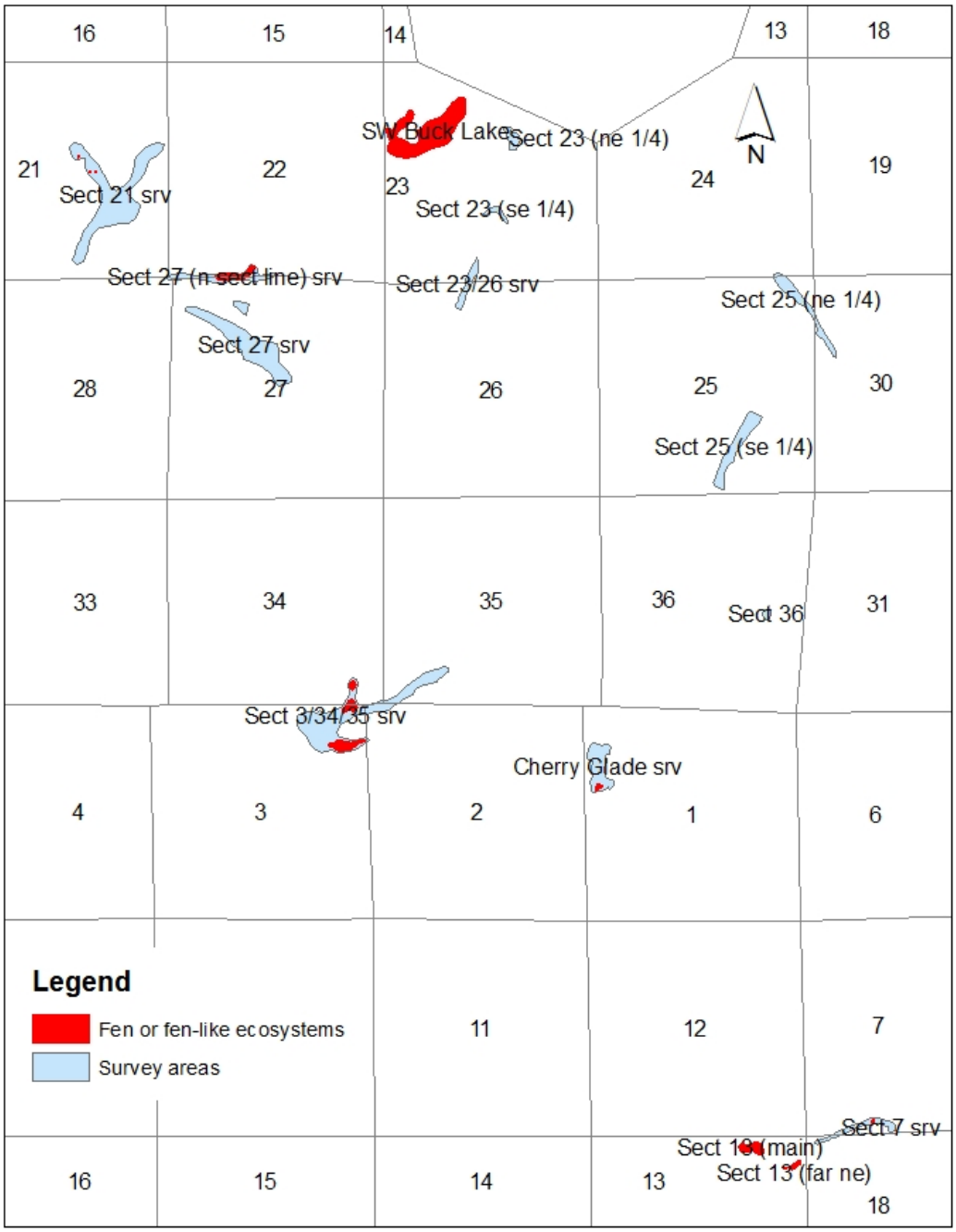
6. Sites essentially lacking fen or fen-like ecosystem character.

Site	Rationale	Notes
Section 27 srv	NWI PSSB/PFOB classification	Survey area *excludes* the "Section 27 (n sect line) srv" described above. Largely a collection of seasonally spring-fed small drainages supporting ALNUS, RHAL and SPDO, SCMI and VERAT; only fen indicator taxa detected were at far upper SE end of system near the junction of the 38-5E-28.1 and 38-5E-24 roads; in the SE corner of this survey area, PLDI3, CAEC, CAJO, MIPR and HYAN2 were found on two very small patches of moist soil intensely pitted by hooves of cattle.
Section 23 (SE ¼)	NWI PSSB classification	A stand of thick, tall ALNUS supported be seasonal spring flow; no fen indicator taxa detected.
Section 23 (NE ¼)	NWI PSSC classification	A very soppy-wet, largely ALNUS-dominated community with low-volume surface water output; sedge-dominated community immediately N of ALNUS is wet apparently due to mix of groundwater and surface outflow from ALNUS community; only fen indicator taxon detected was possible CAUT.
Section line 23/26	NWI PSSB classification	A seasonal, steep-sloped seasonal water course with primarily a VERAT-PTAQ community below 38-5E-24.0 road and an ALNUS community above road; no fen indicator taxa detected.
Section 25 (NE ¼)	Included within a riparian area included in original Klamath Falls RA proposal	This is a NW/SE-oriented riparian corridor that appears to be seasonally wet, but with occasional seepy channel edges along its route. Damming effect of Keno Access Road may account for more extensive soil wetness on private land at

		intersection of riparian corridor and the K.A. Road. Corridor dominated by ALNUS with intermixing of RHAL, RIBES, SALIX. Only fen indicator taxon detected = PLDI3.
Section 25 (SE ¼)	Included in original Klamath Falls RA proposal; NWI PSSB and PFOB classification.	This is basically a seasonally wet, ALNUS-dominated riparian corridor within which no fen indicator taxa were detected. Notably, shortly SE of the PFOB poly, the fen indicator taxa CASI2 and TRGL5 were found in a small, soppy-soiled community where groundwater is discharging where the upslope edge of a bulldozed landing has intercepted a shallow groundwater aquifer.
Section 36	Included in original Klamath Falls RA proposal; NWI PFOB.	This is a dry meadow dominated by PTAQ; even seasonal groundwater discharge areas were not noted within or bordering this site.
Horsetail Springs	Included in original Klamath Falls RA proposal.	Two low volume active spring channels flowing eastward down steep, rocky slopes toward Klamath River. Few damp/wet substrate options for bryophytes other than rock. Adjacent plant community with white oak, mountain mahogany, deerbrush, incense cedar, ponderosa pine and juniper. No opportunity for development of fens or fen-like ecosystems in this biophysical setting.
Eastern edge of federal land within otherwise privately held S ½ of Section 12, Surveyor Mtn.	Included in original Klamath Falls RA proposal.	Not visited because no NWI polys mapped here and because NAIP imagery indicates zero likelihood of groundwater-fed plant communities here.
NE/SW-oriented riparian corridor in S ½ Section 13, Surveyor Mtn.	Included in original Klamath Falls RA proposal.	Not visited because no NWI polys mapped here and because NAIP imagery indicates low likelihood of groundwater-fed plant communities here.

Appendix B – Where the extent of a survey area and included fen/fen-like ecosystem is the same, fen/fen-like ecosystem is shown on map.

Surveyor Mt. - survey areas (labeled), fens and fen-like ecosystems



Appendix C – Plant taxa noted at project field sites. Fen indicator taxa denoted by yellow highlighting.

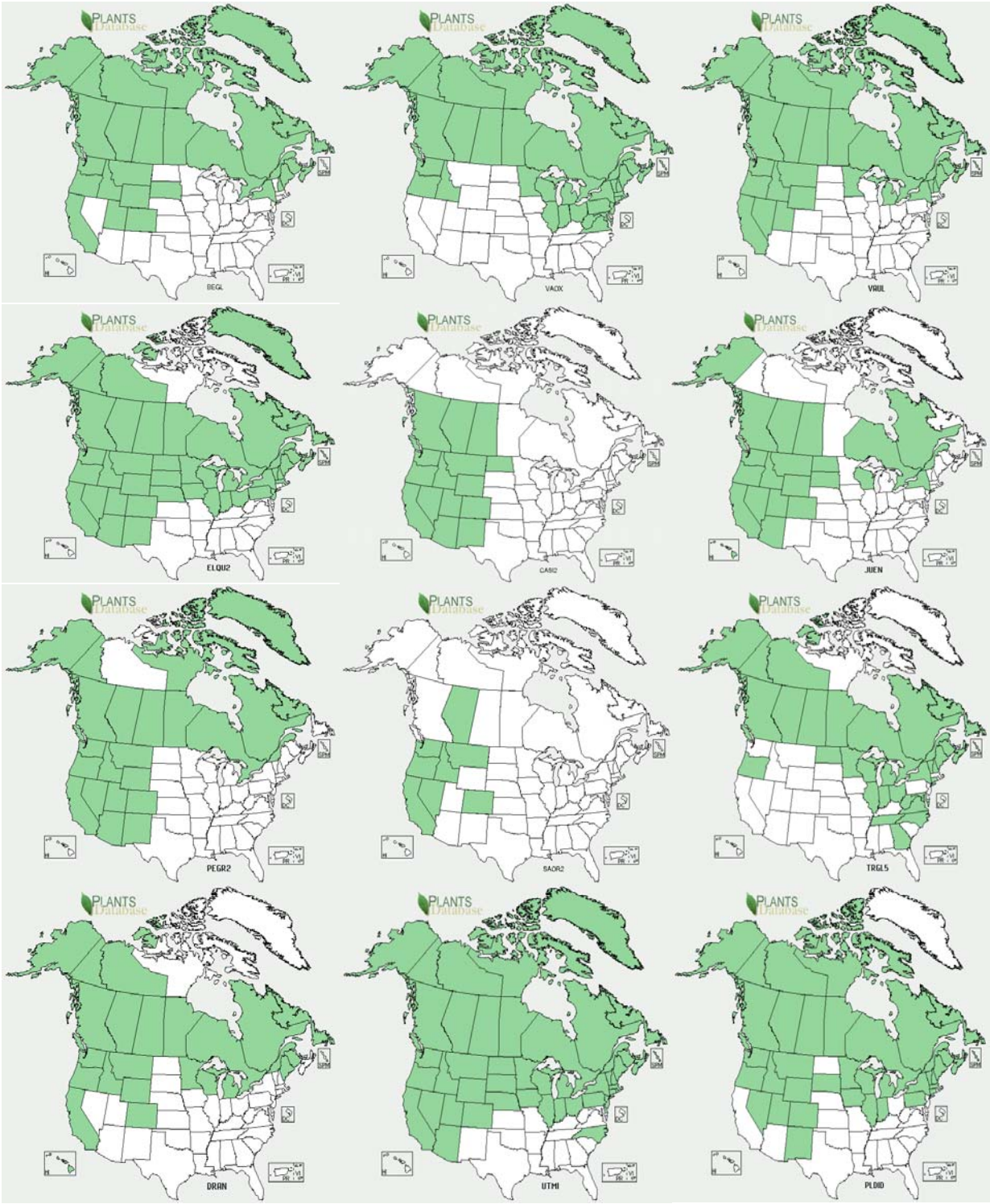
	Code	Scientific name
Graminoids		
	AGROS2	Agrostis
	CAAP3	Carex aperta
	CAAQ	Carex aquatilis
	CACU5	Carex cusickii
	CADI6	Carex disperma
	CAEC	Carex echinata
	CAJO	Carex jonesii
	CALE10	Carex leptalea
	CALI7	Carex limosa
	CALU7	Carex luzulina
	CASI2	Carex simulata
	CAUT	Carex utriculata
	CAVE6	Carex vesicaria
	DECE	Deschampsia cespitosa
	ELQU2	Eleocharis quinqueflora
	ERGR8	Eriophorum gracile
	JUBA	Juncus balticus
	JUEN	Juncus ensifloius
	JUNCU	Juncus
	JUNE	Juncus nevadensis
	JUOR	Juncus orthophyllus
	LUCA2	Luzula campestris
	MUFI2	Muhlenbergia filiformis
	PHAL2	Phleum alpinum
	PHLEU	Phleum
	SCMI2	Scirpus microcarpus
Forbs		
	BOTRY	Botrychium
	CASTI	Castilleja
	COPA28	Comarum palustre
	DELPH	Delphinium
	DODEC	Dodecatheon
	DRAN	Drosera anglica
	DRRO	Drosera rotundifolia
	EPILO	Epilobium
	EQAR	Equisetum arvense
	EQHY	Equisetum hyemale
	FRVI	Fragaria virginiana

GALIU	Galium
GEMA4	Geum macrophyllum
GESI3	Gentianopsis simplex
HYAN2	Hypericum anagalloides
HYFO7	Hypericum formosum
LEMNA	Lemna
LUPIN	Lupinus
METR3	Menyanthes trifolium
MIGU	Mimulus guttata
MIPR	Mimulus primuloides
NUPHA	Nuphar
PEGR2	Pedicularis groenlandica
PLDI3	Platanthera dilitata
POBI6	Polygonum bistortoides
RAGO	Ranunculus gormanii
SAOR2	Saxifraga oregana
SETR	Senecio triangularis
SIDAL	Sidalcea
SISYR	Sisyrinchium
SPCA5	Sphenosciadium capitellatum
SPRO	Spiranthes romanzoffiana
SYFOF	Symphyotrichum foliaceum var. foliaceum
TRGL5	Triantha glutinosa
TYPHA	Typha
UTIN2	Utricularia intermedia
UTMA	Utricularia macrorhiza
UTMI	Utricularia minor
VALER	Valeriana
VERAT	Veratrum
VERON	Veronica
VIOLA	Viola

Shrubs

ALNUS	Alnus
BEGL	Betula glandulosa
KAMI	Kalmia microphylla
LONIC	Lonicera
RHAL	Rhamnus alnifolia
RIBES	Ribes
SALIX	Salix
SPDO	Spiraea douglasii
VAUL	Vaccinium uliginosum

Bryophytes

AMBLY4	Amblystegium
AUPA70	Aulacomnium palustre
BRPS70	Bryum pseudotriquetrum
BRWE70	Bryum weigelii
CAPO17	Campylium polygamum
CHPO14	Chilocyphus polyanthos
DRAD2	Drepanocladus aduncus
HAVE70	Hamatocaulis vernicosus
MAPO16	Marchantia polymorpha
METR70	Meesia triquetra
MEUL70	Meesia uliginosa
PHFO6	Philonotis fontana
PLEL2	Plagiomnium ellipticum
RHIZO2	Rhizomnium
RIPA6	Riccardia palmata
TONI70	Tomentypnum nitens

Appendix D – Biogeography of selected fen indicator taxa (FIT).). Species from left to right, by row: Row 1 = BEGL, VAOX, VAUL; Row 2 = ELQU2, CASI2, JUEN; Row 3 = PEGR2, SAOR2, TRGL5; Row 4 = DRAN, UTMI, PLDID. Maps are from NRCS Plants Database. See Appendix D for species codes.