Vegetation Assessment and Ranking of Fen and Wet Meadow Sites of the Shasta-Trinity National Forest, California

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INTRODUCTION

The Vegetation Program of the California Native Plant Society (CNPS) has worked collaboratively with the USDA Forest Service (USFS) to assess the vegetation/habitat features and provide Conservation Significance rankings of several fens and wet meadows in the Shasta-Trinity National Forest (NF). We collected data in fens and wet meadows in three separate regions of the NF in 2009 (Sikes et al. 2010b), and we recently collected additional data in the diverse region surrounding Mt. Eddy, in the eastern Klamath Mountains, within three watersheds in 2011.

One of the goals of the project was to characterize and rank the ecological integrity and quality of fens and wet meadows within the Shasta-Trinity NF. We did this using an expanded fen survey protocol and a recently developed peatland ranking system (Sikes et al. 2011). Additional project goals were to classify the sampled vegetation stands and to create GIS maps of the surveyed sites.

This project combined data from 2009 (30 vegetation samples from 10 distinct meadow openings) with additional data from 2011 (50 vegetation samples from 18 distinct meadow openings), to produce the rankings for a total of 28 distinct meadow openings. All surveys were conducted by CNPS staff with technical guidance from USFS staff. A field-based classification has been produced for the data, using the National Vegetation Classification System's hierarchy of alliances and associations. These are floristically and environmentally defined plant communities, such as those described in the CNPS publication of *A Manual of California Vegetation* (Sawyer et al. 2009). In this report, 25 vegetation types are mapped for the 2011 sites surrounding Mt. Eddy, with full vegetation and environmental data taken in 25 different types. The Sikes et al. (2010b) report provides a summary of vegetation types and maps from three regions in Shasta-Trinity NF.

BACKGROUND

Fens are among the most sensitive habitat types identified in ecological assessments of the Sierra Nevada (Sierra Nevada Ecosystem Project 1996, US Forest Service's Sierra Nevada Forest Plan Amendment 2004 (SNFPA)), and in State Natural Community Inventories of California (CNDDB 2009). The 2001 version of the SNFPA, supplemented in 2004, brought fens to the attention of Region 5 National Forests by requiring that inventories for "fens and bogs" be completed as part of botany project analysis and that fens be maintained, restored, preserved, and/or enhanced. Fens were determined to be particularly important for their biological diversity and as habitat for species of *Sphagnum*, *Meesia*, and other bryophytes. Though Shasta-Trinity NF is not covered by the SNFPA, it has benefited from increased attention to fen inventory throughout Region 5.

California fens are rare natural communities because of their ecological characteristics (CNDDB 2009, Sawyer et al. 2009), and recent detailed surveys indicate that each fen/meadow complex may contain few to many vegetation types, which are not necessarily rare. Beyond using factors such as soils, geomorphology, and hydrology, fens can be classified by their vegetation type, rarity, and diversity. By identifying vegetation assemblages of fens, we are able to better understand the plant species as well as environmental factors that define this rare wetland habitat.

Little is known about the vegetation in fens of the Klamath Mountains and northern Coast Ranges in northwestern California. This region includes the Klamath, Mendocino, Six Rivers, and Shasta-Trinity National Forests. Based upon what is generally known about these systems, it is likely that unique fen types exist in these Forests, including those areas that have developed peat accumulations through atypical plant materials such as liliaceous plants (*sensu lato,* e.g., *Narthecium, Triantha)*, orchids (e.g., *Platanthera)*, and carnivorous plants (e.g., *Darlingtonia californica)*.

Fens are peat-forming wetlands, supported by nearly constant groundwater inflow (Bedford and Godwin 2003). Their permanent saturation creates oxygen-deprived soils with very low rates of decomposition, allowing the accumulation of organic matter produced by wetland plants. Fens form and are maintained only in a hydrologic regime that creates perennial soil saturation on the time scale of millennia. For an ecosystem to be classified as peatland, the thickness of organic soil must equal or exceed 40 cm (Soil Survey Staff 1994, 1999). The deep organic layer in fens means that plants root in the peat and derive all, or almost all, of their water and nutrients from the peat body rather than the underlying mineral layer.

Fen peat bodies accumulate very slowly and persist for thousands of years (Wood 1975). Fens also are hotspots of biological diversity (Sikes et al. 2010a). In California, fens have formed in many mountainous and north-coastal areas and vary in botanical, ecological, geochemical, and hydrologic characteristics. The perennial supply of water provides refugia for plant and animal species that persist only in fens. Many of these species have the main ranges of their distribution far to the north in Alaska and Canada (Chadde et al. 1998), with their southernmost range in California or Rocky Mountain fens. The presence of water in fens makes them an important component of surrounding forest ecosystems, providing moisture and forage for animals, including livestock, in drought situations (Cooper and Wolf 2006a).

Fens often occur in meadow complexes consisting of areas of wet meadow (usually saturated for 1-2 months; Benedict 1983) intermixed with fens that develop in areas of the meadow that remain saturated for most of the year. A meadow complex may also contain areas of dry meadow, which are wet for only a few weeks during snowmelt (Benedict 1983, Cooper and Wolf 2006a). Most meadows and fens are dominated by herbaceous plants, though they may also have high cover of woody vegetation and/or mosses. Most fens in California are less than a hectare in size (Sawyer et al. 2009).

A main criterion for fen determinations in the United States is the presence of Histisols, where half or more of the top 80 cm of soil are organic rather than mineral (Soil Survey Staff 1999). Wet meadows may have apparent accumulations of peat as well, at any amount less than 40 cm. Therefore, most vegetation types that are seen in fens may also be found in wet meadows, and a clear distinction between the two designations is not always possible.

Another primary criterion for fen determination is soil saturation for most of the year. As a measure for this characteristic, surveyors try to determine whether the water table is within 20 cm of the soil surface during July and August of a normal precipitation year. This is based on studies of fens in the Southern Rocky Mountains (Cooper 1990, Chimner and Cooper 2003) and in Sweden (Silvola et al. 1996), where soil saturation or water tables within 20 cm of the soil surface through July and August accumulated peat (Weixelman and Cooper 2009).

Fens are threatened by any condition or activity that disturbs the hydrologic regime or soil temperature of a fen, causing drying or warming.. The semi-arid landscape of California makes these systems especially vulnerable to regional climatic warming and drying. The SNFPA (2004) identified five major threats to the Bog and Fen Guild: hydrologic alteration, mechanical treatments, stock trampling, roads, and off-road vehicles. Impacts reported from recent inventory surveys, including road and trail construction, ground and surface water pumping, and grazing activities that increase bare peat or cause development of headcuts, have the potential to disturb the hydrologic regime. Other activities that could threaten or destroy a fen include removal of significant amounts of peat, deposition of mineral soil or debris on to the surface of the fen, or changes in the nutrient composition of the groundwater.

METHODS

Study Area

The study area is in Shasta-Trinity National Forest (NF), the largest NF in California (Figure 1). Shasta-Trinity NF is managed by the United States Forest Service for long-term sustainability of natural resources and forest ecosystems. Forest Service lands provide clean water, motorized and non-motorized recreational opportunities, wildlife habitat, timber, minerals, energy, and commercial livestock grazing (USFS 2010).

Surveys in 2011 were conducted in the Mount Eddy Region, along the boundary of Siskiyou and Trinity Counties in the Mount Shasta Ranger District (Figure 1). The 2011 survey sites, as well as the 2009 West Branch Crow Creek survey site, are all within the geologic feature known as the Trinity Ultramafic Sheet (Miles and Goudey 1997). The survey sites were selected by Julie Nelson, Forest Botanist, and Philip Brownsey, Range Program Manager, in collaboration with CNPS vegetation ecology staff, Julie Evens and Kendra Sikes. The majority of the Mount Eddy Region, notable for its ultramafic geology, is mapped as "Ultramafic rocks, mostly serpentine" (Jennings 2010). The second most common geology in the Region is mapped as "Gabbro and dark dioritic rocks." Surveys in 2009 were conducted by CNPS in three separate areas displayed in Figure 1, including 11 plot samples in the Mt. Eddy region.

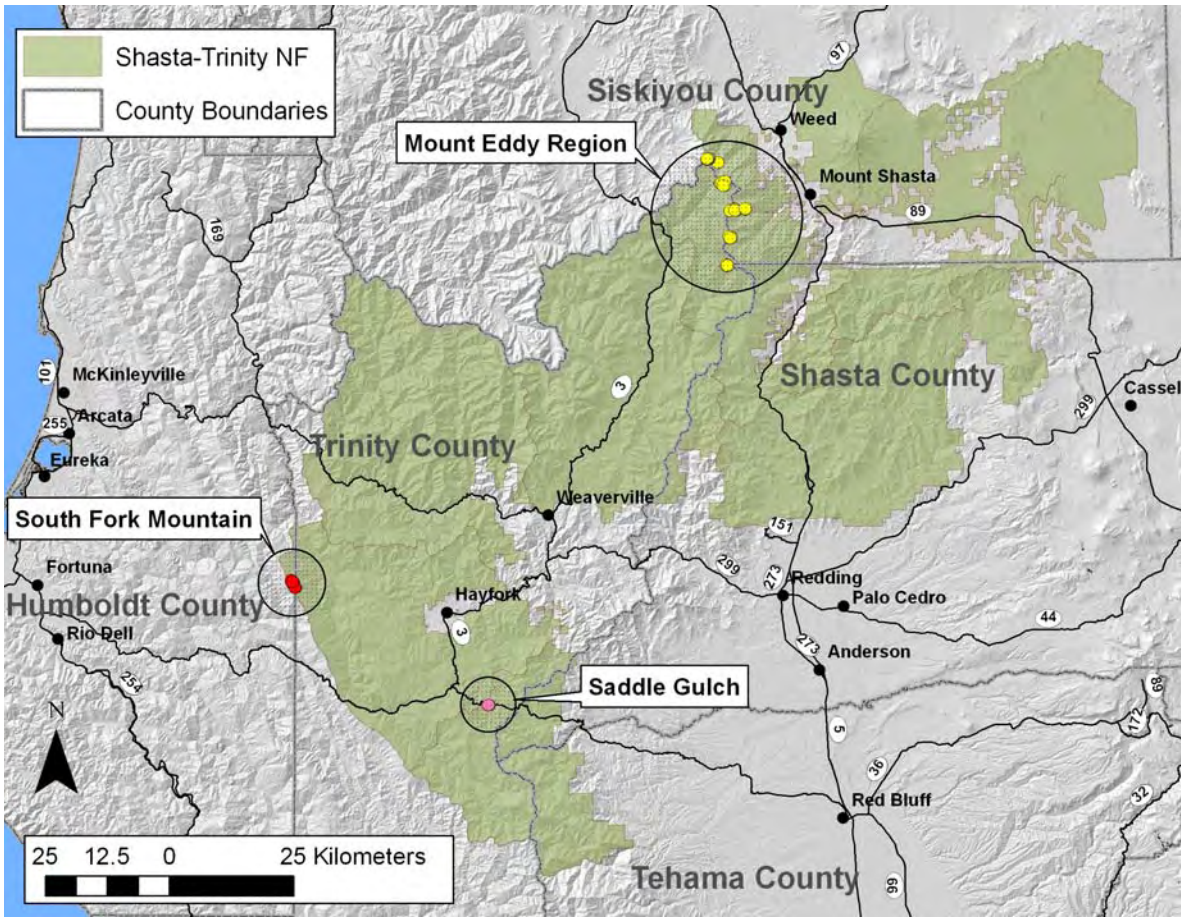


Figure 1. Overview of Shasta Trinity National Forest with locations of CNPS fen and wet meadow surveys from 2009 and 2011.

Range allotment status varies by location, and indicates whether a grazing permit has been issued (USFS 2008a). Of the five allotments that fen meadows occurred within on the Shasta-Trinity, two are active, with only one in the Mount Eddy Region. The other active allotment is Wildwood, where Saddle Gulch Fen is located, which has an active permit for 20 horses and mules (P. Brownsey, pers. comm. 2011). Though the South Fork Mountain fens are not within an active allotment, CNPS staff found evidence of cattle grazing occurring there in 2009 (hoof punch and cowpies) due to an active adjacent allotment that is about 350 m from the closest fen and averaging 500 m from the other five fens.

Survey sites in the Mount Eddy Region varied in elevation from 1800 to 2100 m, following the crest of the Eddy's and the county line. West Branch Crow Creek, furthest to the south, was surveyed in 2009 and is located in Upper East Fork Trinity River Watershed (Figure 2). Further north, Fawn Creek Meadow, Middle Fork Sacramento, and Toad Lake are located in the South Fork Sacramento River Watershed (Figure 2), and are accessed from the east using South Fork Road (Forest Route 40N26). Both Fawn Creek Meadow and Toad Lake have been known as sites for the rare plant *Raillardella pringlei,* but they had not been surveyed for the presence of fens.

Continuing north, Deadfall Meadows is within the High Camp Creek - Trinity River Watershed, while Caldwell Lakes Meadows and Tamarack Flat are located in Parks Creek Watershed (Figure 2), which drains to the Shasta River, a tributary of the Klamath River. Both Deadfall Meadows and Tamarack Flat had been visited and surveyed by the Carex Working Group (in 2001 and 2003 respectively), but they had not been tested for fen designation. The Caldwell Lakes Meadows site includes Sundew and Bogbean Meadows, which are located along the trail to Caldwell Lakes. Access to these northernmost meadows is from the north using Interstate 5's Edgewood Exit. Stewart Springs Road becomes Forest Route 42N17 (Parks Creek Road), which passes access roads to Caldwell Lakes and Tamarack Flat. The Deadfall Meadows area is accessed directly from 42N17.

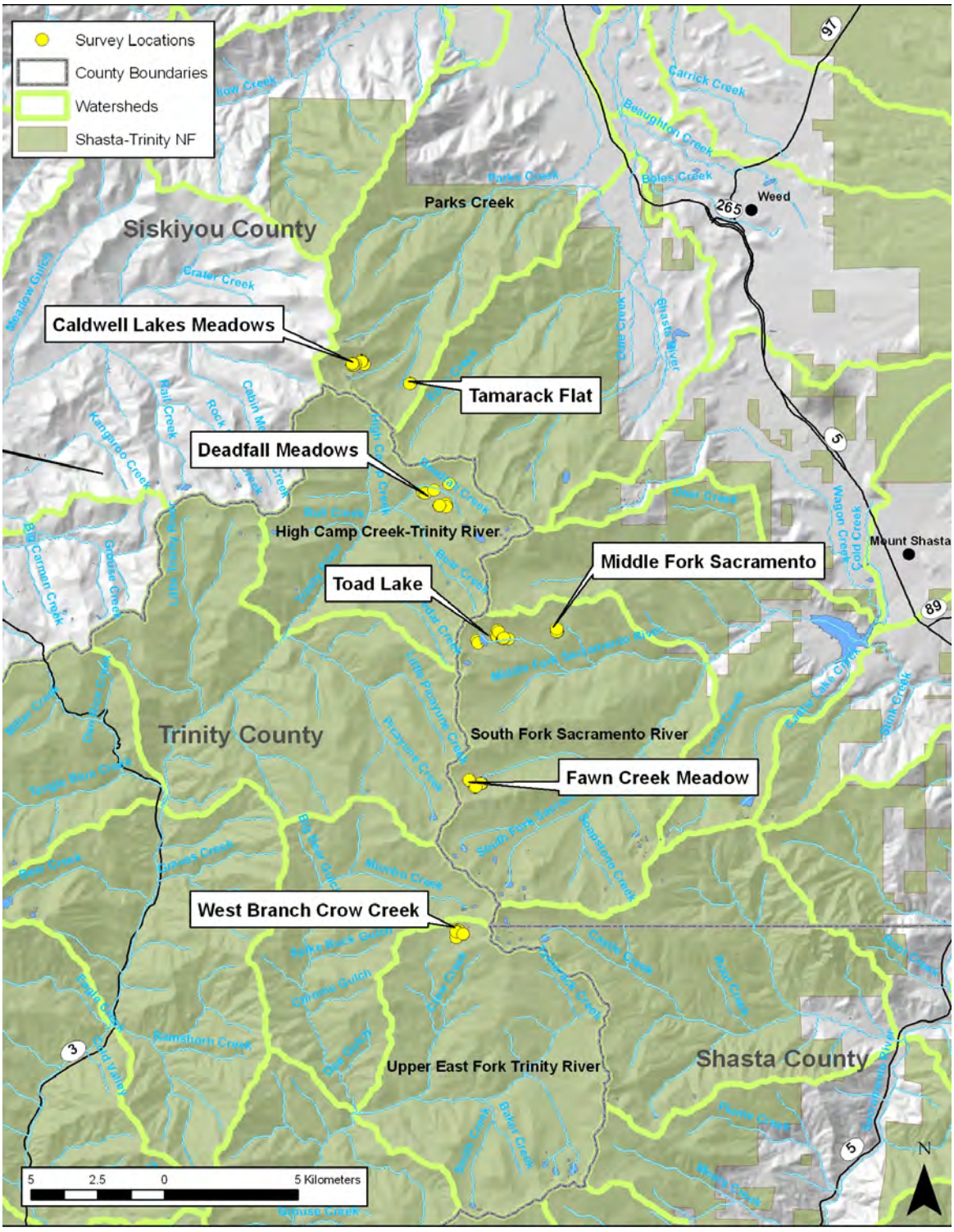


Figure 2. Mount Eddy Region with locations of CNPS surveys from 2009 and 2011 and labeled watersheds.

Field Sampling

During 2011, 50 plot samples were collected in the 18 distinct fen or wet meadow openings that were surveyed. Typically, multiple plot samples were collected at each fen or wet meadow site to capture information on the different stands of vegetation and to define the various plant communities in each opening. Fen meadows were sampled during August to September 2011 when the different vegetation types were phenologically active and plants contained mature fruits. The field crew consisted of CNPS Ecologists Jennifer Buck, Danielle Roach, Deborah Stout, and Kendra Sikes (who acted as primary supervisor for the field effort). Volunteer, Melissa Holly DeSiervo, spent one week assisting in the fieldwork. USFS Environmental Coordinator, Talitha Derksen, assisted for one field day, while other USFS Botany staff, Julie Nelson and Mary Ellen Colberg, assisted crews in plant identification on site. Barbara Wilson of The *Carex* Working Group additionally assisted with identification of collected graminoid specimens, as well as other vascular plants on site, and Martin Lenz provided identification of bryophytes both on site and for specimens collected and provided to Mr. Lenz by field crews.

Sampling was implemented using the standard CNPS Relevé plot-based protocol and the expanded Region 5 fen/wet meadow sampling protocol (updated August 2010). Appendix 1 contains copies of the field forms and protocols. At some plot locations, soil samples were collected from soil pits to confirm organic carbon (OC) content if there appeared to be enough peat development for a fen designation (i.e. >40 cm of peat). Samples from soil pits were analyzed to confirm peat development and fen status; results are displayed in Table 2. To be defined as organic, soil OC must be greater than 18% if the soil is greater than 60% clay, and it must be greater than 12% OC if without clay (Soil Survey Staff 1999). For intermediate amounts of clay, the amount of OC must be greater than 12% plus 0.1 times the percentage of clay in the soil) (Soil Survey Staff 1999). For example, a soil that is 20% clay would be classified as mineral if OC is less than 14%, and as organic if OC is greater than 14%.

Mapping was accomplished using a combination of reconnaissance using a GPS and hard-copy maps in the field, along with heads-up digitizing and photo-interpretation using ArcMap 9.3 in GIS. In the field, we estimated the extent of each fen using a soil probe (identifying boundaries/areas of at least 40 cm of peat depth), drawing the outline on printed aerial imagery, and/or using a GPS to mark the edges. Back in the office, we added the GPS data onto a backdrop of true-color aerial imagery (NAIP 2009) in GIS to allow delineation and attribution of wet meadow and fen polygons based on field sketches, GPS-traced outlines, and the aerial imagery. The fen delineations were based on our best estimate of the extent of the area that meets the criteria for being a fen, with emphasis on peat depth using a soil probe. Each meadow outline, based on soil moisture and vegetation, has been used as a general indicator of the size of the fen and wet meadow complex.

Vegetation Classification

The vegetation classification in this report is based upon the U.S. National Vegetation Classification (USNVC). In California, the classification has been developed by NatureServe in partnership with the State Natural Heritage Program of the Department of Fish and Game (CDFG) and the California Native Plant Society (CNPS). First and second editions of the national classification provide a thorough introduction to the classification, its structure, and the list of vegetation units known in the United States (Grossman et al. 1998, FGDC 2008). Refinements to the classification have occurred during its application, which are best seen using the NatureServe website at http://www.natureserve.org/explorer/.

A preliminary fen vegetation classification has been produced using fen data from across USFS Forest lands in California, including the Southern Cascades and Modoc Plateau (Sikes et al. 2010a). Additional classification analysis was conducted to include the 2009 Shasta-Trinity data (Sikes et al. 2011). Therefore, the vegetation types attributed in the geodatabase for some 2009 surveys have been changed from those provided previously to the NF. The classification of vegetation types for the 2011 surveys has been completed recently through a comparison of the

new data with the most recent classification analyses. Some vegetation types are considered provisional, if they are represented by less than ten (10) plot samples. This report begins to integrate the 2011 data with the existing classification while describing the local variation of Shasta-Trinity fens.

Ranking Criteria and Methods

Each site was ranked according to several criteria to determine its Conservation Significance. We ranked all wet meadow sites surveyed by CNPS in 2009–2011. We have assembled data from 28 separate meadows or openings (including one without any meadow form and one without any plots surveyed). Fens have been confirmed at 17 of these sites (9 of which were confirmed in 2011) and another four were of uncertain status (1 of which was visited in 2011). For 17 of these meadow locations, we collected complete meadow diversity data using our revised meadow data form from the expanded protocol for USFS R5 fen surveys. For the other 11 meadows sampled previously in 2009, an older version of the R5 fen meadow form was used; therefore, we are not able to fully assess their Diversity criteria and their ranking.

Our ranking system is adapted from the system by Chadde et al. (1998) for the Rocky Mountains, which had been based on the work of several other authors working in peatlands. They subjectively assessed each peatland using seven criteria on a 3-point scale. We have attempted to more objectively rate each criterion, by assembling and combining various factors with quantifiable characteristics to determine ratings. Since we were able to quantify a fairly large range of variation for some of the criteria assessed, we have chosen to use a 5-point scale, with resulting scores for each site being the sum of their individual scores in each criterion. We first applied this system to fens of the Lake Tahoe Basin (Sikes et al. 2011), and some adjustments have been made to fit the circumstances of this project.

Another departure we took from the Chadde et al. (1998) system was that we included two types of within-meadow diversity, Physical/Topographic Diversity and Biological Diversity (or Biodiversity). Each criterion scored is explained below. These eight criteria receive equal weight towards the concluding Conservation Significance rating. Lower ranking values represent lower significance based on comparisons across the current data at hand using this quantitative system.

Uniqueness

This criterion provides representation for the range of possible environmental conditions, giving higher ratings to meadows with more unusual characteristics. We chose three aspects of the meadow setting to identify those that occur outside of the main distribution of environmental conditions: elevation, geology, and pH. Chadde et al. (1998) included the criterion Representativeness as a means to insure a wide range of representative types within any protection system for peatlands. Our focus in this criterion is not whether a meadow typifies its category, which is a departure from the Chadde et al. (1998) method, but whether it is out of the ordinary. We wanted to give more attention to fens that fall outside of the average, by highlighting areas that represent the edges of the range of environmental conditions instead of the mean of the range.

Elevations for the surveyed meadows of the Shasta-Trinity NF range from approximately 1180 to 2100 m. The average of these values was 1865 with a standard deviation of 204 m. Those meadows outside of the primary distribution of elevation (i.e., below 1661 m or above 2069 m) were considered of higher value for Uniqueness.

The average pH value for 14 sites was calculated, and meadows that did not have pH measured were assumed not to have unusual pH. Mineral ions are more readily available to plants as pH

increases, because higher pH values are driven by higher ion concentrations. Fens with the lowest pH levels are categorized as poor fens (pH < 5.5; Weixelman and Cooper 2009), meaning they are poor in both species diversity and in mineral ions. If the values fell into the poor fen range, with an average pH less than 5.5, or the rich fen range, with an average pH greater than 6.9, these were considered of higher value for Uniqueness. Average pH ranged from 5.5 to 7.3, with five sites in the rich fen range.

Geology for each site was determined using a 1:750,000 geologic GIS layer (Jennings 2010). The majority (4 out of 6) of the HUC12-level subwatersheds were either ultramafic, gabbro or other volcanics. In addition, most of the meadows fell onto ultramafic or gabbroic mapping units. Though this was the more common condition of the Shasta-Trinity meadows that we visited, in general it is more unusual for fen sites, and therefore adds to the overall uniqueness value. There were other geological types present, however, including those underlying fen sites. The other types mapped were glacial till and moraines (or glacial drift), sedimentary, pyroclastic and volcanic mudflow (including andesite). We considered sites that were on volcanic, ultramafic, or gabbroic substrates to be of higher value for Uniqueness.

In practice, we gave a point for each of the four unique features, and the sum of these ranged from 0 to 3 for any site. Sites with no unique features received a score of 1, while those with one unique feature received a score of 2. Sites with two unique features received a score of 3, while those with three unique features received the highest score of 5. No sites received a score of 4.

Quality

Quality is a term used to categorize the level of disturbance or impact(s), based on Chadde et al. (1998). The highest Quality fens show minimal impact(s) or disturbance. Each fen meadow, whether visited by CNPS or not, was scored for impacts by searching the data for any notations about impacts and fitting that information into the scoring format for disturbances provided in the latest version of the survey protocol (see Appendix 2). The impact was assigned to occur either in the meadow polygon or the buffer zone, and both an intensity level and extent level were chosen. For the sake of consistency, the scoring process was done for meadows visited by others in previous years and reviewed for meadows that we visited this year. Therefore, one person scored all the disturbances while referring to field notes, and some disturbance scores were changed from what they had been rated in the field.

In addition to disturbances or impacts noted by the field surveyors, each fen meadow was checked through GIS analysis for its distance to the closest road. However, if this disturbance had already been noted by the surveyors, additional impacts would not be assigned due to the GIS results. Distance to the closest road was calculated using a GIS tool, but also checked visually with aerial imagery and road layers in GIS. If the polygon was within 100 m of a road, it is an impact, just as it would be when filling out the meadow form. Extent of road and trail disturbances were assigned according to what portion of the meadow fell within 100 m of the road or trail. A mapped Forest Service trail was rated as if it were a constructed road, rather than a trail that develops from trampling, however its disturbance value was cut in half as compared to a constructed road to reflect its lesser impact.

Numerical values for various disturbance impacts were assigned for both extent and intensity, with increasing extent and intensity receiving higher values. Disturbance intensities were classed into four categories based on the Disturbance Factor descriptions included in Appendix 2. Disturbance extent was rated on a 5-point scale as displayed on the second page of the sample data sheet (Appendix 1), with 1 representing a disturbance on <10% of the site, and 5 covering 100% of the site.

For each disturbance, the extent and intensity were multiplied to achieve a single value. If the disturbance was in the buffer, rather than the polygon itself, the resulting value was multiplied by one half. Since each disturbance had one value, the total disturbance for each meadow equals

the sum of their separate disturbance values. Total impacts for each meadow ranged from 0 to 9 and Quality ranks were assigned accordingly, with the lowest impact scores receiving the highest Quality scores. Since the disturbance values were not evenly distributed, the highest quality (six sites) has a disturbance value of 1.5 or less, while the lowest quality (four sites) had disturbance values of 7.5 or higher.

Rarity

Presence of rare plant species and rare vegetation types were both considered to indicate Rarity for the fen meadows. The species considered rare were those with any California Natural Diversity Database (CNDDB 2011) or California Rare Plant Rank (CRPR, CNPS 2012) status. The number of rare plants known from a site varied from none (13 out of 28 sites had no rare species) to three species (at Sundew Fen and Toad Lake Meadow 3). Since Darlingtonia was so common in the region, it is possible that it was not noted in some meadows where it occurred.

As with species, vegetation types are classified as floristic units that range from extremely common to extremely rare. NatureServe's Heritage Program methodology was used for defining the Natural Community Conservation Ranks (NatureServe 2010). The S value indicates the alliance's rarity and threat ranking in the state of California. Alliances with an S1 through an S3 ranking are considered as rare and threatened in California, and they are designated as high inventory priority by the California Department of Fish and Game (DFG 2010). Information on rarity was assembled from multiple sources (see Sikes et al. 2010a, 2011). About half of the vegetation types assigned to plot samples were considered rare (Table 4).

To score Rarity, each rare species recorded at a site received points according to its CRPR (CNPS 2012). The taxa that were ranked 4.2 or 4.3 received one point, plants that were 2.2 or 2.3 received 2 points, and List 1B plants received 3 points. Therefore, meadows received a score for rare species that was the sum of these points. The totals awarded for the rare species portion varied from 1 (for example, if *Darlingtonia* was the only special status species present) to 6 (for Toad Lake 3). For vegetation types, each rare type identified by plot sample at a site received 1 point. To prevent the number of samples taken at each site from having a strong influence on scoring for Rarity, the number of rare types per site was divided by the number of vegetation types in which surveys were performed, and the result multiplied by a constant of 5, such that the values for rarity of vegetation types (0 to 5) were on a similar level to the values for rare species (0 to 6). Site Rarity scores overall ranged from 0 (three sites receiving Rarity 1) to 9 (three sites). The 1 to 5 ranks were assigned accordingly.

Biological Diversity (or Biodiversity)

Three measures of Biological Diversity were considered: species richness, presence of fen and/or woody-dominated fen, and number of vegetation types per meadow unit. We recorded more data on the sites that we visited in 2011 compared to the fen meadows visited in 2009, but we were able to estimate values for 2009 sites based on the data collected.

Each of our plot samples includes a full list of species per fen stand (usually within a 20-m^2 plot area). The sites we visited averaged between 8 and 32 taxa per stand (with variation from one to nine plot surveys completed per meadow). Because no stand/plot surveys were performed at Toad Lake 2, we assigned it a medium rank of 3 for average species richness per plot).

Another measure of Biological Diversity known for meadows that we visited is whether a fen was present (17 out of 28 meadows) and whether shrub or tree fen types were present in addition to herbaceous dominant vegetation. Only one of the fen meadows (Sundew Fen) that we surveyed contained a confirmed woody-dominated fen vegetation type. Only three ranks were assigned for this second measure of Biodiversity: 1 for meadows without fens, 3 for meadows with fens, and 5 for meadows with woody fens.

The third measure of Biological Diversity is the number of vegetation types per site (which varied from 1 to 12) per unit area. This was based on the estimated number of vegetation types according to the field surveyors (estimated using the new protocol for this project) with review after surveys were keyed to type. For 2009, the number of vegetation types was estimated by counting the number of types mapped plus the number of types of surveys after classification if not mapped. The number of different types recorded was divided by the area of the fen meadow opening in acres. The higher the numerical result, the more diverse the fen meadow.

Each site received 1 to 5 points for each measure, and the sum of three measures determined their complete rank for Biological Diversity.

Physical / Topographical Diversity

In addition to variation in plant species and vegetation type diversity, or Biological Diversity, several indicators of Topographical Diversity were recorded in our data collection procedure, which were newly added measures since the 2009 fieldwork. Therefore, we ranked 17 sites for this criterion, and the rest were assigned the middle score of 3 on a 5-point scale. Five topographical features were listed on the datasheet and checked for presence or absence: 1. open water (defined as perennial water features such as a pond), 2. floating mat, 3. channels (perennial watercourses that cross the fen meadow), 4. hummocks or patterned ground (some kind of relief in addition to channels or gullies), and 5. terrace (a raised berm with different ground levels on either side). The presence of each characteristic contributed to the Topographical Diversity of the site.

In addition to noting presence or absence of topographical features, the field surveyors rated topographical complexity with the option of choosing none, low (one raised feature), moderate (up to several separate raised features, or one complex feature), and high (numerous features and/or very well-developed network of features). This functions as a second measure of Physical Diversity.

The third measure of Physical Diversity was the number of water sources that were noted during field surveys. Three possible water sources were provided on the data form with surveyors checking all that apply: surface channel, springs, and subsurface. The number of source types checked is a rough estimate of hydrological variation. In addition to these three types of water source, additional credit was given to meadows that had more than the average number of incoming channels and/or springs. If more than one incoming channel was counted, or more than 2 springs were noted, an additional half point was credited to the site. Therefore water source scores varied from 1 to 3.5.

Each measure was given equal weight in determining the complete rank of Physical Diversity, and those sites with higher ranks ultimately had more varied topography.

Viability

We used two different factors to rate Viability: size of the meadow complex, and presence of other meadows nearby. These factors are related to Viability as defined by Chadde et al. (1998) as the likelihood to persist in the future. Besides the size of the peatland and habitat diversity, they also considered the position in the watershed and water source as factors that influence Viability. We did not attempt to rate Viability using position in the watershed or the source of water maintaining the peatland. An additional aspect of this measure that potentially could be included, if data were available, is the likelihood of a site to be affected by climate change or changing hydrology. Since we did not have a quantititative basis for deciding whether one site was more vulnerable to this than another, we did not include this probability in our assessment.

We ranked the size of the site using the outline of the meadow. A more precise measure of the meadow complex was not available. Sizes of the 28 fen meadow polygons varied from 740 to 108,000 square meters. The smallest meadows were considered to be under 3,000 square meters, with 8 sites in this category. The largest size category was over 34,000 square meters, with 3 sites.

The other Viability factor is based on the presence of other meadows and is a measure of habitat diversity outside of the meadow site itself. Since the habitat diversity within each site is well represented in our Diversity ranking, we chose to assess how many other fen or wet meadow sites were present within a certain distance of each site. This factor represents potential sources for migration of species between sites or potential refugia from a disturbance or changing conditions.

A measure of diversity surrounding each site was calculated by determining how many meadows fell within 500 m of the site. This distance was not based on knowledge of dispersal distance, but simply chosen because the largest meadow polygon, Deadfall Meadow 1, is almost 1 km in length. Therefore, a single point at the center of the complex would be within 500 m of the rest of the complex. The aerial imagery was viewed at 1:5,000, and green areas that appeared to be meadows within 500 m of assessed sites were marked in their centers. The results varied from 2 to 11 meadows found within 500 m from each site. This was transformed to a five point scale, such that those with 2 to 3 meadows close by were the least viable (6 locations), while those with 9 or more were considered most viable (6 locations).

The sum of these two Viability rankings was taken and transformed to a 5-point scale.

Defensibility

Our sole basis for rating sites according to Defensibility was our knowledge of each site's state of land protection. Two types of designations were taken into account for Defensibility. One was inclusion in an Inventoried Roadless Area (USFS 2009). Six sites fell into two categories of Inventoried Roadless Areas. We gave a score of 3 to locations where road construction is prohibited, 2 to sites which included portions where construction was both prohibited and not, and a score of 1 to those which were in the Roadless areas where construction is not prohibited.

All of the sites fall within the boundary for the Northwest Forest Plan (USFS 2006a), as does all of Shasta-Trinity NF, with two regions denoted, Cascades and Klamath (which are separated along the summit that divides Trinity and Siskiyou Counties). All sites are, by definition, within Riparian Reserves, which are areas along all streams, wetlands, ponds, lakes and unstable, or potentially unstable areas, where the conservation of aquatic and riparian dependent terrestrial resources receives primary emphasis. They are a type of Administratively Withdrawn Area, for which standards and guidelines apply in addition to all other land-use allocations that are assigned to the sites that we are assessing (Espy & Babbitt 1994b). The other Land Use Allocations include Administrative Withdrawal, Adaptive Management Area, Late Successional Reserve, and Other (USFS 2008c). We gave Late Successional Reserves 4 points because they are the most protected, they are a special type of Administratively Withdrawn Area. Administrative Withdrawal Areas are not open to timber production, so they received 3 points (Espy & Babbitt 1994a). Adaptive Management Areas received 2 points and Other received 1. Non-federal, private lands received 0 points. If a meadow fell within more than one of these allocations, the average of the scores was taken.

Toad Lake 5, the opening on the west side of Toad Lake, was the only meadow to fall into a Special Interest Area as mapped (USFS 2008b). It was designated for its botanical value. Five special status plants were mapped in that area (CNDDB 2011) including four 1B species, one of which is listed as endangered by the state of California (*Eriogonum alpinum*). This designation is also Administratively Withdrawn, receiving 4 points, which was on par with the Late Successional Reserve assignment.

Scores from these sources were summed, resulting in values from 0.5 to 6, which were ranked on a 5-point scale.

Scientific and Educational Value

Accessibility and proven use for science or education were combined to select a rating for this criterion. Accessibility was determined mainly by distance to roads. Generally the most accessible sites are less than 50 m to a public, paved road (rank 5), with those less than 50 m from a dirt road receiving a rank of 4. The next most accessible are between 50 and 200 m, while the least accessible are more than a kilometer away from a road. While some sites may have been used in past research projects (e.g., Whipple 1981, Deadfall Basin), no values were assigned for research or education use. Though this criterion is somewhat subjective, it provides some level of current value.

RESULTS

Species and Vegetation Data

In the 80 vegetation samples collected in 2009 and 2011 by CNPS on Shasta-Trinity lands, over 145 vascular plant taxa and 26 moss taxa were identified to the species or subspecies level. Appendix 2 provides a complete list of scientific and common names for the taxa identified in the field surveys. The scientific names of the taxa were converted to alpha-numeric codes for the data analyses, as recorded in the appendix.

Table 1 provides a summary of the site locations visited in 2011. Fifty plot samples were collected, and an additional 52 vegetation stands were mapped. The total area assessed was 97.5 acres or 39.5 hectares. Only about 6.5 acres or 2.6 hectares (6.7%) were designated as fen. The recorded data were stored in a version of the R5 Fen Geodatabase that was modified for our purposes with additional data fields. The original User's Guide (Fischer et al. 2006), our modifications, and some instructions for updating fields have been provided to the Forest along with the geodatabase.

Compared to 2009 fieldwork, we covered a much larger area in a similar amount of time, and did not map all vegetation types within the area. We also used soil probes to estimate our fen delineations and confirmed our plot sample soil pits with lab analysis for Carbon content. Some plot samples that field personnel believed to be fen were determined by subsequent laboratory analysis as not being fen, based on soil carbon content (Table 2). Soils were sampled at 18 plots and each distinctive layer in the column was collected, resulting in 40 separate samples for analysis. While some of the soil cores had averages that put them within the organic soil range, if a significant portion of the column did not meet the organic soil range for Carbon, the plot was not designated as fen.

In addition to the data recorded by CNPS staff in 2009 and 2011, we included seven surveys conducted at South Fork Mountain and Saddle Gulch fens by Cooper and Wolf in 2002 (Cooper and Wolf 2006) in our classification of vegetation types for Shasta-Trinity fens and wet meadows. Table 3 summarizes the 31 vegetation types that were mapped. Table 4 indicates the Alliance and Association level classification and the number of plot samples assigned to each type.

Conservation Significance Rating

Table 5 provides the Conservation Significance ratings for the meadows surveyed by CNPS in 2009 and 2011. The sum of scores for eight individual criteria led to total scores ranging from 16 to 34, producing 14 levels for the 28 sites. The highest scoring meadow was Sundew Meadow, which had the largest fen area of any of the meadows (though not the highest percentage of fen). The lowest scoring meadow was West Branch Crow Creek 3, surveyed in 2009. The average score for the Eddy's Region meadows was 25.8 while meadows in the other two regions averaged 20.9. These Conservation Significance ratings are displayed graphically for the Eddy's Region in Figure 3.

Table 1. Vegetation Surveys conducted in 2011 at Shasta-Trinity National Forest.

Area	Site Locations	Number of Releves	Number of mapped stands	Area Assessed		Fen Area Estimate	
				acres	sq m	sq m	%
Parks Creek Watershed	Bogbean Meadow	8	8	3.5	14,125	8,666	61.4
	Sundew Meadow	5	12	7.4	29,786	8,719	29.3
	Tamarack Flat	2	4	0.4	1,643	0	---
Deadfall Creek	Allium Waterfall Meadow	4	12	6.9	27,991	1,111	4.0
	Deadfall Meadows 1	1	1	26.7	107,964	0	---
	Deadfall Meadows 2	1	1	3.1	12,510	0	---
	Nuphar Meadow	6	6	1.9	7,730	3,897	50.4
	Senecio Meadow	2	6	0.5	1,966	188	9.6
Toad Lake	Middle Fork Sacramento Meadow	3	3	8.4	34,096	1,248	3.7
	Toad Lake Meadow 1	3	4	1.4	5,549	0	---
	Toad Lake Meadow 2	0	2	0.4	1,743	0	---
	Toad Lake Meadow 3	2	3	8.0	32,346	174	0.5
	Toad Lake Meadow 4	2	3	4.8	19,252	0	---
	Toad Lake Meadow 5	2	3	2.9	11,843	94	0.8
	Toad Lake Meadow 6	1	3	0.6	2,459	0	---
Fawn Creek	Fawn Creek Meadow	4	12	19.2	77,671	1,627	2.1
	Fawn Creek Mdw South	2	14	1.2	4,862	697	14.3
	Fawn Creek Mdw West	2	5	0.3	1,157	0	---

Table 2. Results of soil analysis. Portion of column refers to the measurement of the soil core from the ground surface down, in centimeters. TC= Total Carbon.

Site	Plot Survey	Portion of Column	Fraction of Column	TC%	TC% x fraction	Average TC%	Outcome
Allium Waterfall	0514_59_AWM_1A	0 - 15 15 - 30 30 - 40	0.375 0.375 0.250	34.94 26.28 35.00	13.10 9.85 8.75	31.71	confirmed
Bogbean	0514_59_CLB_1B	0 - 40	1.000	34.74	34.74	34.74	confirmed
Bogbean	0514_59_CLB_1C	0 – 25 25 - 40	0.625 0.375	32.73 24.02	20.46 9.01	29.46	confirmed
Sundew	0514_59_CLS_1A	0 – 30 30 - 40	0.750 0.250	24.99 25.37	18.74 6.34	25.08	confirmed
Deadfall2	0514_59_DFM_2A	0 – 7 7 – 18 18 - 40	0.175 0.275 0.550	27.78 20.78 4.46	4.86 5.72 2.45	13.03	not fen
Fawn Crk	0514_59_FC_1A	0 - 40	1.000	31.53	31.53	31.53	confirmed
Fawn Crk	0514_59_FC_1B	0 - 40	1.000	28.96	28.96	28.96	confirmed
Fawn Crk South	0514_59_FCS_1A	0 – 30 30 - 40	0.750 0.250	11.21 14.89	8.40 3.72	12.13	not fen
Fawn Crk West	0514_59_FCW_1B	0 – 20 20 - 40	0.500 0.500	17.83 8.55	8.91 4.27	13.19	not fen
Mid Fork Sacto	0514_59_MFS_1A	0 – 15 15 - 40	0.375 0.625	32.12 23.18	12.04 14.49	26.53	confirmed
Mid Fork Sacto	0514_59_MFS_1B	0 - 40	1.000	33.48	33.48	33.48	confirmed
Nuphar	0514_59_NDF_1B	0 – 6 6 - 17 17+	0.150 0.275 0.575	29.39 12.39 9.70	4.41 3.41 5.58	13.39	not fen
Senecio	0514_59_SDF_1A	0 – 5 5 - 40	0.125 0.875	31.90 29.71	3.99 26.00	29.99	confirmed
Toad Lk3	0514_59_TL_3B	0 – 11 11 – 30 30 - 40	0.275 0.475 0.250	33.24 30.13 6.49	9.14 14.31 1.62	25.08	confirmed
Toad Lk4	0514_59_TL_4A	0 – 25 25 - 40	0.625 0.375	16.06 6.34	10.04 2.38	12.41	not fen
Toad Lk4	0514_59_TL_4B	0 – 2 2 – 8 8 – 14 14 – 20 20 - 40	0.050 0.150 0.150 0.150 0.500	18.70 29.22 20.27 18.50 7.13	0.93 4.38 3.04 2.78 3.56	14.70	not fen
Toad Lk5	0514_59_TL_5B	0 – 10 10 – 25 25 – 35 35 - 40	0.250 0.375 0.250 0.125	30.99 22.60 15.37 0.00	7.75 8.48 3.84 0.00	20.07	confirmed
Tamarack Flat	0514_59_TMF_1A	0 – 20 20 - 40	0.500 0.500	9.82 9.30	4.91 4.65	9.56	not fen

Table 3. Mapping classification used for Shasta-Trinity fens and wet meadows, including number of stands assigned to each vegetation type and whether the type was found in the Eddy's region or elsewhere (**Other =** South Fork Mountain or Saddle Gulch). The **Code** was used in the geodatabase domain to indicate vegetation type.

Mapping level	Mapping Unit	Code	Eddy's	Other
Association	*Caltha leptosepala* Association	CALE_P	1	4
Association	*Carex echinata/Philonotis fontana-Sphagnum subsecundum* Association	CAEC_PF_SS	2	
Association	*Carex utriculata* Association	CAUT	2	2
Association	*Darlingtonia californica* Association	DACA	14	
Association	*Eleocharis quinqueflora* Association	ELQU	5	
Association	*Juncus arcticus* var. *balticus* Association	JUAR_balt	1	
Association	*Juncus nevadensis* Association	JUNE	1	
Association	*Narthecium californicum* Association	NACA	5	7
Association	*Rhododendron columbianum/Pinus contorta* ssp. *murrayana* Association	LEGL_PICO	1	
Provisional Association	*Nuphar lutea* ssp. *polysepala* Provisional Association	NULU_P	1	
Provisional Association	*Triantha occidentalis* Provisional Association	TROC_P	3	
Alliance	*Alnus incana* Alliance	L_ALIN	4	
Alliance	*Carex (luzulina)/Bryum pseudotriquetrum* Alliance	L_CAIL_BRPS	1	
Alliance	*Carex echinata* Alliance	L_CAEC	4	
Alliance	*Carex scopulorum* Alliance	L_CASC	1	
Alliance	*Darlingtonia californica* Alliance	L_DACA	2	
Alliance	*Deschampsia cespitosa* Alliance	L_DECE	4	
Alliance	*Eleocharis quinqueflora* Alliance	L_ELQU	12	
Alliance	*Juncus nevadensis* Alliance	L_JUNE	6	
Alliance	*Pinus contorta* ssp. *murrayana* Alliance	L_PICO	4	
Alliance	*Scirpus microcarpus* Alliance	L_SCMI	1	
Alliance	*Veratrum californicum* Alliance	L_VECA	2	
Provisional Alliance	*Caltha leptosepala* Provisional Alliance	L_CALE_P	4	5
Provisional Alliance	*Helenium bigelovii* Provisional Alliance	L_HEBI	3	17
Provisional Alliance	*Rhododendron occidentale* Provisional Shrubland Alliance	L_RHOC		3
Group	Western Cordilleran montane-boreal summer-saturated meadow	G434	6	1
Group	Western Cordilleran montane-boreal mesic wet meadow	G290	5	
Macrogroup	Western cool temperate scrub swamp	MG031		1

Mapping level	Mapping Unit	Code	Eddy's	Other
Macrogroup	Western North American Montane/Boreal Peatland	MG063	3	
Stand	*Menyanthes trifoliata* Stand	METR	1	
Stand	*Pteridium aquilinum* Stand	PTAQ		1

Table 4. Floristic classification of vegetation types of Shasta-Trinity fens and wet meadows, including number of plot samples assigned to each type, for the Eddy's region or elsewhere (**Other =** South Fork Mountain or Saddle Gulch, including Cooper 2002 plots). Types that were considered rare for the scoring of sites for Conservation Significance are indicated with an asterisk (*). Vegetation type names follow Sawyer et al. 2009.

Mapping Unit	Alliance	Association	Eddy's	other
Alnus incana Alliance	*Alnus incana*			
Not mapped (plot only)	*Bistorta bistortoides-Mimulus primuloides*	*Mimulus primuloides*	1	
Caltha leptosepala Alliance	*Caltha leptosepala*			
Caltha leptosepala Association	*Caltha leptosepala*	*Caltha leptosepala**	5	5
Carex (luzulina)/Bryum pseudotriquetrum Alliance	*Carex (luzulina)/Bryum pseudotriquetrum*			
Not mapped (plot only)	*Carex (luzulina)/Bryum pseudotriquetrum*	*Carex luzulina/Bryum pseudotriquetrum**	2	
Carex echinata Alliance	*Carex echinata**		2	
Carex echinata/Philonotis fontana-Sphagnum subsecundum Association	*Carex echinata*	*Carex echinata/Philonotis fontana-Sphagnum subsecundum**	1	5
Carex scopulorum Alliance	*Carex scopulorum*			
Not mapped (plot only)	*Carex scopulorum*	*Carex scopulorum*	2	
Not mapped (plot only))	*Carex simulata*	*Carex simulata**	1	
Carex utriculata Association	*Carex (utriculata, vesicaria)*	*Carex utriculata*	4	1
Not mapped (plot only)	*Carex (utriculata, vesicaria)*	*Carex vesicaria*	1	
Darlingtonia californica Alliance	*Darlingtonia californica*			
Darlingtonia californica Association	*Darlingtonia californica*	*Darlingtonia californica **	9	
Deschampsia cespitosa Alliance	*Deschampsia cespitosa*			
Eleocharis quinqueflora Alliance	*Eleocharis quinqueflora*			
Eleocharis quinqueflora Association	*Eleocharis quinqueflora*	*Eleocharis quinqueflora*	6	1
Not mapped (plot only)	*Eleocharis quinqueflora*	*Eleocharis quinqueflora/Philonotis fontana-Bryum pseudotriquetrum**	1	
Not mapped (plot only)	*Eriophorum spp.* Saturated Herbaceous Alliance	*Eriophorum crinigerum* (Provisional)*		1

Mapping Unit	Alliance	Association	Eddy's	other
Helenium bigelovii Provisional Alliance	*Helenium bigelovii (*Provisional*)*			
Not mapped (plot only)	*Helenium bigelovii (*Provisional*)*	*Helenium bigelovii* Provisional	2	2
Juncus arcticus var. *balticus* Association	*Juncus arcticus*	*Juncus arcticus* var. *balticus*	1	
Juncus nevadensis Alliance	*Juncus nevadensis**		1	
Juncus nevadensis Association	*Juncus nevadensis*	*Juncus nevadensis**	3	
Narthecium californicum Association	*Narthecium californicum–Triantha occidentalis*	*Narthecium californicum**	4	10
Nuphar lutea ssp. *polysepala* Provisional Association	*Nuphar lutea* Provisional	*Nuphar lutea* ssp. *polysepala**	3	
Not mapped (plot only)	*Oreostemma alpigenum-(Gentiana newberryi)*	*Oreostemma alpigenum*	3	
Pinus contorta ssp. *murrayana* Alliance	*Pinus contorta* ssp. *murrayana*			
Not mapped (plot only)	*Pinus contorta* ssp. *murrayana*	*Pinus contorta* ssp. *murrayana/ Carex* spp.	1	
Rhododendron columbianum/ Pinus contorta ssp. *murrayana* Association	*Rhododendron columbianum*	*Rhododendron columbianum/ Pinus contorta* ssp. *murrayana**	1	
Rhododendron occidentale Provisional Shrubland Alliance	*Rhododendron occidentale* Provisional*			1
Scirpus microcarpus Alliance	*Scirpus microcarpus*			
not mapped	*Senecio triangularis*	*Senecio triangularis*	1	
Triantha occidentalis Provisional Association	*Narthecium californicum-Triantha occidentalis*	*Triantha occidentalis* (Provisional)*	1	
Veratrum californicum Alliance	*Veratrum californicum*	*Veratrum californicum*	1	
Western cordilleran montane-boreal mesic wet meadow Group			2	
Western Cordilleran montane-boreal summer-saturated meadow Group			1	
Western North American Montane/ Boreal Peatland Macrogroup			1	

Table 5. Summary of Conservation Significance rankings for surveyed wet meadow sites in Shasta-Trinity NF**.** Sites are arranged by significance rankings (highest to lowest, with higher values indicating more noteworthy meadows). Sites with an asterisk (*) were visited by CNPS in 2009 and received automatic scores of 3 for Physical Diversity. Refer to Figure 3 for a graphical representation of these scores.

Site Name	ID_for_Meadow	Uniqueness	Quality	Rarity	Biodiversity	Physical Diversity	Viability	Defensibility	Value	Total Score
Sundew Fen	0514_59_CLS_1	5	5	4	5	5	4	4	2	34
Allium Waterfall Meadow (Deadfall)	0514_59_AWM_1	2	4	3	4	5	5	5	2	30
Fawn Creek Meadow	0514_59_FC_1	5	3	4	3	5	5	3	2	30
Toad Lake 3	0514_59_TL_3	3	5	5	2	4	5	3	3	30
Fawn Creek West	0514_59_FCW_1	5	4	4	5	3	2	3	2	28
Saddle Gulch Fen*	0514_52_SG01	5	5	5	4	3	1	2	2	27
Deadfall Meadow 2	0514_59_DFM_2	2	5	5	1	2	4	5	3	27
Bogbean Fen	0514_59_CLB_1	5	4	2	2	4	4	4	1	26
Fawn Creek South	0514_59_FCS_1	3	5	4	3	5	2	3	1	26
Toad Lake 4	0514_59_TL_4	5	4	3	2	1	4	3	4	26
Middle Fork Sacramento	0514_59_MFS_1	3	3	2	3	4	3	3	4	25
Nuphar Meadow (Deadfall Mdws)	0514_59_NDF_1	2	3	2	3	3	4	5	3	25
Toad Lake 5	0514_59_TL_5	5	2	5	3	1	3	4	2	25
Senecio Meadow (Deadfall Mdws)	0514_59_SDF_1	3	5	2	5	1	1	5	2	24
Tamarack Flat 1	0514_59_TMF_1	3	3	4	5	4	1	1	3	24
Jennings Fen*	0514_52_SFM05	2	3	3	4	3	2	2	4	23
Deadfall Meadow 1	0514_59_DFM_1	2	2	1	1	3	5	4	5	23
Blake Fen*	0514_52_SFM02	2	2	3	4	3	2	2	4	22
Kerlin Fen*	0514_52_SFM06	2	1	3	5	3	2	2	4	22
Mistletoe Fen*	0514_52_SFM07	2	4	2	3	3	2	2	4	22
West Branch Crow Creek 1*	0514_58_WBCC01	3	2	3	3	3	2	1	4	21
Toad Lake 1	0514_59_TL_1	3	3	1	2	2	4	3	3	21
Toad Lake 6	0514_59_TL_6	3	1	3	3	2	3	3	3	21

Site Name	ID_for_Meadow	Uniqueness	Quality	Rarity	Biodiversity	Physical Diversity	Viability	Defensibility	Value	Total Score
Doehop Fen*	0514_52_SFM04	2	1	3	3	3	3	1	4	20
Toad Lake 2	0514_59_TL_2	3	1	1	3	1	3	3	4	19
Mill Fen*	0514_52_SFM01	1	2	2	3	3	1	2	4	18
West Branch Crow Creek 2*	0514_58_WBCC02	3	2	1	2	3	1	1	5	18
West Branch Crow Creek 3*	0514_58_WBCC03	3	2	1	1	3	2	1	3	16

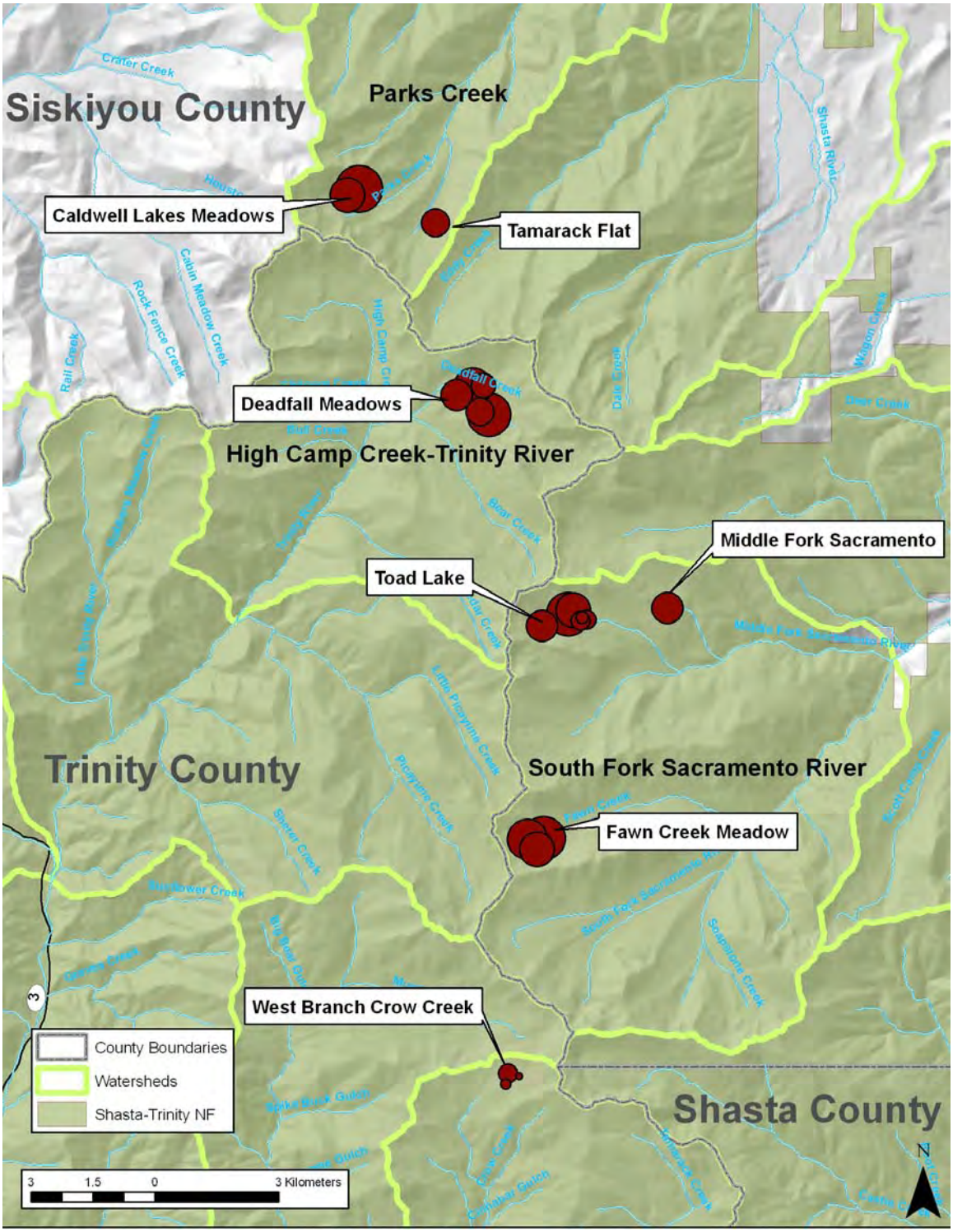


Figure 3. Conservation Rankings of meadow sites in the Eddy's Region symbolized with graduated circles, and names of subwatersheds displayed. The largest circles have the highest ratings.

DESCRIPTIONS AND MAPS BY SITE LOCATION

Each of the four general areas visited in 2011 are summarized below, starting in the north and continuing southward (excluding West Branch Crow Creek, which was visited in 2009). General area maps are presented for each, followed by individual maps of each meadow displaying a meadow boundary, any fen areas delineated, location and classification of plot samples, additional vegetation types mapped, and special features such as water sources.

Vegetation stands, other than plot samples, are designated in one of two ways. In some cases, a GPS point was taken at the approximate center of a stand and additional attributes of the stand were attached to that point, including the estimated size of the stand. This method was used because many of the stands observed were too small to be effectively mapped as polygons. We adopted a minimum mapping unit size of 1,000 square meters (approximately ¼ acre). Where this information is complete, the point is surrounded by a transparent circle that has the same area as the stand. In other cases, field personnel recorded polygon boundaries for the vegetation.

Caldwell Lakes Meadows and Tamarack Flat

Fifteen plot surveys were completed in three meadows in the Parks Creek Watershed (Figure 4). To get to Caldwell Lakes Meadows turn right on 41N74 from 42N17. Drive as far as it is safe then walk to trail 06W01 for 0.6miles, going left at smaller trail. Near the stream crossing, proceed uphill on east side of stream for 0.2 miles until you reach **Sundew Meadow**. This large meadow (7.4 acres) contains about 2 acres of well developed fen (Figure 5). The vegetation is dominated by *Darlingtonia* and *Narthecium* with *Drosera rotundifolia* being a common component. The rare plant *Parnassia cirrata* var. *intermedia* (CRPR 2.2) is present throughout the meadow, while *Carex scabriuscula* (CRPR 4.3) occurs in one plot. Other dominant plants are *Carex echinata*, *Eleocharis decumbens*, *Juncus nevadensis*, and *Eriophorum cringer*. The meadow edge is dominated by *Pinus contorta* var. *murrayana*. Five samples were completed at this large meadow complex. This area is fed by many springs and a few streams running into and throughout the meadow. Some small pools of standing water are found in the southern portion of the fen. The water from this meadow flows south into the creek. Range allotment status is vacant.

Bogbean Meadow is just 150 m southwest of Sundew Meadow. This meadow is 3.5 acres and 2.1 acres is fen (Figure 6). There are multiple ponds at this site, many with *Menyanthes* growing in them. The largest of these ponds is about 0.7 acres. A large stream flows into the meadow and branches throughout the fen, feeding the large pools, and flows out of the meadow as a single stream. Many fish, toads, and snakes were seen in the complex. One prominent fen vegetation type was mainly vegetative, and believed to be a mix of *Carex echinata* and *Eriophorum criniger,* found around the edge of most of the pools, however, much of it was vegetative and was difficult to accurately identify. Other dominant plants at the site included *Carex luzulina*, *Carex utriculat*a, *Eleocharis* decumbens, *Juncus balticus*, *Juncus nevadensis, Narthecium*, and *Pinus contorta* var. *murrayana*. Special status plants present include *Darlingtonia californica* (CRPR 4.2) and *Carex scabriuscula* (CRPR 4.3). Eight surveys were completed at this site.

Tamarack Flat is just past the Caldwell Lakes junction going south on 42N17, then turning left onto 40N46. The area that we sampled is about a mile from the junction on the east side of the road, 70 m from and above the roadside. This small meadow is 0.4 acres (Figure 7). One small spring mound seemed potentially to be fen, however, the soil tested did not reach the histosol Carbon content limit. The meadow contained vegetation dominated by *Darlingtonia*, *Elymus* with mixed grasses, *Juncus balticus*, and *Triantha occidentalis*. *Carex scabriuscula* (CRPR 4.3) is also present in this opening. Two plot surveys were completed at this site.

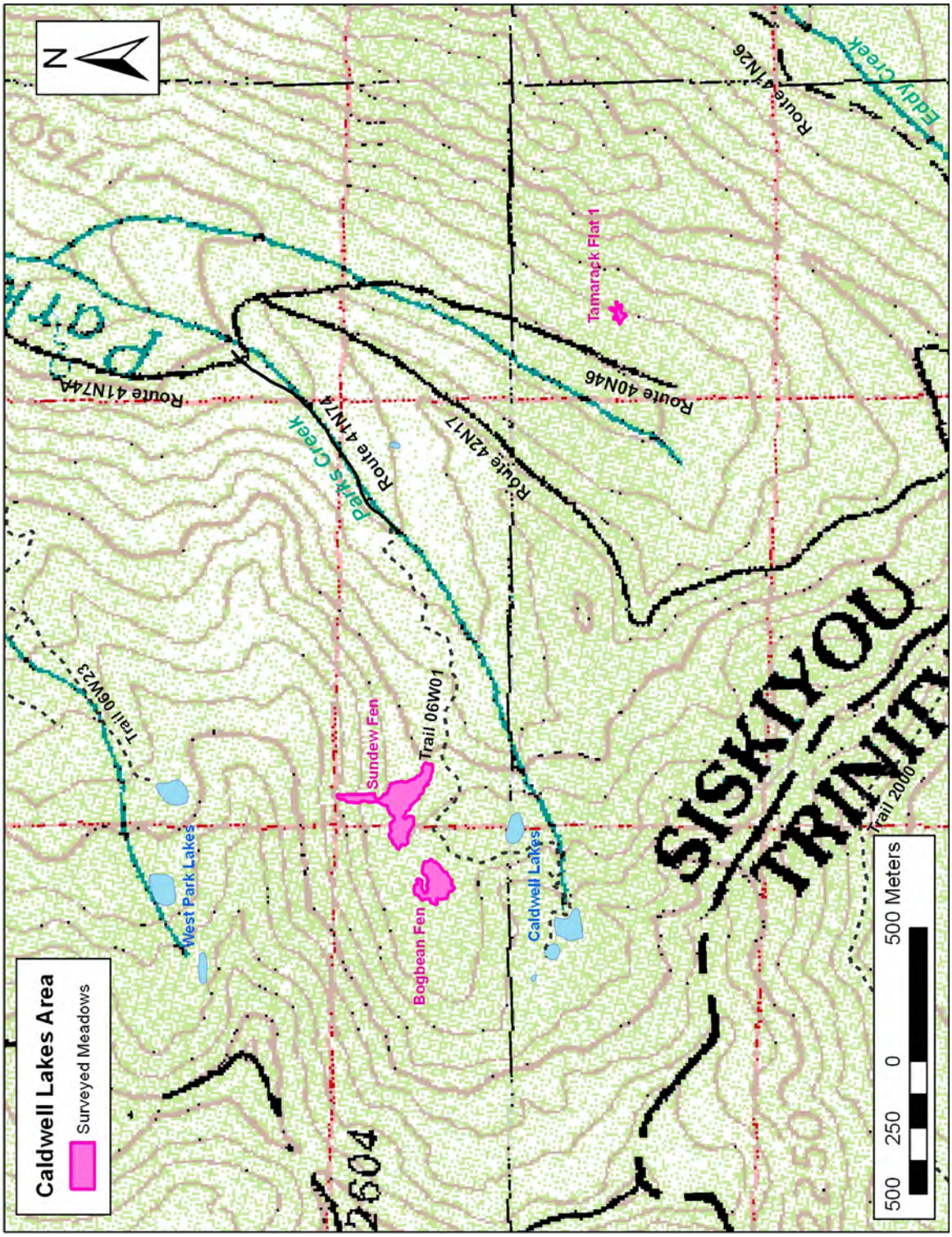
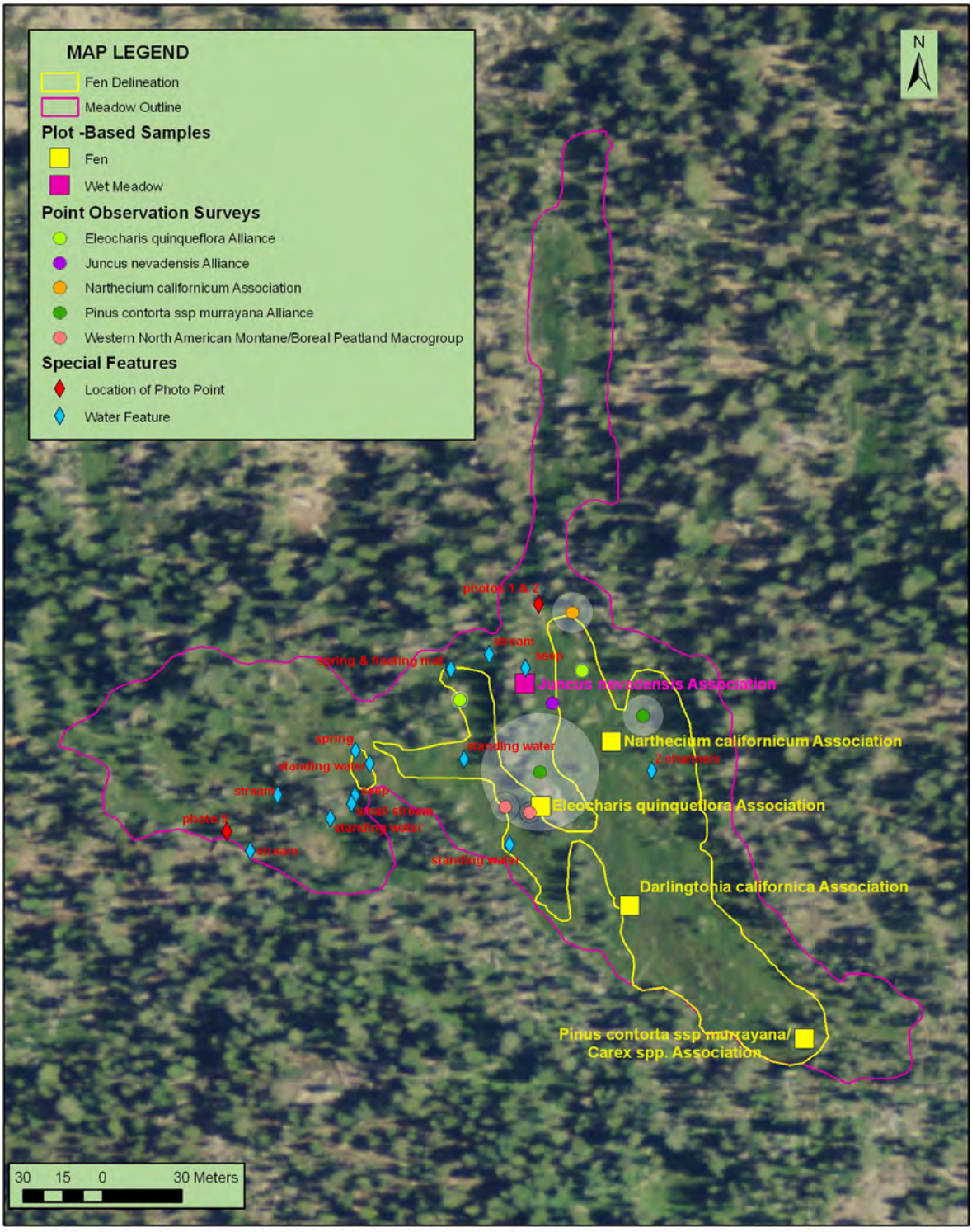


Figure 4. Meadows surveyed within Parks Creek Watershed, including Caldwell Lakes and Tamarack Flat.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 5. Sundew Meadow, along the trail to Caldwell Lakes. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 6. Bogbean Meadow. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

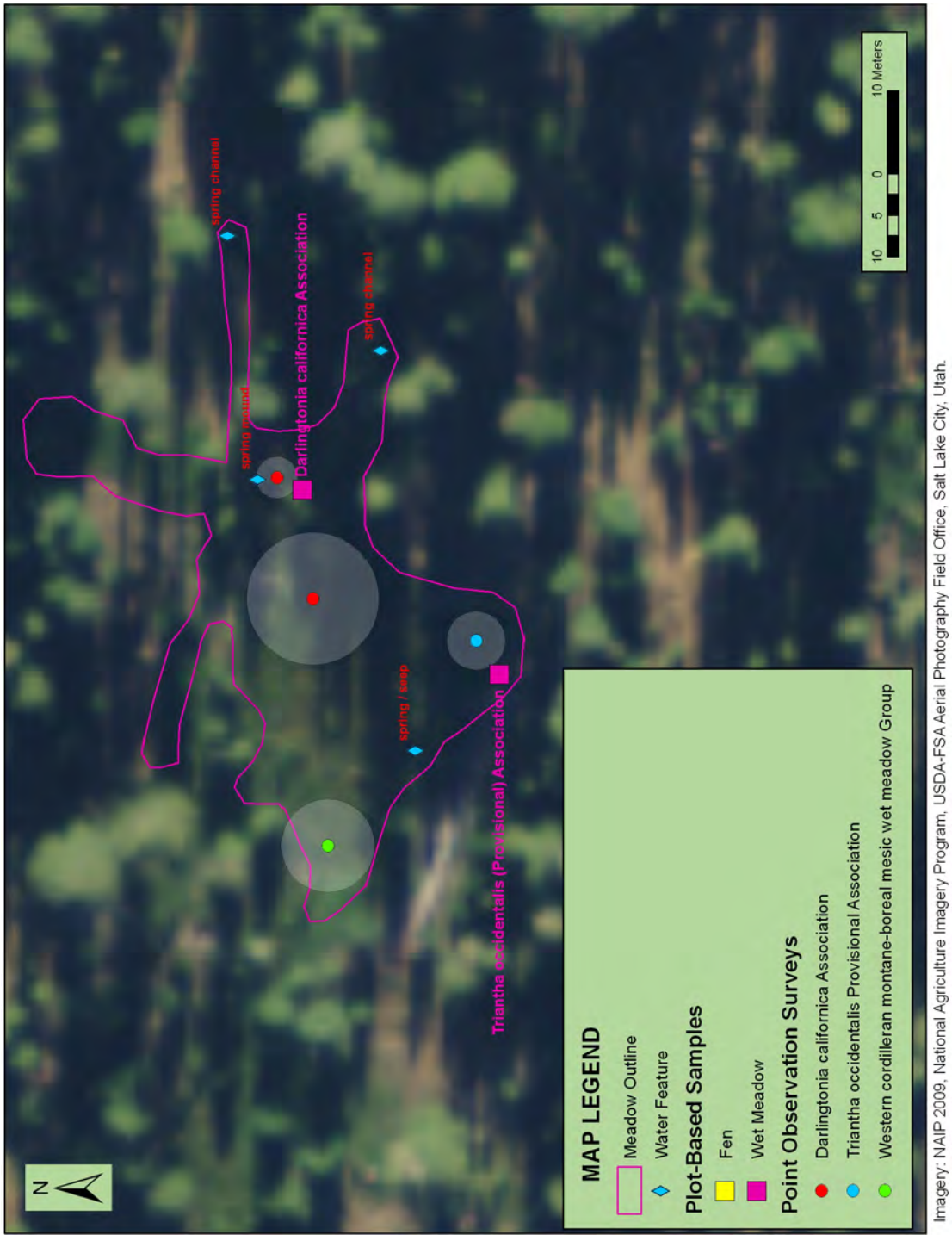


Figure 7. Tamarack Flat 1 Meadow. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

Deadfall Meadows

The Deadfall Meadows area begins at the hairpin turn on 42N17, where there is a parking lot on 42N17D and a trailhead for Deadfall Lakes (trail 06W05; Figure 8). This area falls within Bear Creek Pasture which has an active permit for cattle grazing (P. Brownsey, pers. comm. 2011). Multiple wet meadow locations were found in the area and at each location a probe helped determine if any fen development was present. Any source, spring or seep found in the area was mapped using GPS. Four meadow forms were completed in this area, as well as 14 plot surveys.

Immediately alongside the beginning of trail 06W05 is a large wet meadow dominated by alder and graminoids, **Deadfall Meadow 1** (Figure 9). The vegetation has been badly trampled by humans and horses. We recommend a boardwalk for the area where the trail crosses the wet meadow, particularly where the trail intersects drainages. Northeast off the trailhead and around the *Alnus* thickets were multiple spring locations that contained some peat development. There was not enough peat accumulation to be called fen in this entire 26.7 acre meadow. A plot sample was done in a stand dominated by *Veratrum californicum*.

Deadfall Meadow 2 is just southwest off the beginning of the trail, across Deadfall Creek from the first meadow (Figure 9). Deadfall Meadow 2 is about 3 acres and slopes northeast toward the creek. A *Caltha leptosepala* stand was sampled here but the description of the meadow complex (the meadow form) was not completed. *Darlingtonia californica* (CRPR 4.2) is present.

Allium Waterfall Meadow is reached by going 500 m down the 06W05 trail from the trailhead and then following the small streams that cross the trail towards the south until you come to a large meadow complex (Figure 10). This 7 acre meadow is only about 4% fen. There is a large waterfall that falls into an alder patch and flows north through the entire wet meadow. Two plots were completed in the fen areas and two plots were done in the wet meadow. Vegetation types were dominated by *Alnus, Caltha, Darlingtonia, Juncus nevadensis,* and *Mimulus primuloides. Carex scabriuscula* (CRPR 4.3) is present.

Senecio Meadow is located about 150 m due west from the fen portion of Allium Waterfall Meadow. This meadow is only about a half an acre in size and contains about 10% fen (Figure 11). A *Caltha* plot was completed in the fen portion and a *Senecio triangularis* plot was surveyed in the meadow. *Juncus nevadensis* and vegetative *Carex* sp. were also dominant plants in some parts of the meadow.

Follow the road 42N17 and turn left on 40N45 and left at 40N45G and park at the campsite and hike east until you reach a large terraced fen, **Nuphar Meadow** (Figure 12). This 2 acre meadow is about half fen, containing multiple ponds that include *Nuphar lutea* ssp. *polysepala*, *Carex utriculata* and a *Carex* hybrid. We sampled six vegetation stands within the meadow at this diverse location.

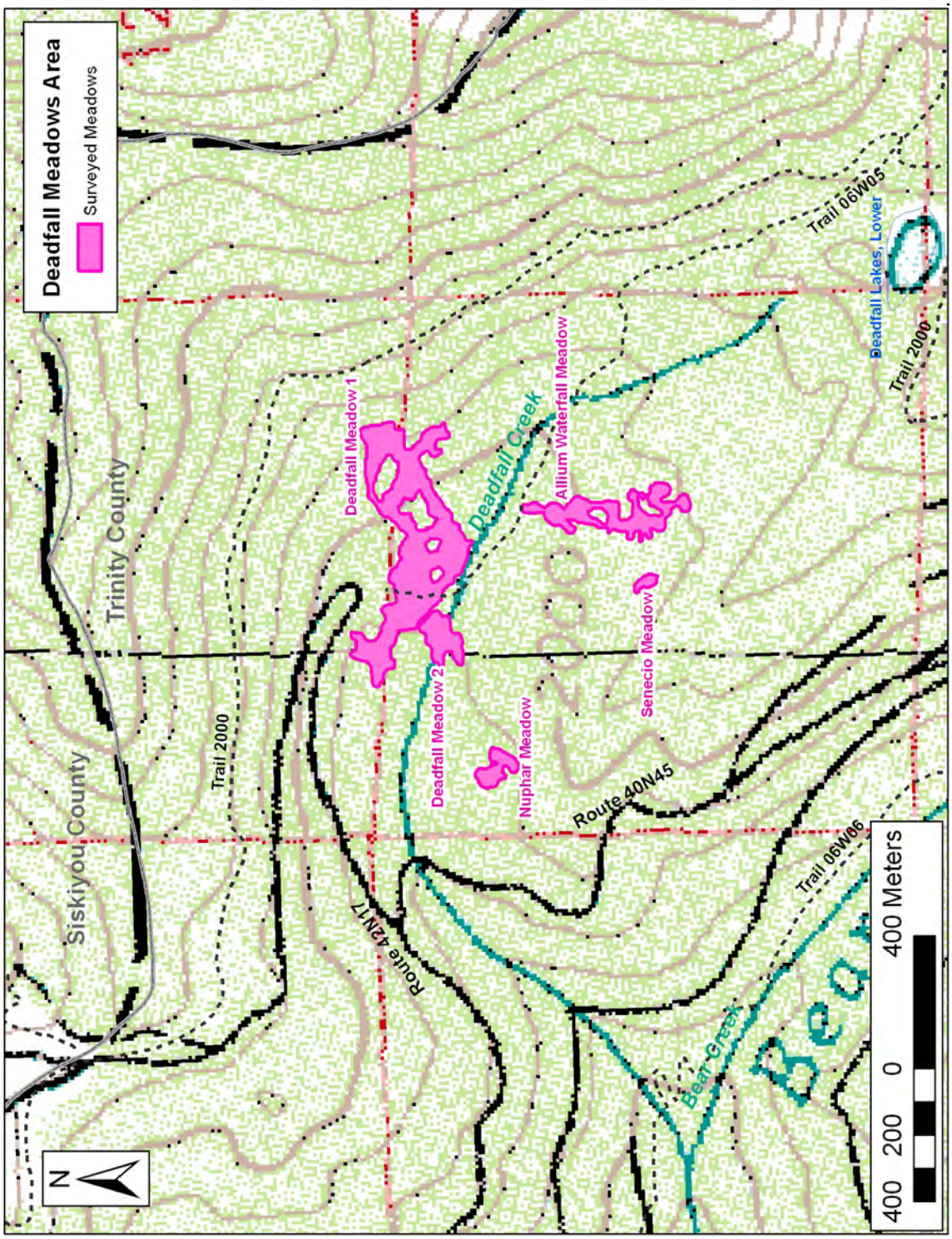


Figure 8. Meadows surveyed in the Deadfall Meadows area, High Camp Creek – Trinity River Watershed, in Trinity County.

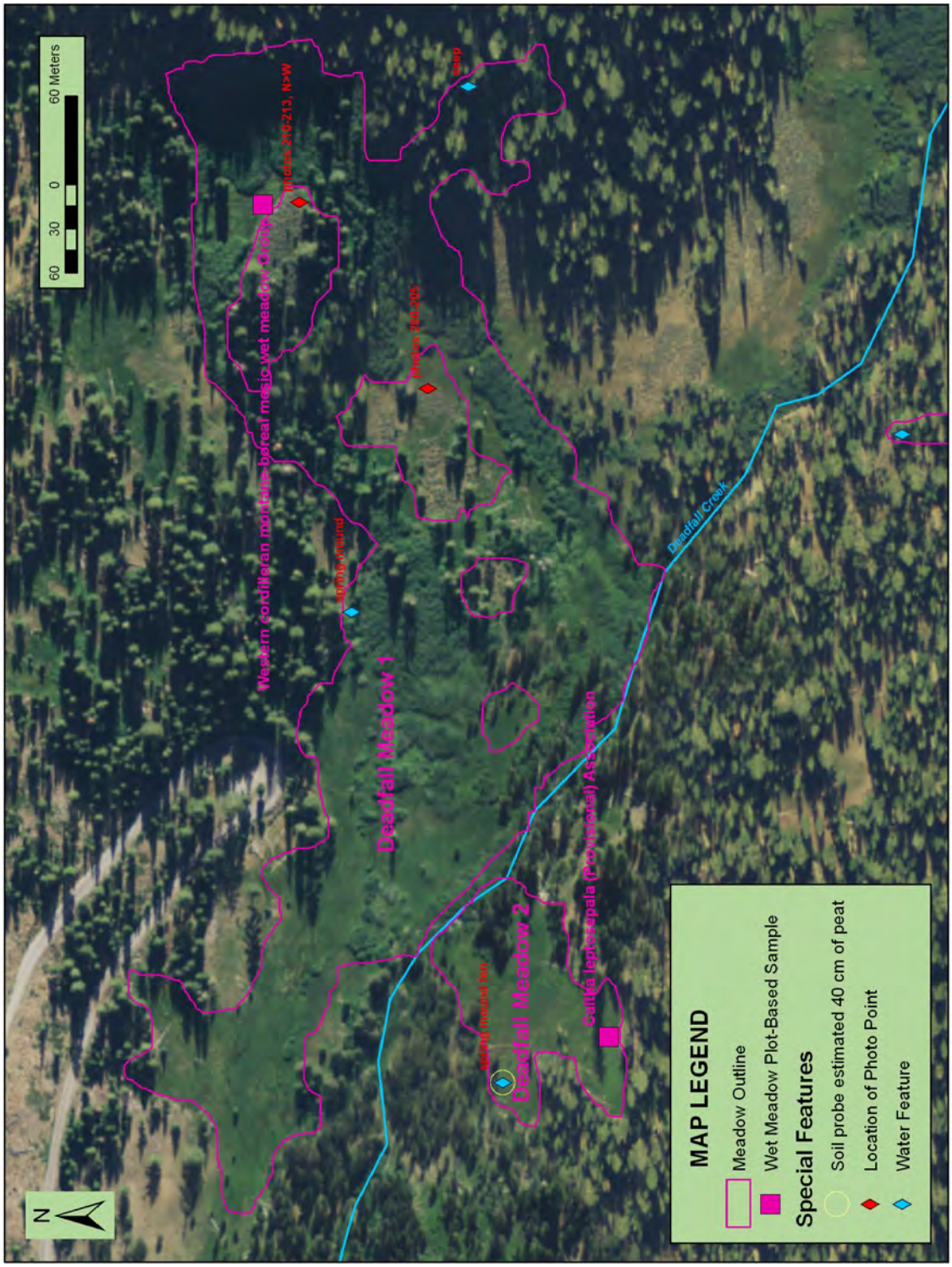
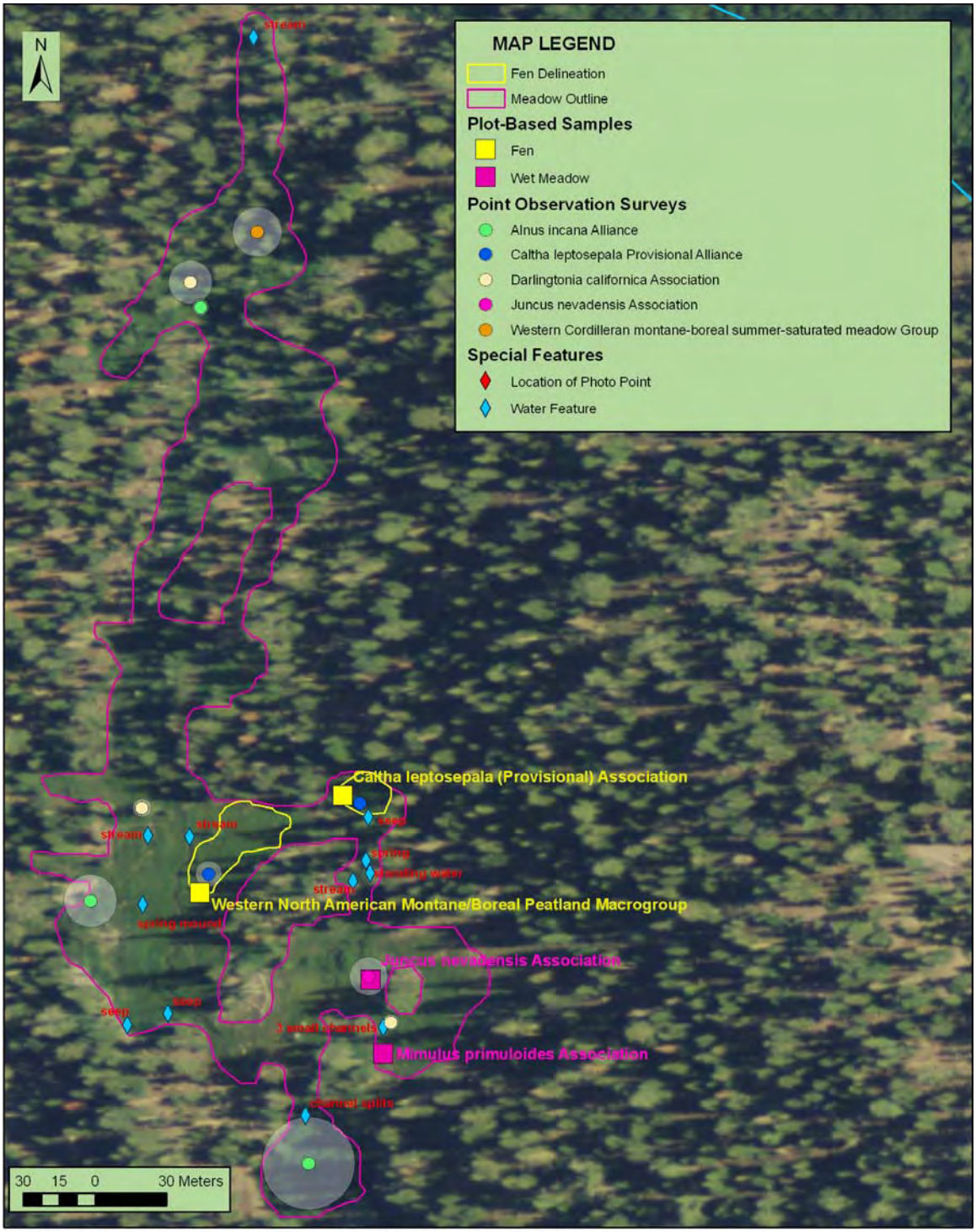
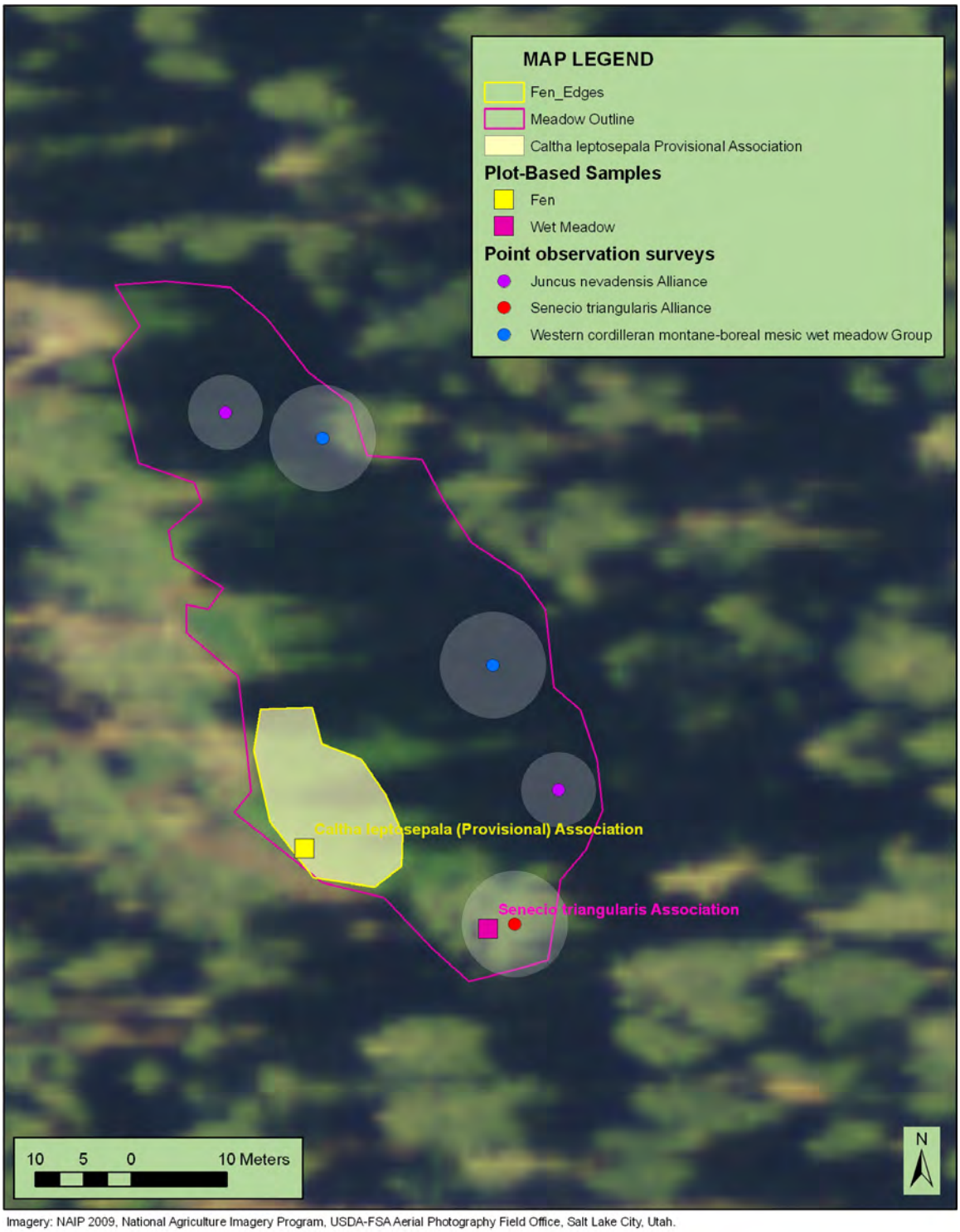


Figure 9. Deadfall Meadows 1 and 2.



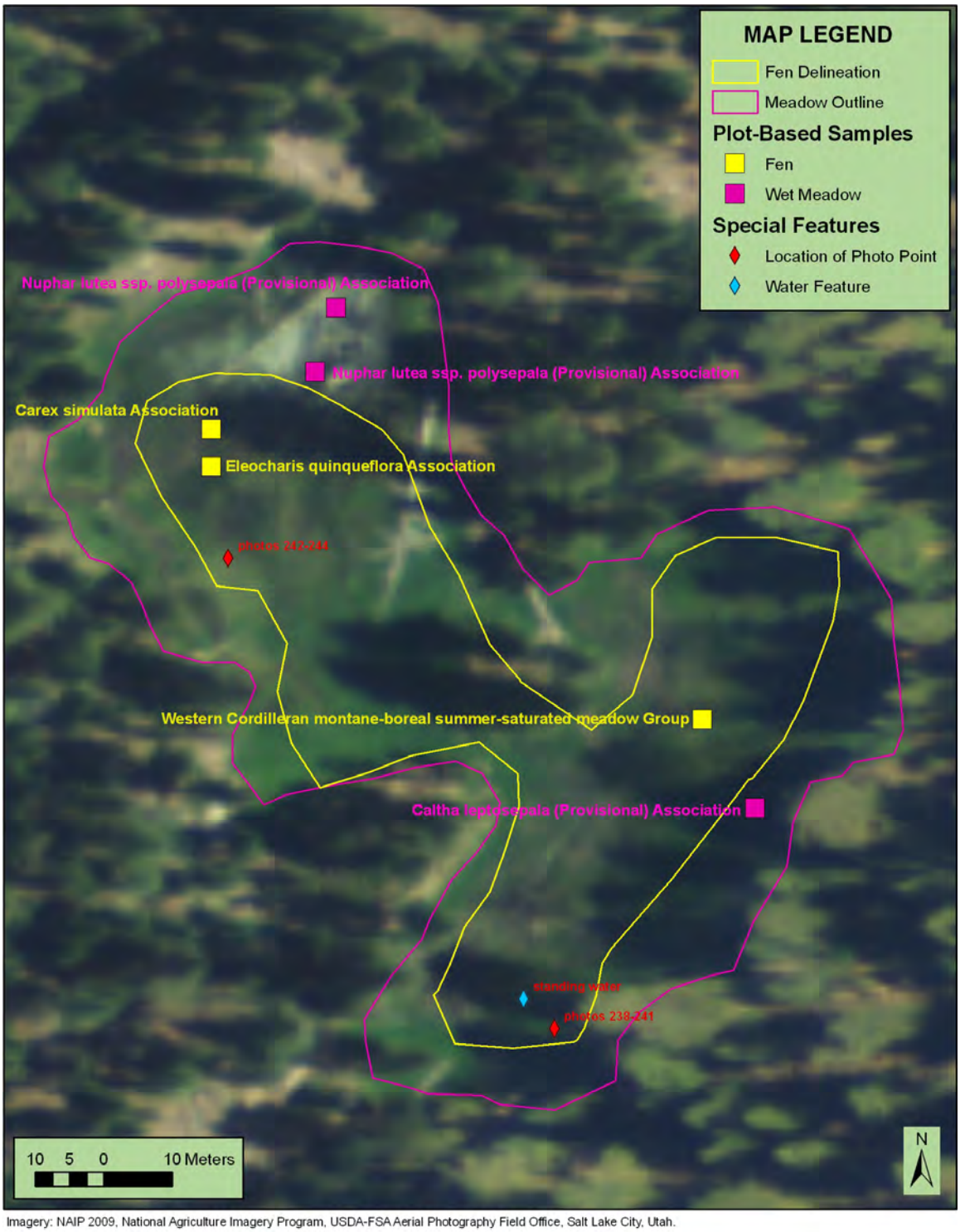
Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 10. Allium Waterfall Meadow located near Deadfall Creek. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 11. Senecio Meadow located near Deadfall Creek. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 12. Nuphar Meadow near Deadfall Meadows.

Toad Lake and Middle Fork Sacramento

Toad Lake Road is accessed from South Fork Road, west of Mount Shasta City. About midway along Toad Lake Rd. there is a turnoff which heads for another meadow that has been called Middle Fork Sacramento for the closest named watercourse (Figure 13). This meadow, along with six more that are closer to Toad Lake, are summarized here. The area has not been permitted for grazing since 2008 (P. Brownsey, pers. comm. 2011).

Middle Fork Sacramento Meadow is off of road 40N64 on the way to Toad Lake. Turn right onto 40N64A and make a left at a well-used spur which dead ends into a large meadow. This large meadow is 8.4 acres, with four distinct locations judged to be fen (Figure 14). The area of fen is estimated to be less than a third of an acre. *Caltha* and *Carex luzulina* stands were surveyed in the fen areas and a *Veratrum californicum* stand with mixed grasses was surveyed in the meadow complex. *Darlingtonia* is also present. There are multiple spring mounds and springs present at this site as well as a small floating mat.

Six additional meadows are accessed from the trailhead for Toad Lake (Trail 05W05), located at the terminus of road 40N64. The rare species *Raillardella pringlei* occurs along drainages throughout this meadow complex. Immediately south of the trailhead is **Toad Lake Meadow 2**. This is a small wet meadow (about 0.4 acres) containing no fens (Figure 15). Dominant communities are *Veratrum californicum* and diverse meadow characterized by sedges and *Perideridia* sp. Water in the meadow is derived primarily from a small stream that runs the length of the meadow. Underground sources such as seeps may also be present. Observed impacts include foot traffic associated with the Toad Lake Trail, which bisects the northern edge of the meadow. No plot samples were taken here.

Toad Lake Meadow 1 is contiguous with the southwestern edge of Toad Lake Meadow 2. This is a small wet meadow (about 1.4 acres) containing no fens (Figure 16). Water is derived from underground seeps which form many small channels throughout the meadow, and eventually merge into a single outflow channel. Plot surveys were completed in a *Juncus balticus*, a vegetative *Carex echinata*, and a *Helenium bigelovii* stand. *Deschampsia californica* was another dominant plant species in the meadow. One soil pit was dug but soil samples were not collected.

Toad Lake Meadow 3 is approximately 100 meters west of Toad Lake Meadow 2, and is bordered on the south by Trail 05W05. This is a large wet meadow, 8 acres in size, with a small fen area of less than 200 sq meters (Figure 17). Water is derived from springs and a single channel that runs the length of the meadow along the southern edge. Outflow occurs via multiple channels. Vegetation is dominated by *Darlingtonia, Narthecium*, *Eleocharis decumbens* and *Carex echinata*, and diverse meadow that includes *Hastingsia alba* and *Perideridia* sp. Of the two spring mounds observed, one supported a floating mat. The rare taxa *Parnassia cirrata* var. *intermedia* (CRPR 2.2) and *Raillardella pringlei* (CRPR 1B.2) both occur in this meadow.

Toad Lake Meadow 4 is adjacent to Toad Lake Meadow 3 to the northeast, and approximately 100 meters north of Toad Lake Meadow 1. Toad Lake Meadow 4 is a large wet meadow (4.8 acres) that does not contain fens (Figure 18). Water is derived from multiple seeps and 3 springs, which converge into a single outflow channel. Although most seeps and springs arise in upper portions of the meadow, there are at least two that arise from within the central portion of the meadow. The largest channel occurs at the southern edge of the meadow and supports dense *Darlingtonia*. Outflow occurs via this and additional smaller channels. Other dominant species include *Juncus nevadensis*, *Narthecium*, and *Carex echinata*. The rare taxon *Parnassia cirrata* var. *intermedia* (CRPR 2.2) is also present.

Toad Lake Meadow 5 is located at the southwestern edge of Toad Lake. It is a moderately large wet meadow (3 acres) that contains one small area mapped as fen (Figure 19). Water is derived from several small drainages that enter the meadow at several locations; 5 separate channels

were observed during surveys. The area mapped as fen is located in the wettest portion of the meadow where braided channels cross and flow into Toad Lake. Dominant communities are *Narthecium, Carex echinata – Eleocharis*, *Eleocharis*, and diverse meadow. Plot surveys were completed in a *Carex echinata* and a *Narthecium* stand. Both *Darlingtonia* and *Raillardella* are present. One soil pit was dug and soil samples were collected. Impacts noted during surveys include a trail and associated foot traffic which bisects the meadow at the northern edge.

Toad Lake Meadow 6 is located approximately 60 meters east of Toad Lake Meadow 1. It is a small wet meadow (0.6 acres) that contains no fens (Figure 20). Water is derived via seeps and two springs, which form a single outflow drainage. Seeps / springs arise both from the edges and the central portions of the meadow. Dominant communities are *Helenium, Eleocharis* and *Darlingtonia.* A plot sample was completed in a *Helenium bigelovii* stand. Other dominant plants include *Darlingtonia, Eleocharis decumbens*, and *Veratrum*. There is also a large creek that runs along the southern edge of the meadow and supports scattered stands of *Raillardella pringlei*.

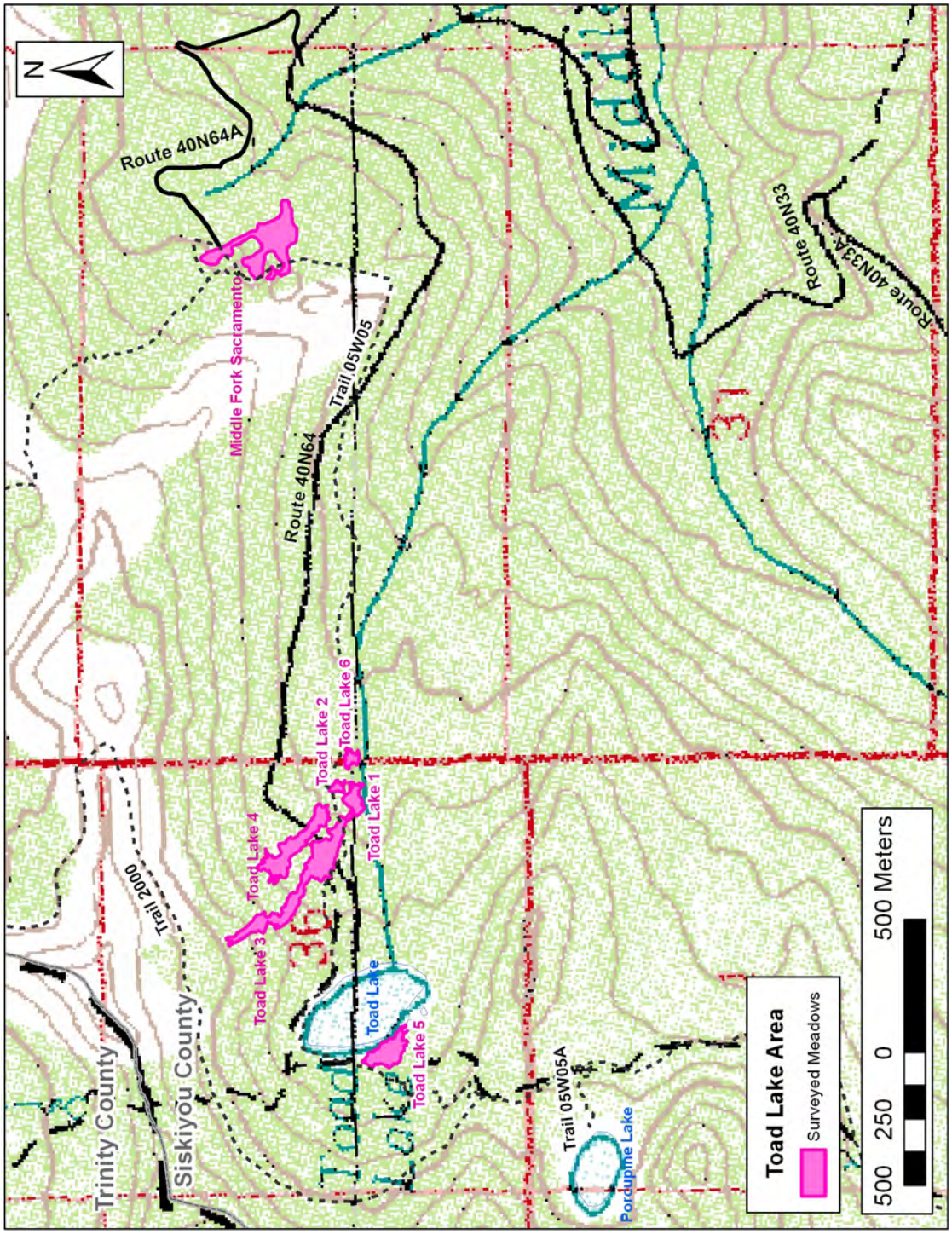
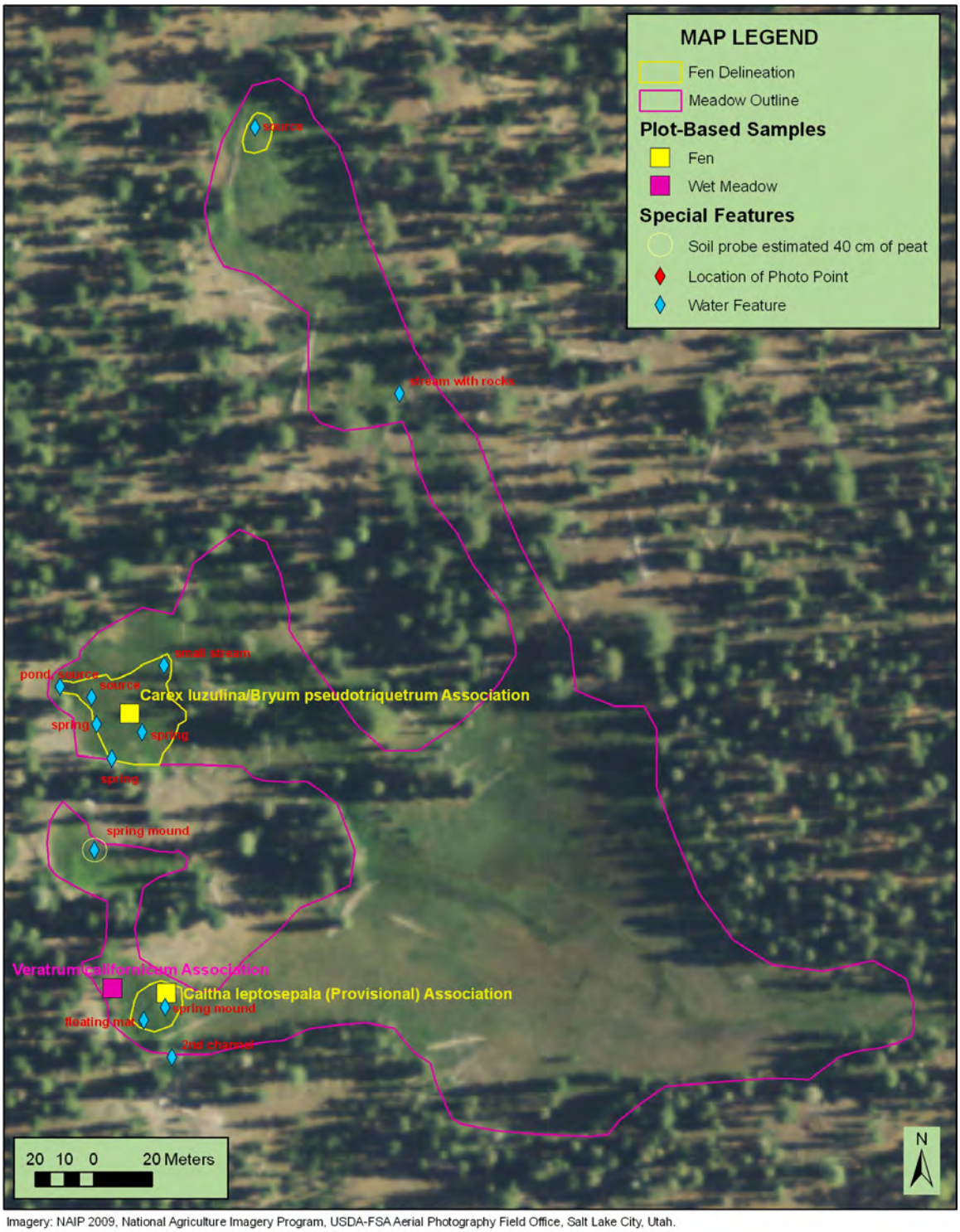


Figure 13. Meadows surveyed near Toad Lake and the Middle Fork of the Sacramento River.

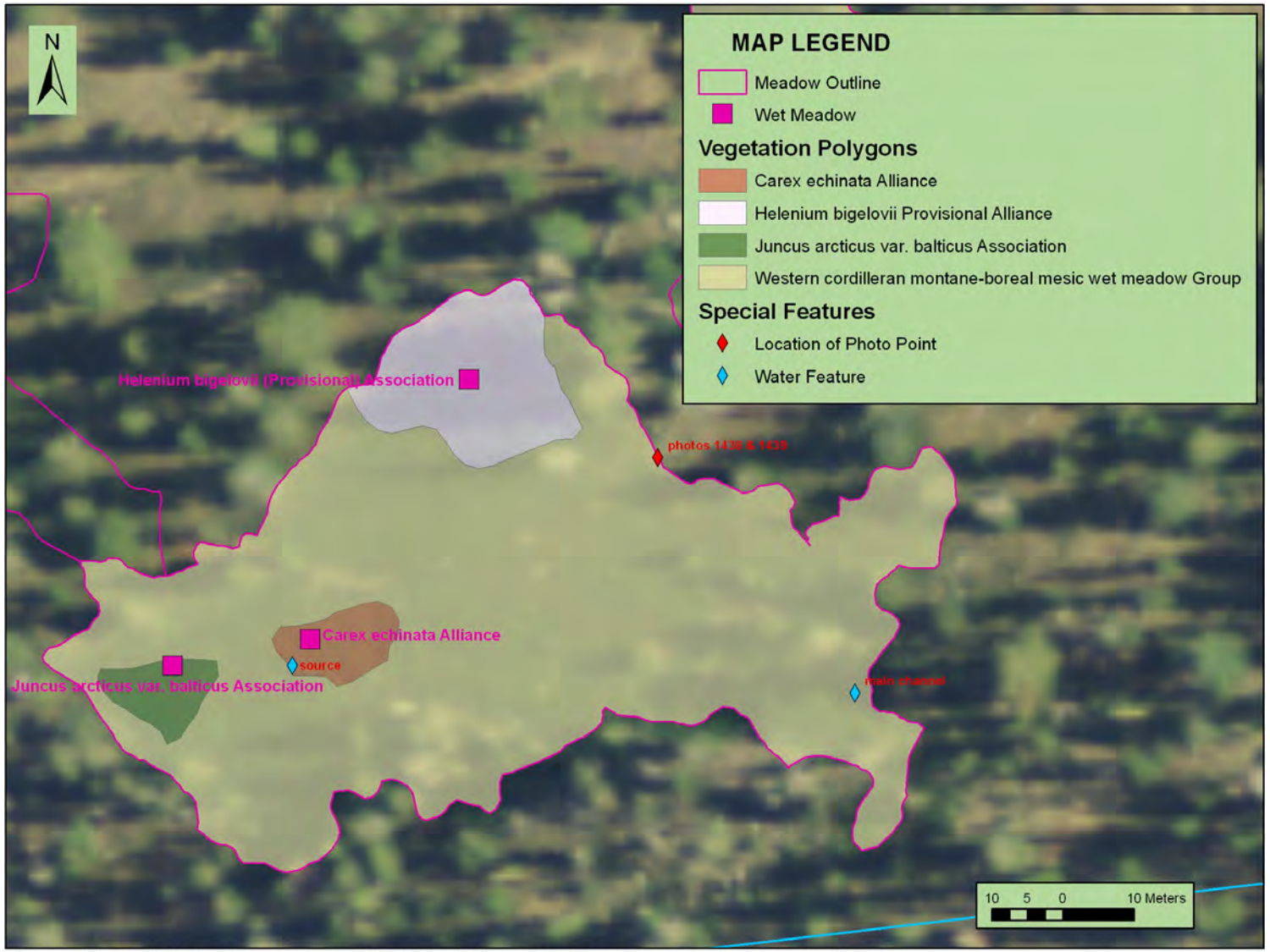


Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 14. Middle Fork Sacramento Meadow.

Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 15. Toad Lake Meadow 2.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 16. Toad Lake Meadow 1.

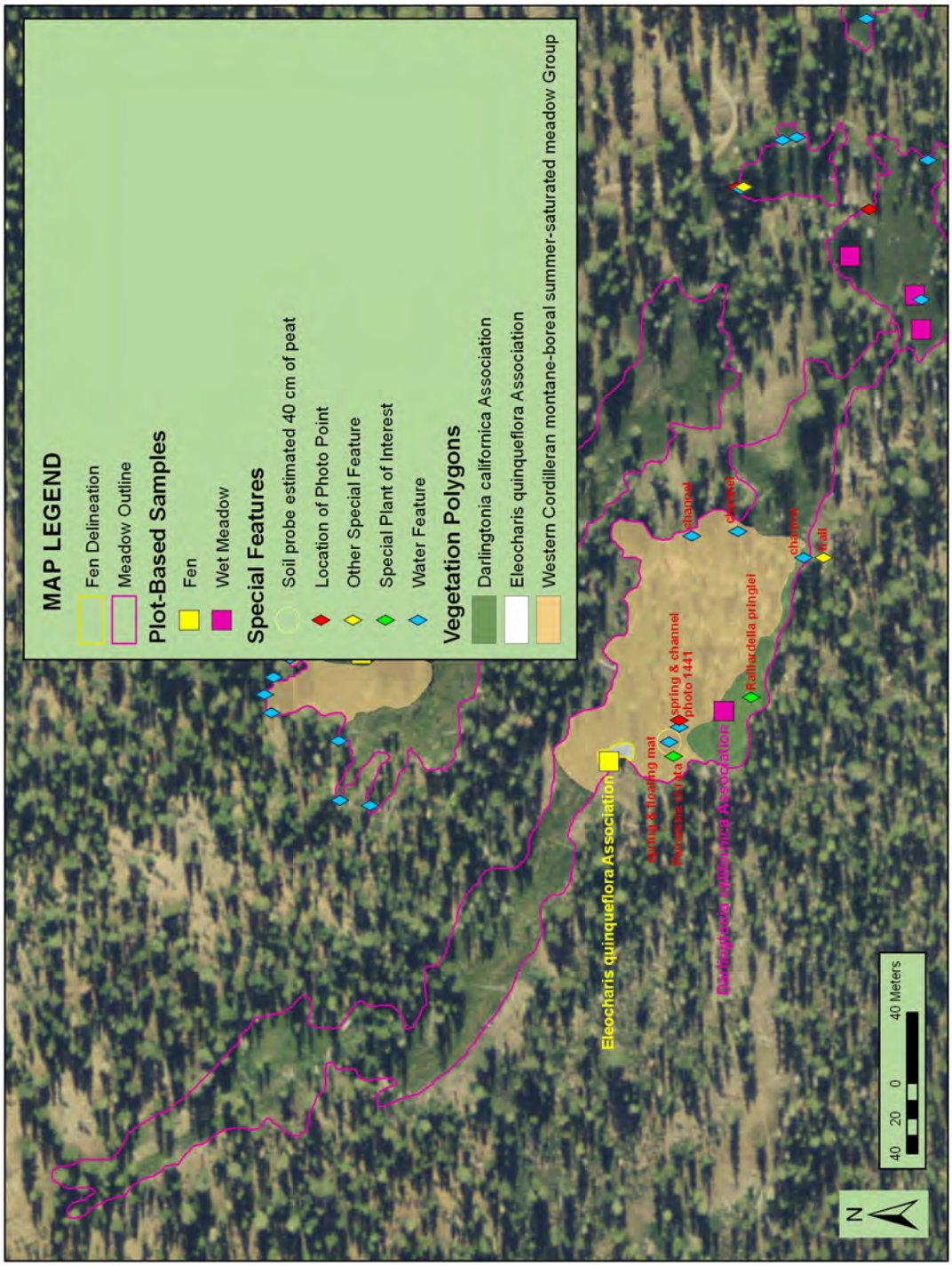
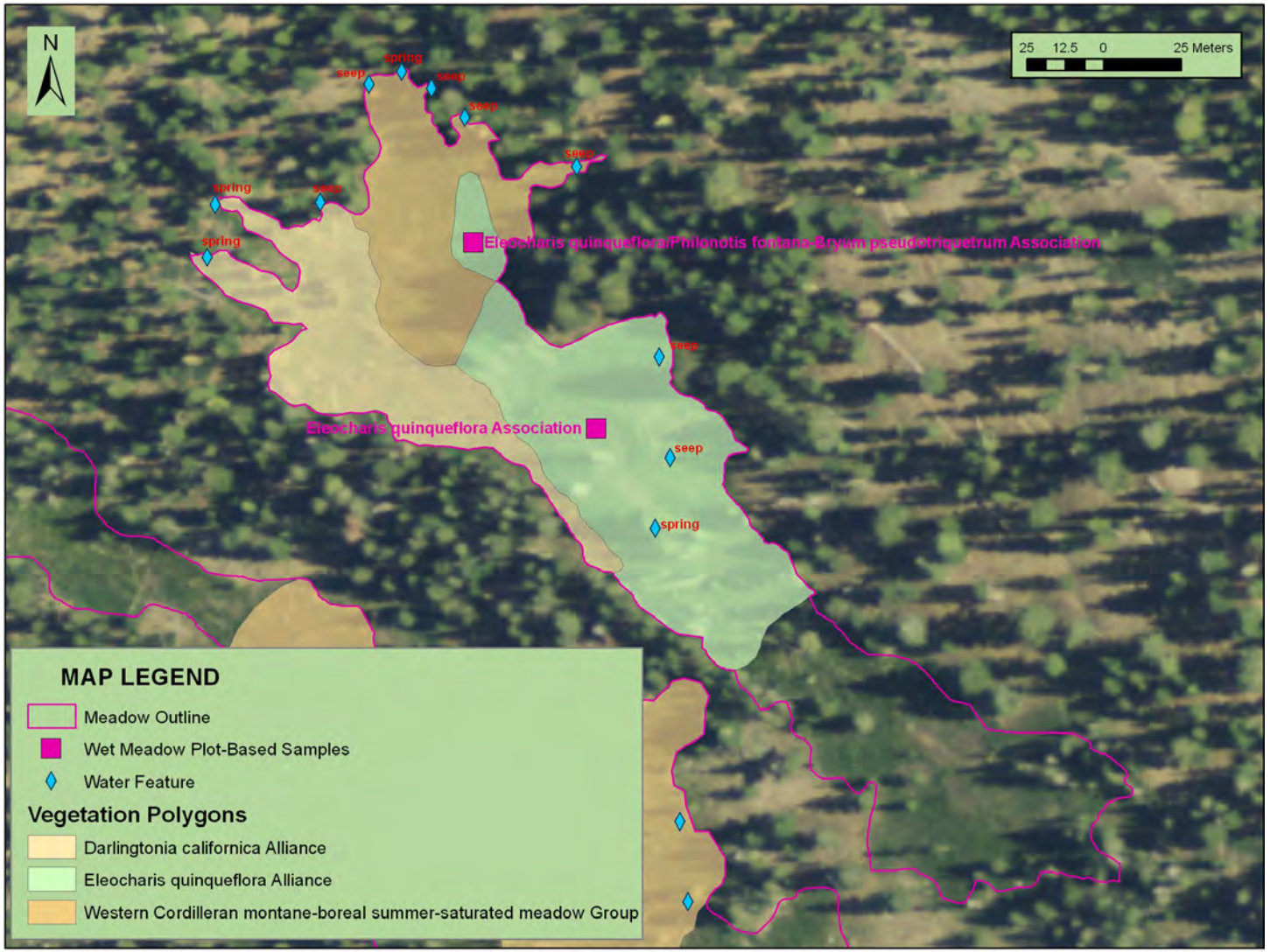
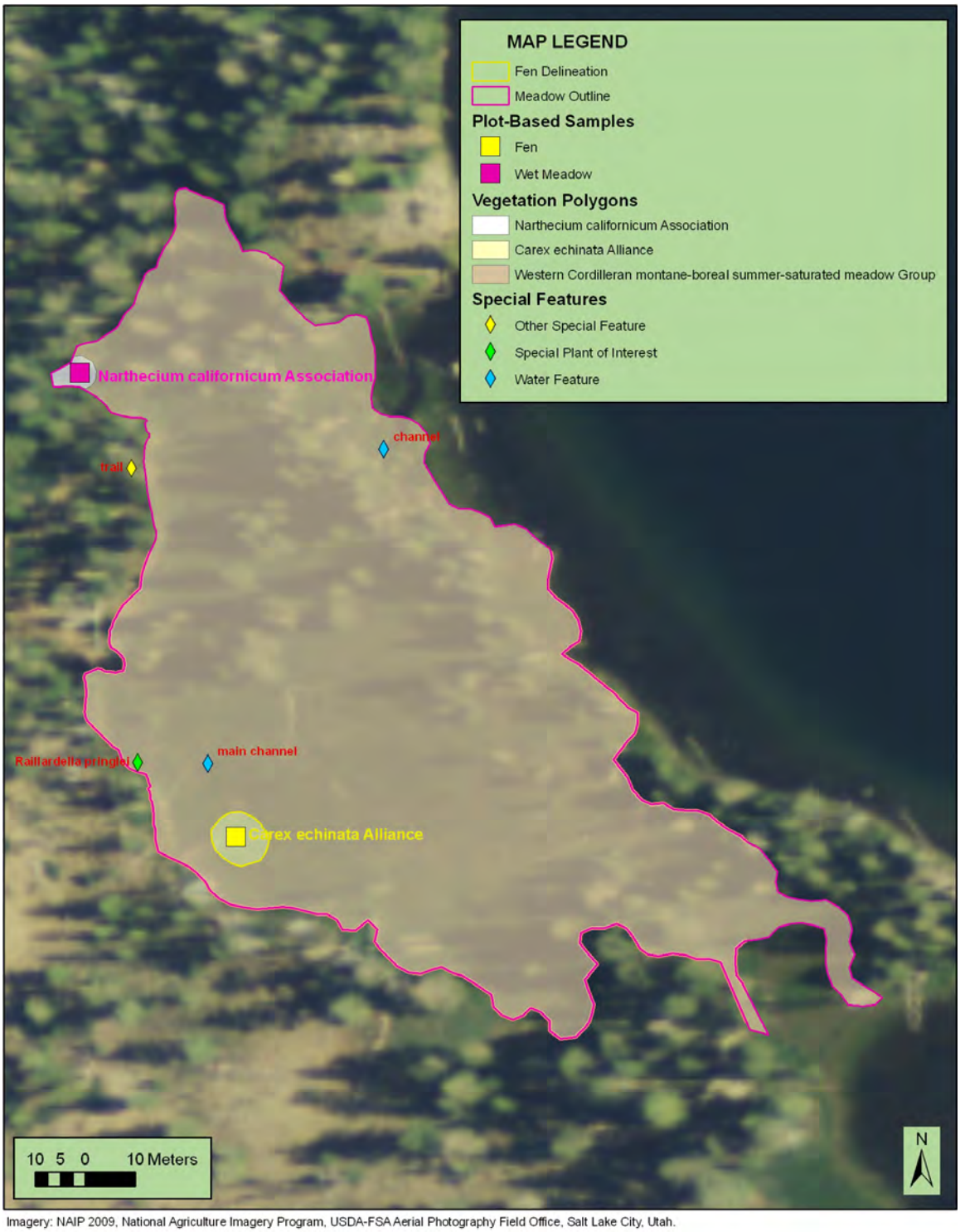


Figure 17. Toad Lake Meadow 3.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 18. Toad Lake Meadow 4.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 19. Toad Lake Meadow 5.

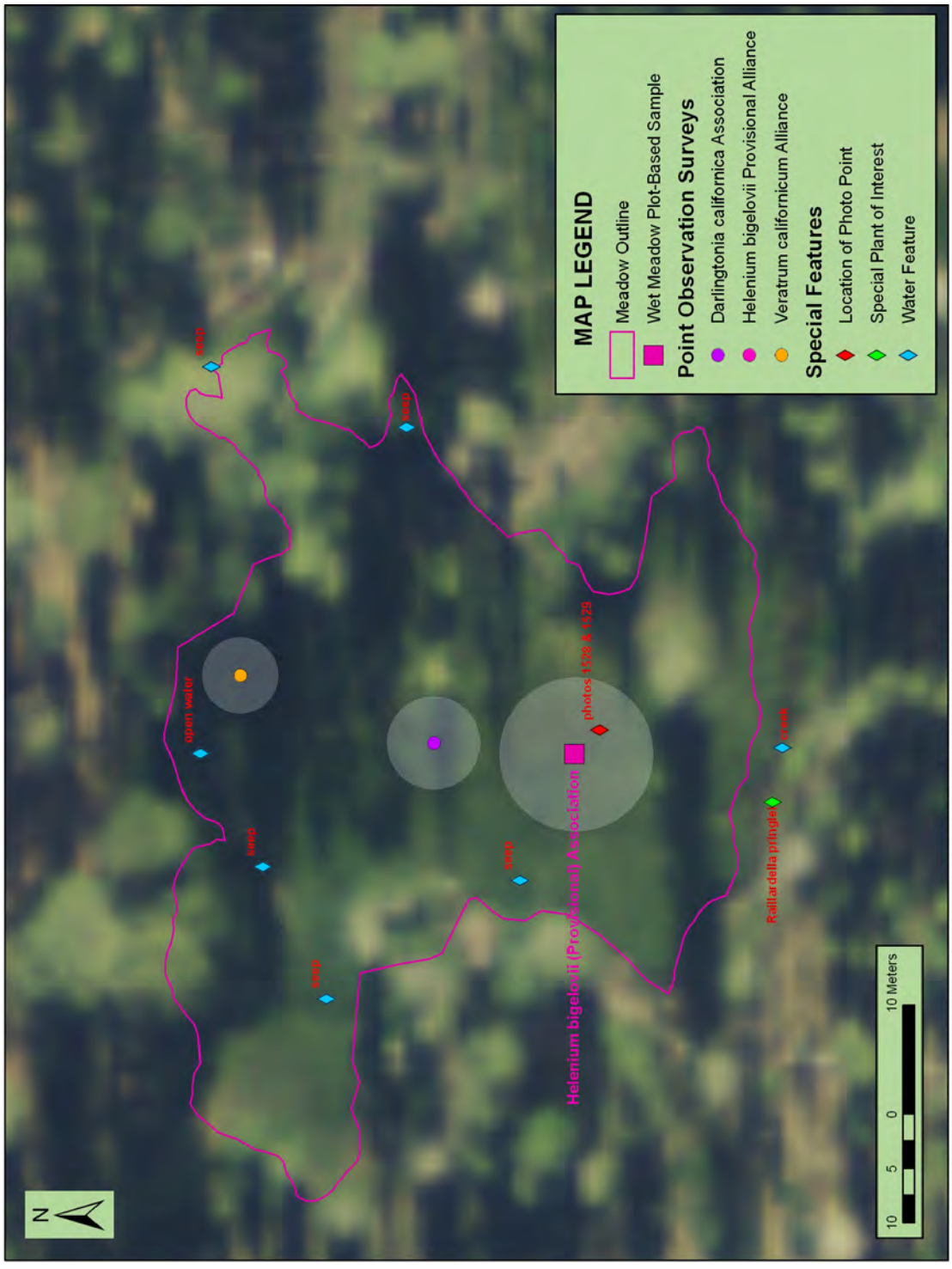


Figure 20. Toad Lake Meadow 6. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

Fawn Creek Meadows

The rare plant *Raillardella pringlei* is present throughout all three of the Fawn Creek sites. The geodatabase contains points where some populations were seen. The area has not been permitted for grazing since 2008 (P. Brownsey, pers. comm. 2011).

Fawn Creek Meadow is located 800 m west of the end of the road 40N42 (Figure 21). This meadow is 19.2 acres and contains large stands of *Carex* spp., *Eleocharis decumbens*, and *Pinus contorta* var. *murrayana* (Figure 22). Only a small area within this meadow is fen (0.4 acres), however, the diversity of the plant communities is high (Figure 23). Four plot surveys were taken in the fen complex, in stands dominated by *Juncus nevadensis*, *Eleocharis decumbens*, *Darlingtonia*, and *Carex scopulorum*. Some un-sampled types present in the meadow are; *Carex echinata*, *Danthonia californica*, *Deschampsia cespitosa*, *Hastingsia alba*, *Juncus balticus*, *Narthecium*, and *Veratrum*. At the lowest end of the meadow are large stands of *Eleocharis* in standing water. In the upper meadow there are meandering rivulets and stream channels with multiple spring sources and some spring mounds.

Fawn Creek West is located up a small stream, on a slope 200 m west of the northwestern edge of the main meadow. This smaller opening is about 1,200 m^2 (Figure 24) and contains two spring sources and two large spring mounds that seemed like they could be fen, but the soil results were too low in Carbon. A *Darlingtonia* stand and a *Raillardella pringlei – Juncus nevadensis* stand were sampled in the small fen-like areas. Other vegetation types present that were not sampled were dominated by *Eleocharis decumbens*. and *Deschampsia cespitosa.*

Fawn Creek South is located 50 m south of the southwestern edge of the main meadow. This meadow is 1.2 acres and has an estimated area of about 700 square meters of fen (Figure 25). This meadow complex is quite sloped and is fed by seeps and springs. Vegetation is dominated by *Carex scopulorum*, *Caltha leptosepala, Juncus nevadensis*, *Darlingtonia*, *Deschampsia cespitosa*, and *Eleocharis decumbens*.

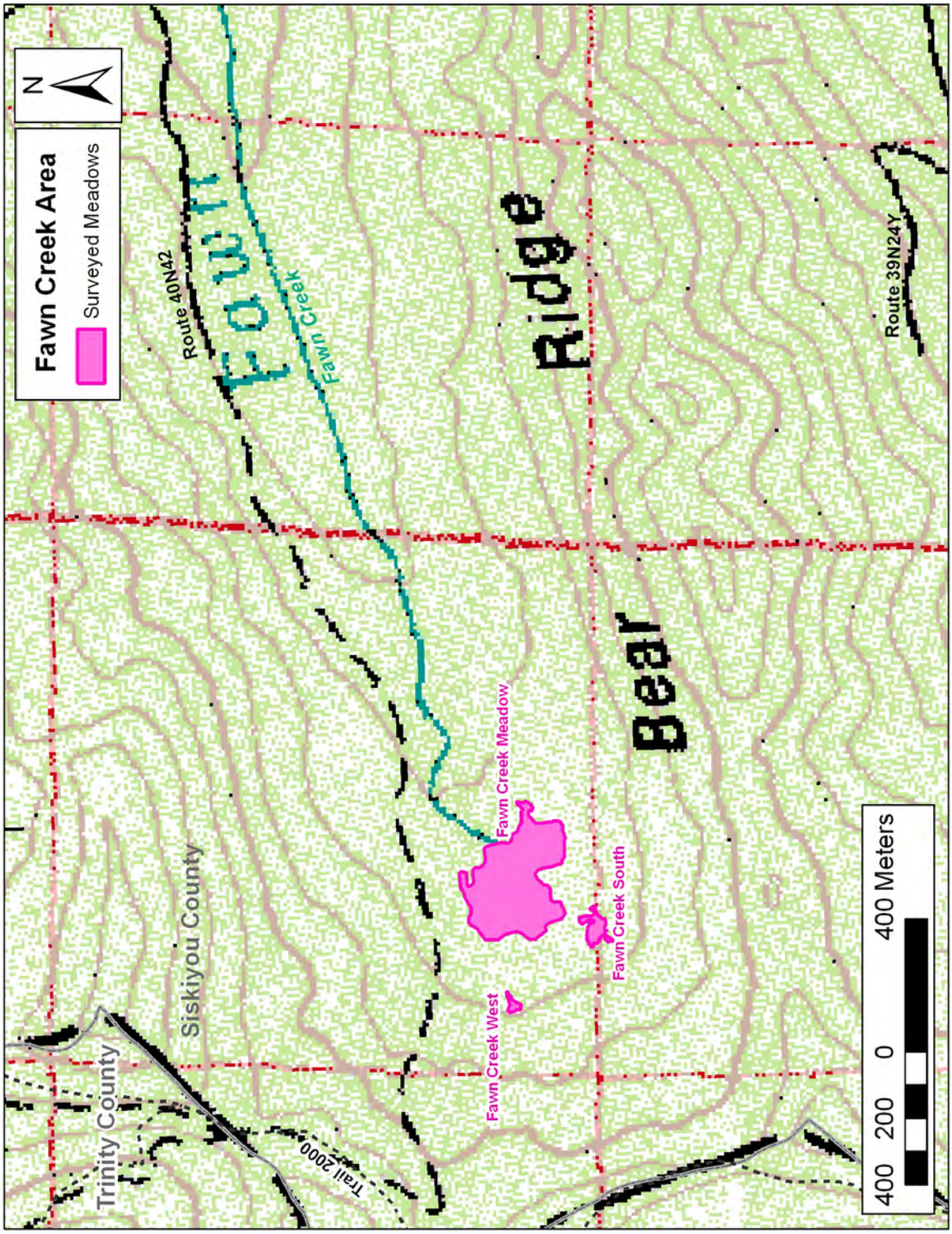


Figure 21. Meadows surveyed surrounding the headwaters of Fawn Creek.

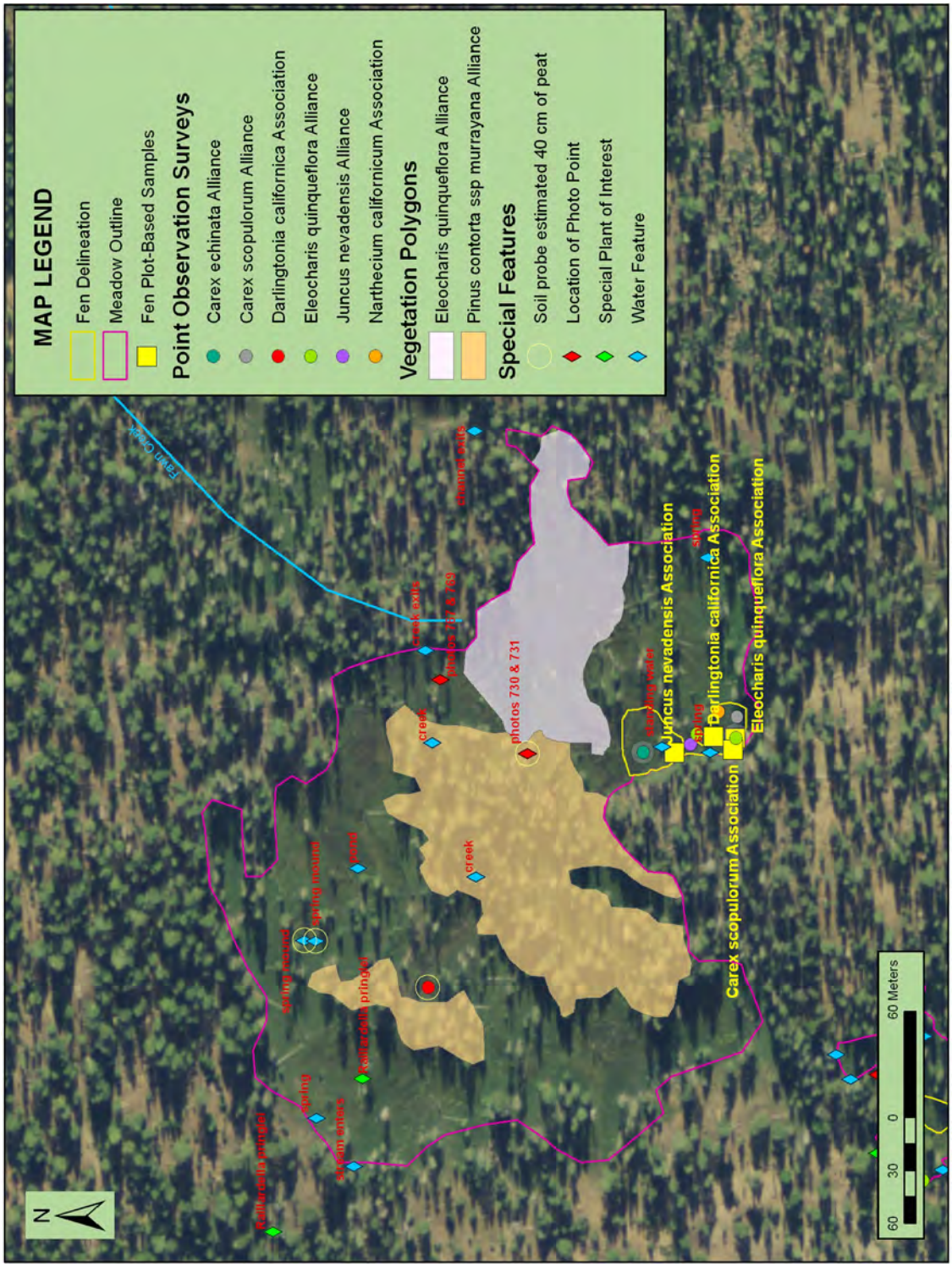
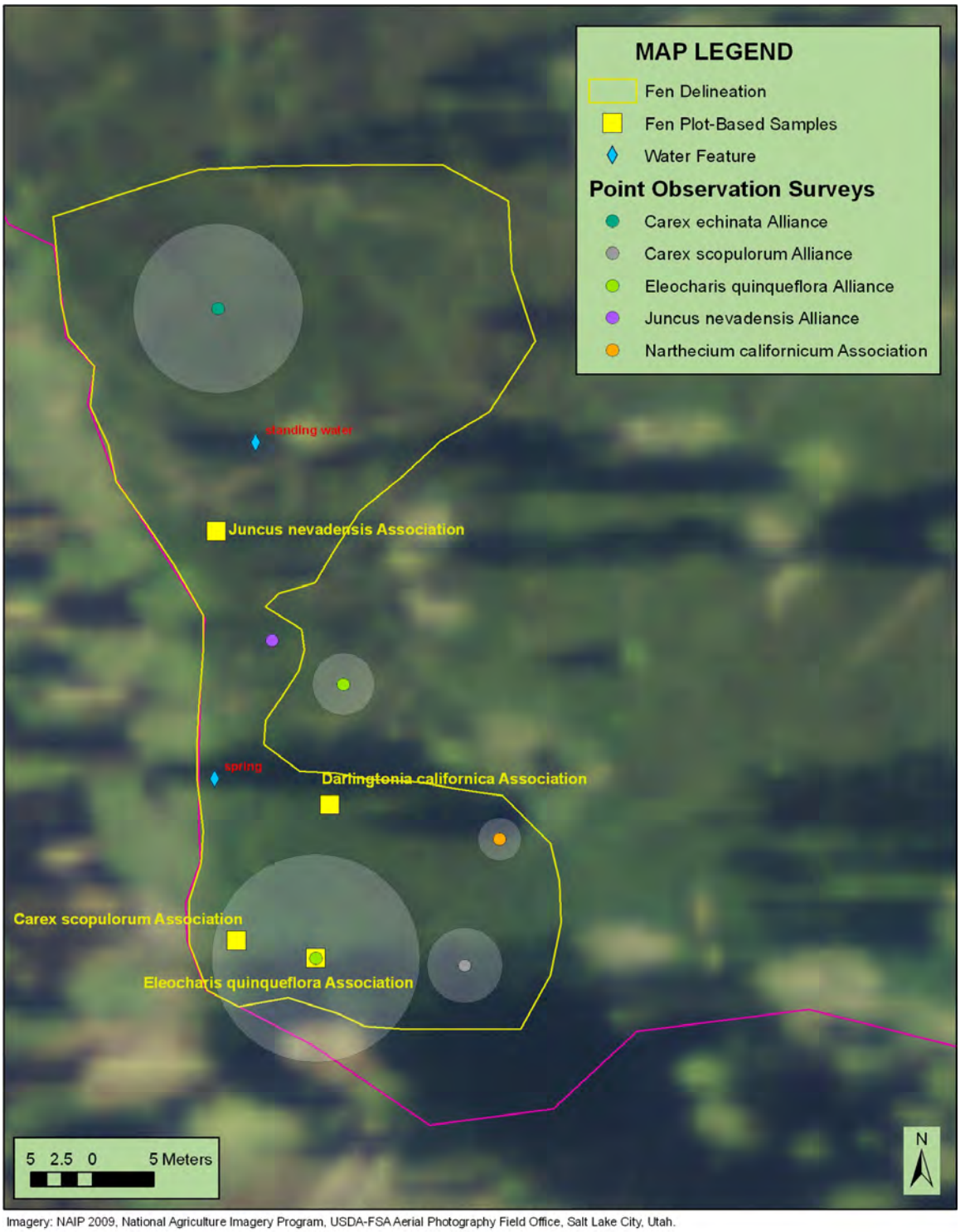


Figure 22. Fawn Creek Meadow. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.



Imagery: NAIP 2009, National Agriculture Imagery Program, USDA-FSA Aerial Photography Field Office, Salt Lake City, Utah.

Figure 23. Closeup of Fen Area within Fawn Creek Meadow. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

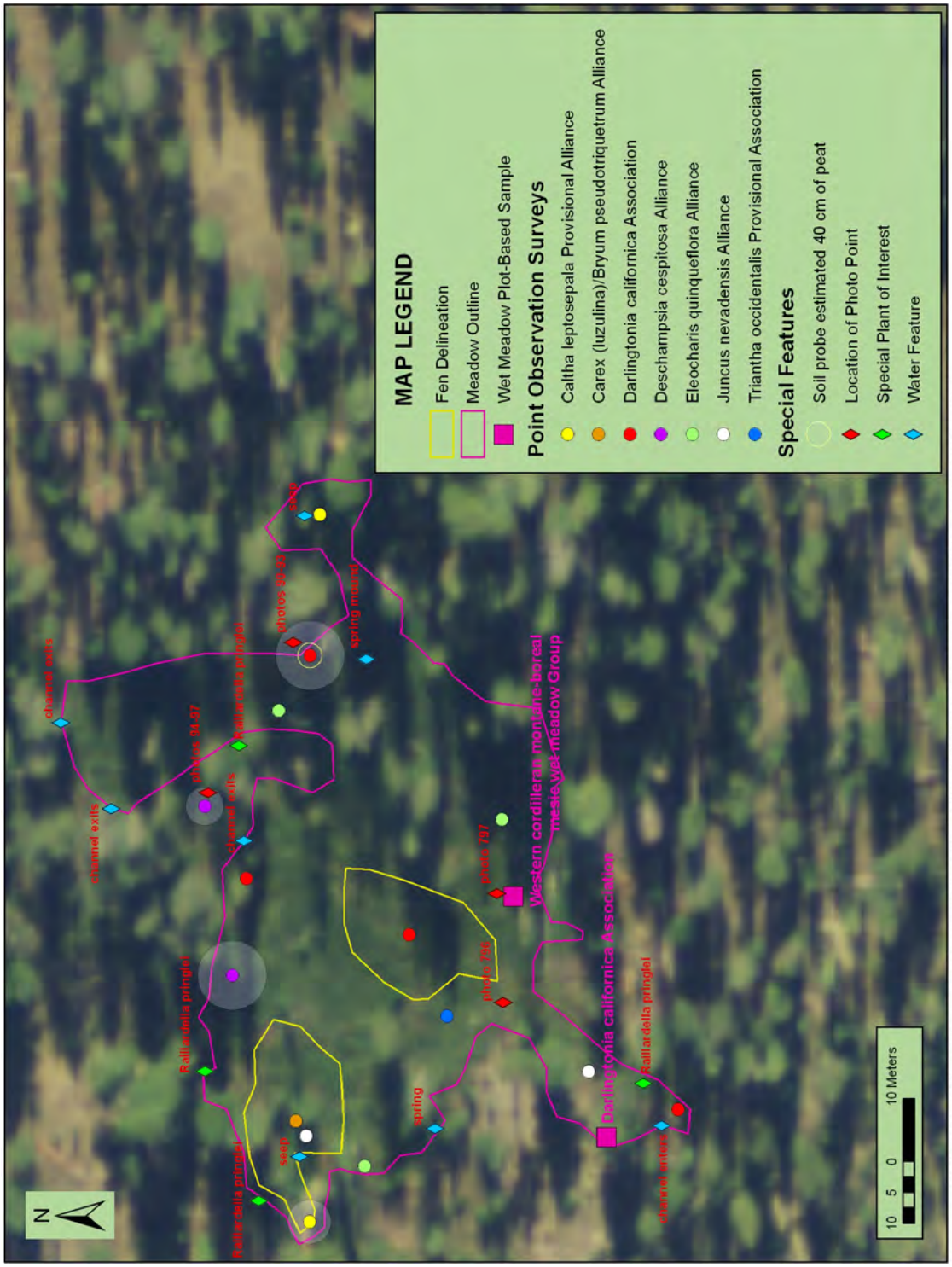


Figure 24. Fawn Creek Meadow South. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

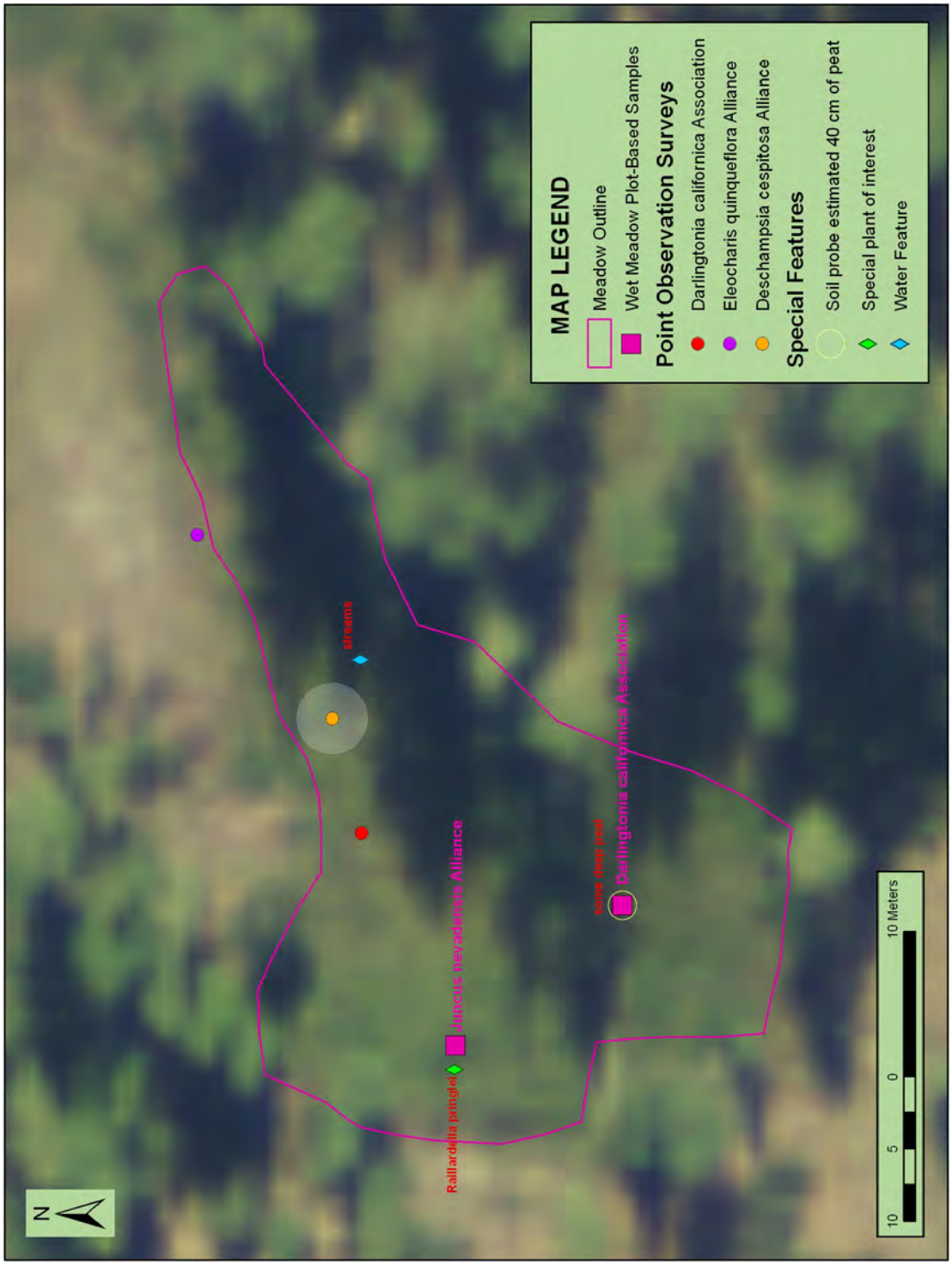


Figure 25. Fawn Creek Meadow West. Transparent circles surrounding point observation surveys are the same area as the estimated size of the stand.

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APPENDIX 1A. Field forms used for meadow surveys and vegetation plot sampling.

FEN SURVEY FORM Required fields are in **bold** **USFS REGION 5** **AUGUST 2010 VERSION.**

Meadow Name: Allium Waterfall Meadow 1 **Date:** 9/21/11 Aerial Photo #

Fen ID: 0514-59-AWM-1 **Surveyors:**

Location info: Take 2N17 to hairpin turn and park. Hike down trail 06W05 about 1km and at small stream follow it due South for 500m until you reach a fen opening. **Description:** Large Meadow with many streams running through 2 separate fen areas w/a wet meadow. Most of meadow is a mixture of wet meadow species.

Forest: **District:**

County: Trinity County T: R: Section: **Quad:** South China Mt NE **Elevation:** 2015 ft / m

Overview Photos, all survey photos are filed at:

Photo #	View	Description	Photo #	View	Description
		*Get photo #s from Deb	246 - 248		

Surveyed Area Size: 1 acres, Entire meadow surveyed? yes / no) 25 %, % of Meadow that is Fen: 15% +

# of Stands surveyed: 4 1° H_2O source: Meadow Seep Spring (Drainage) 2° H_2O source: Meadow (Seep) Spring Drainage

# of Stands present: 6 List veg types present: Caltha - Darlingtonia (fen), Alnus (both), Juncus nevadensis (meadow), Senecio (meadow), Northern mix

Bedrock type:

Meadow Polygon delineated correctly? ☐ Accurate ☐ Not Accurate (Correct Map) ☒ New Polygon; Comments:

Fen Polygon delineated correctly? ☐ Accurate ☐ Not Accurate (Correct Map) ☒ New Polygon

CHARACTERISTICS OF THE WHOLE MEADOW POLYGON

- **OPEN WATER PRESENT?** (NOT FLOWING) ☒ YES ☐ NO
- **FLOATING MAT PRESENT?** ☐ YES ☒ NO
- **CHANNEL(S) THROUGH SITE?** ☒ YES ☐ NO
- **SHRUB FEN PRESENT?** ☐ YES ☒ NO
- **TREED FEN PRESENT?** ☐ YES ☒ NO
- **HUMMOCKS OR PATTERNED GROUND PRESENT?** ☒ YES ☐ NO
- **TERRACE PRESENT?** ☒ YES ☐ NO
- **COMPLEXITY OF MICROTOPOGRAPHY**
  - ☐ 1 None
  - ☐ 2 Low. One raised feature.
  - ☒ 3 Moderate. Up to several separate raised features, or one complex feature.
  - ☐ 4 High. Numerous features and/or very well-developed network.of features.

WATER SOURCE / INFLOW (CHOOSE ALL THAT APPLY)

- ☒ Subsurface, no incoming channel
- ☒ Surface channel inflow; # incoming: 1
- ☒ Spring(s) observed; # 1

WATER OUTFLOW (CHOOSE ALL THAT APPLY)

- ☐ Subsurface, no outgoing channel
- ☒ Surface channel outflow; # out: 2
- ☐ Basin Topography, wetland surface below surrounding land along entire perimeter, NO OUTFLOW.

STREAM FREQUENCY

- ☐ 1 None
- ☐ 2 Low. One single thread
- ☐ 3 Moderate. Up to several separate features, or one thread with branching laterals.
- ☒ 4 High. Numerous streams and/or very well-developed network.

STREAM SIZE

- ☒ SMALL - 1 meter wide and/ or < 50 cm deep
- ☐ LARGE – features large > 1 meter wide and/or > 50 cm deep.

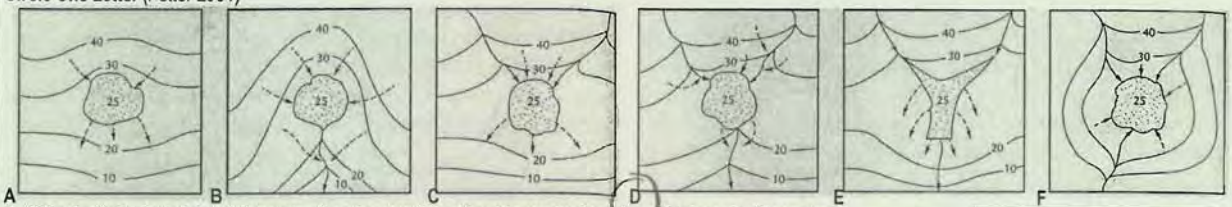
GULLY FREQUENCY

- ☒ 1 None
- ☐ 2 Low. One single thread
- ☐ 3 Moderate. Up to several separate features, or one thread with branching laterals.
- ☐ 4 High. Numerous gullies and/or very well-developed network.

GULLY SIZE

- ☐ SMALL - 1 meter wide and/ or < 50 cm deep
- ☐ LARGE – features large > 1 meter wide and/or > 50 cm deep.

Circle One Letter (Fetter 2001)



A. Groundwater dominated, both inflow and outflow are subsurface. No evidence of surface channels into or out of the wetland.
B. Groundwater inflow dominant. No surface channel inflow to wetland, but a surface channel outflow exists. Outflow may be perennial or intermittent.
C. Surface water inflow. No evidence of an outflow channel.
D. Surface water dominated. Evidence of both surface water inflow and outflow.
E. Impoundment, either man-made reservoir or natural fill associated with slumping or landslide. Similar to D. Reservoirs can not create a fen, but they may have inundated one.
F. Topographically a closed basin. Surface inflow, but no outflow. Do not confuse with A or C. Wetland surface is obviously lower than surrounding perimeter area.

Water-table contour — 30 —
Stream →
Ground-water flow - - - →

DESCRIPTION OF THE ENTIRE MEADOW POLYGON CONTINUES HERE

☐ HYDROLOGIC ALTERATION ☒ NONE ☐ LOW ☐ MODERATE ☐ HIGH IF PRESENT, SPECIFY USING DISTURBANCE CATEGORIES IN THE FOLLOWING SECTION

(dikes, diversions, ditches, flow additions, or fill present in wetland that restricts or redirects flow)

LOW = such as roads at or near grade, small diversion or ditches (< 30 cm deep) or small amount of flow additions

MODERATE = such as 2-lane road, low dikes, roads w/ culverts adequate for stream flow, medium diversion or ditches (30–100 cm deep) or moderate flow additions.

HIGH = such as 4-lane Hwy., large dikes, diversions, or ditches (>1 m deep) capable of lowering water table, large amount of fill, or artificial groundwater pumping or high amounts of flow additions

DISTURBANCE* IN POLYGON	AGENT (IF KNOWN)	INTEN-SITY	EXTENT IN POLYGON	☐ NO DISTURBANCE IN POLYGON DISCUSSION
Deer beds		1	1	
Small mammals		1	1	

DISTURBANCE* IN BUFFER†*	AGENT (IF KNOWN)	INTEN-SITY	EXTENT IN BUFFER	☐ NO DISTURBANCE IN BUFFER DISCUSSION

*DISTURBANCE CATEGORIES (IF OTHER, PLEASE DESCRIBE)				INTENSITY	EXTENT
BEAVER ACTIVITY	CAMPSITES	DEPOSITION (SEDIMENTATION)	DE-WATERING	(0 – NONE – NOT USED)	1 COVERS < 10%
BROWSING (WOODY PLANTS)	LITTER/ DUMPING/ TRASH	DITCHES (DUG BY MAN)	GROUNDWATER PUMPING	1 – LOW INTENSITY	2 COVERS ¼
GRAZING	ORV ACTIVITY / TRACKS	EROSION (INCLUDING CHANNEL -INCISION & HEADCUTS)	SURFACE WATER DIVERSION	2 – MODERATE INTENSITY	3 COVERS ½
SMALL MAMMALS	BURIED UTILITY CORRIDORS			3 – HIGH INTENSITY	4 COVERS ¾
TRAILS/ FOOT TRAFFIC	DEVELOPMENT (> ROADS)	GROUND DISTURBANCE -(GENERAL)	DRAINAGE FROM ABOVE - INCREASE IN WATER INFLOW	4 – VERY HIGH INTENSITY	5 COVERS ALL
TRAMPLING/ HOOF PUNCH	POWER LINES	SOIL REMOVAL (PEAT MINING)	FLOODING (INCLUDING DAMS. DIKES)		
EXOTIC PLANT INVASION	ROADS (CONSTRUCTED)	TREE CUTTING / LOGGING			
FIRE					

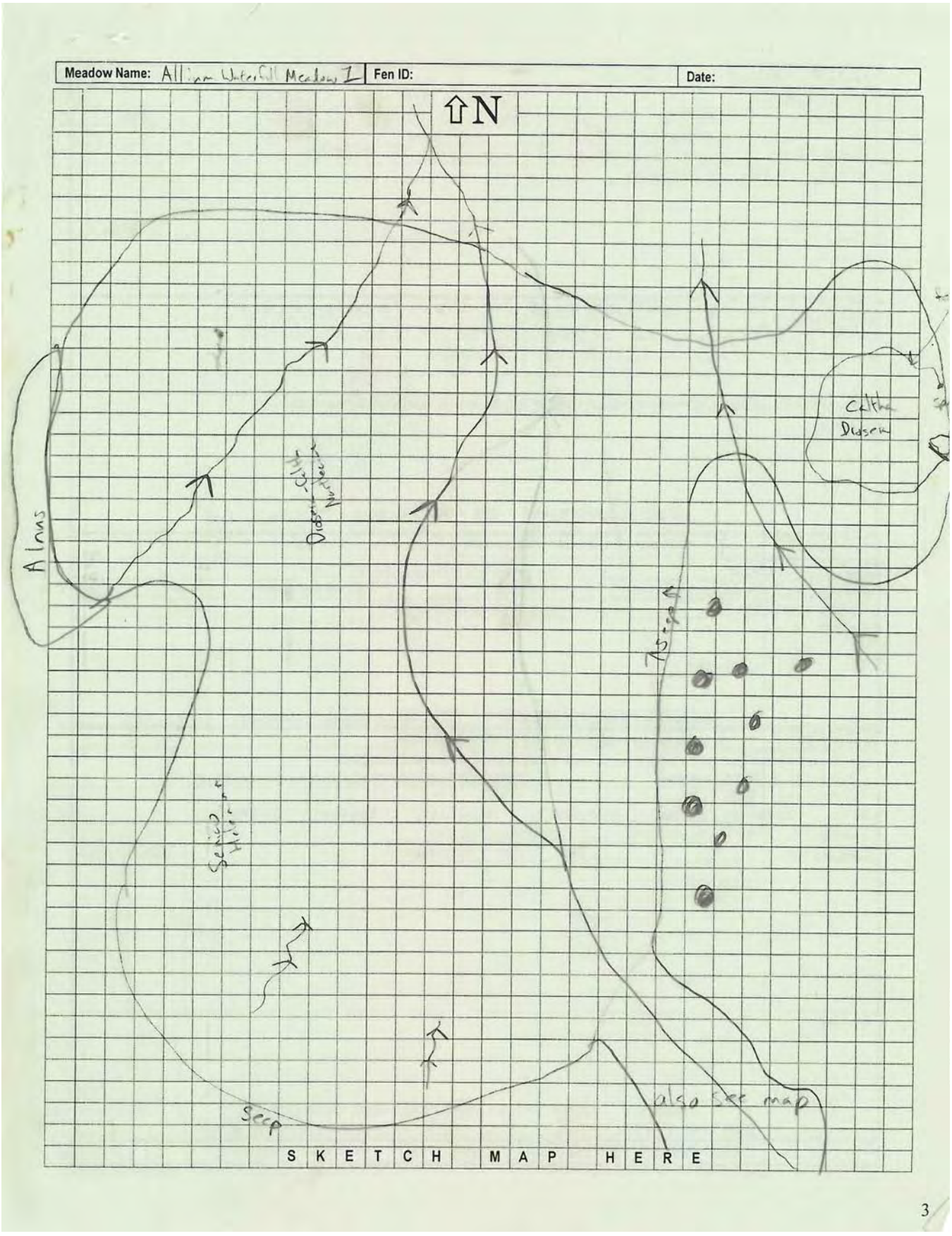
★. REQUIRED FIELDS. †BUFFER IS THE AREA WITHIN THE CONTRIBUTING WATERSHED, UP TO 100 M FROM THE EDGE OF THE WETLAND COMPLEX.

On the following page, provide a map sketch of the entire meadow polygon including:

- Extent and arrangement of Stands, including tree or shrub stands & species where relevant,
- Soil pit and plot locations,
- Streams where they enter and exit the polygon (showing direction of water flow with an arrow),
- Major features such as open water, floating mats, boulder fields, terraces, dry areas, damage areas, or gullies,
- Locations of rare plants, including mosses

USE THE TABLE BELOW TO RECORD ELEMENTS OF THE MAP THAT REQUIRE FURTHER EXPLANATION

Label	Description


Meadow Name: Allium Waterfall Meadow I
Fen ID:
Date:
N
Alnus
Caltha
Seep
also see map
SKETCH MAP HERE
3

0514-54-AWM-1

STAND/PLOT RECORD | Fen ID: Allium Waterfall Meadow 1 | Date: 9/21/11

GPS Coordinates: E 540406 N 4575071 | UTM Zone: 10 / 11 | GPS datum: NAD83

Plot Number: AWM_1A | Fen Type: Basin Mound Sloping Lava Not-fen | Slope: ___ % or 9 degr,

Estimated size of Fen Stand: 100 m² / acres | Aspect: 310 NW

PLOT PICTURES | Defined plot used?: yes / no | If yes, plot size (m²): 10 / 20 / 100 / 4X5

Photo #	View	Description
859-862	N→W	N→W at cardinals
863	NE	NE across plot
864	down	Soil core

Stand is sloping towards stream. Lots of small rivulets, low spots within fen. Caltha + Darlingtonia growing in low spots. Plot uneven.

SOILS Determine the Depth, Thickness (e.g. 0-25), Color and Texture of each Recognizable Horizon

Depth (cm)	Color	Texture	Von Post	Comments: (Type of Peat, Samples Taken)
1-15	Brown	ONBD	5	Saturated @ 10 cm
16-30	Very dark brown	OBD	6	soil not saturated
31-40	Very dark brown	OBD	9	" "

Texture: C = Clay, OBD = Organic-Broken Down, ONBD = Organic-Non-Broken Down, S = Sand, Si = Silt

Remarks:

Pit did not fill after 30 min, but soil is saturated at top

HISTIC SOILS PRESENT ? (YES) NO Uncertain (circle one)

HYDROLOGY Determine if Soil is Saturated for a Good Portion of the Growing Season

Depth of Surface Water	N/A cm	Distance to standing or running water	10 m
Depth to Free Water in Pit (after ≥10 min)	>40 cm	pH: N/A	Electrical Conductivity N/A at T N/A
Depth to Saturated Peat	0 cm	Root Zone temperature:	47 (°F) / C

Remarks: See soil remarks.

WETLAND HYDROLOGY PRESENT ? YES NO (Uncertain) (circle one)

VEGETATION Check the vegetation sampling method used below:

☐ Recorded the 3 Dominant Species within each Stratum and their Aerial Cover Class

☐ Recorded all plants & cover class ☒ Recorded all plants & estimated % cover (instead of class)

% Surface cover: = 100%

Water: 0 BA Stems: 6 Litter: 84 Rock (>2mm): 0 Fines (<2mm): 0 Bare Peat: 10 Cvrd Peat: 0

Overall cover: Total % Non-Vasc cover: — Total % Vasc Veg cover: 80

Plant Species	Strata	Cvr	Plant Species	Strata	Cvr
Caltha leptosepala	F	20	Trifolium longipes	F	4
Tofieldia occidentale	F	4	cf Eleocharis decumbens -dt	G	6
Aster alpigenus	F	2	Carex luzulina	G	1
~~Orthocarpus sp.~~	~~F~~	~~+~~	cf Deschampsia elongata	G	+
Eriophorum criniger	G	1	Helenium bigelovii	F	+
Darlingtonia californica	F	6	Senecio triangularis	F	+
Deschampsia cespitosa	G	+	cf Equisetum hyemale ssp affine	G	1
Juncus nevadensis	G	2	Polygonum	F	2
Remarks: · Narthecium californicum	F	6	Dodecatheon (alpinum)	F	+
· Carex hassii	G	3	Danthonia californicum	G	+
· Allium validum	F	+	cf Senecio sp. Solidago multiradiata	F	+
· Carex (hassii) vegetative	G	30	cf Hypericum anagaloides	F	1

Stratum: T = Tree, S = Shrub, F = Forb, G = Graminoid, M = Moss/ Lichen

Cover Class: T = Trace, 1 = 1-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, 6 = 95-100%

IS THIS SAMPLING POINT A FEN ? (YES) NO Uncertain (circle one)

Caltha Alliance

Podagrostis thurberiana - dt

Festuca alba IF k14

Appendix 1B. Fen survey protocol.

DRAFT PROTOCOL FOR USFS R5 FEN SURVEYS
Expanded August 2010 Version including Optional Vegetation Fields

A few practitioners have made suggestions which we have tried to incorporate to the existing field form while retaining the fields that have been collected in the past. We also wanted to help standardize the collecting process by giving more detailed information about how each field of the data sheet is used.

It is suggested that surveyors start by walking the entire fen meadow polygon, viewing the vegetation, hydrology conditions, and peat accumulation, and assessing which locations are most likely to be a fen when a full survey is completed. Try to identify discernible plant communities that are distinct from the others and of fairly uniform character. If time permits, a plot record for each homogeneous stand of vegetation would be ideal.

In addition to seeking out the most saturated conditions, we would like to encourage centering your plot in a homogenous stand of vegetation. The sample hole should be dug in a location that is clearly representative of that vegetation type, not in a transition zone. A stand is the basic physical unit of vegetation in a landscape and can be thought of as a plant community. It has no set size. A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.
2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. A fen may include multiple vegetation stands, one area dominated by one Carex and an adjacent stand dominated by another. By centering your sampling location within a single stand, the plant data you collect will be limited to a single vegetation type instead of generalizing the fen vegetation over multiple types.

Definition of each field on form:

The first section (first 3 pages) is filled out once for each polygon or meadow survey. It is suggested that the form be printed as a double-sided document with the first 2 sheets of paper (pages 1 through 4) stapled together before going out in the field. Several stands and soil samples may be taken within a single fen meadow. The additional pages of the data sheet are used to assess the individual stands within the larger meadow or fen complex. Check boxes are provided along the margins of the form to assist the recorder in completing all the included fields (they can be checked off as each portion is completed).

FEN SURVEY FORM	Required fields are in bold	**USFS REGION 5**	**AUGUST 2010 VERSION.**

Meadow Name: If a proper name has been assigned to this Meadow, please write it here. New fens may be assigned a name for future reference. It should be a name that has not already been used in your district. Examples of names used include “Grass Lake” or “Madia Fen”.

Date: Date of the sampling / survey.

Aerial photo # (optional): If you are using an aerial photo as reference, record its number or ID here.

Fen ID: This ID is a mix of characters and numbers that is chosen in accordance with the Forest's numbering system. This Fen_ID refers to the whole meadow polygon. The ID may be chosen in the office when the information is recorded digitally. Examples of IDs used in the past include 0506_51_Humbug, 0517_56_ANDMN, and 0515_504M109, where the first four numbers are the region number and forest number. This ID appears as both the Fen_ID and the FenID_fk in multiple tables of the Geodatabase.

Surveyors: The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded. Please note: The person recording the data on the form should circle their name/initials (this is helpful if there are questions later due to the handwriting).

Location: Please give a brief description of how to get to the spot that you are surveying. If no individual stands are surveyed, you will need to include your GPS information here.

Description: Please describe the overall fen meadow mentioning any significant or unique features. Especially include any information about features of the meadow that is not covered elsewhere on the datasheet.

Forest: Record the National Forest where the survey is occurring.

District: Record the Forest District if applicable.

County: Provide the county of the location in question.

T (Township; optional): Township number.

R (Range; optional): Range number.

Section (optional): Section number.

Quad: Name of quad map.

Elevation: Elevation of your location. Circle **ft** or **m** to denote the units that you are using.

Overview Photos (optional), all survey photos are filed at: In the field you can record your camera name here and replace it with the file path when photos are stored. This section is for recording overview fen meadow photos. There are other places to record photos of specific stands, and impacts or disturbances.

> **Photo #:** If you have taken photos of the overall fen meadow, write in the JPEG/frame number in the first column. If there are more than three photos taken, use the space to the right to record additional photos.
>
> **View:** Record the cardinal direction (E, NE, etc.) that the overview photo was taken in. Therefore if the photographer is facing east, the photo is taken towards the east. Mark the spot that the photo was taken on your map of the meadow.
>
> **Description:** Any description of what the photo is showing.

Surveyed Area Size (optional): This is the polygon that you will draw on your map, and may be a meadow opening with several fen stands sampled within it. If there is no meadow opening, but only a single pocket fen in a wooded area, this could be the same thing as the fen stand size. Estimate the

size of the surveyed area in acres. One acre is about the size of one football field or 4000 square meters (50 x 80 m). This is optional since there will be more accurate information about the size of the surveyed area if a GIS polygon is created to represent it.

Entire meadow surveyed? Circle yes or no. If no, include a percentage estimate of how much was completed. Since time is often limited, this field is included so that the surveyor can record whether there is more work left to do at this site.

% of Meadow that is Fen: Please estimate the percentage of the area surveyed that you have identified as a fen.

# of Stands surveyed: Record the number of fen samples that were taken at this meadow in this survey. This number should equal the number of plots that you take data on.

Primary and Secondary H20 source (optional): If known, circle the water source for the fen complex. The four options provided are Meadow, Seep, Spring, or Drainage. This information is called Meadow Type in the Fen Meadow Table of the Geodatabase.

- **Meadow:** the water source cannot be attributed to any of the other three choices and the fen is in a meadow opening.
- **Seep:** the water source appears to be overall seepage from the water table. That is, it is not attributable to a single point source (a spring) or even multiple springs but slowly filters out of the ground in an area.
- **Spring:** the water comes from the ground at a single point or a few points and is generally escapes at a greater volume and rate than a seep.
- **Drainage:** the water drains from the surrounding landscape because of the topography. A drainage is a topographic feature and may have an above-ground watercourse or not.

# of Stands present: Record the total number of distinct fen vegetation stands that are found in this meadow.

List veg types present: Use this space to list the different vegetation types that are seen as you walk around the entire meadow.

Bedrock type (optional): If known, give information on the geology of the area, specifically what bedrock underlies the fen meadow. This information may be most easily obtained afterwards using a geology map in GIS. Bedrock types which have been recorded previously include Andesite, Basalt, Calcareous, Crystalline, Gabbro, Glacial till, Granitic, Lacustrine, Marble, Metamorphic, Metavolcanic, Rhyolite, Sedimentary, Serpentine, Volcanic

Fen previously known? (optional): Circle whether the site had already been verified as a fen meadow.

If no, how discovered? (optional): Record what caused the visit to the area. Examples of answers: known location for *Meesia triquetra,* ground truth visit after analysis of aerials, or information from trail crew. This information can be recorded in the Source field in the Fen Meadow table of the Geodatabase.

Meadow Polygon Delineated Correctly?: The meadow polygon would be an existing potential fen polygon that was probably created using photo interpretation. After having walked through the polygon, decide whether the polygon was delineated correctly. Note whether uplands or wooded areas were included in the polygon. Also note whether adjacent wetlands, part of the same wetland complex, were not included. If necessary, re-delineate the polygon on the printed map. If the polygon was drawn by the crew (a new polygon), check New Polygon and draw it on the printed map.

Fen Polygon Delineated Correctly?: The fen polygon would be an existing fen polygon that was delineated after a previous visit. After having walked through the polygon, decide whether the

polygon was delineated correctly. Note whether wet meadow areas were included in the polygon or whether all fen areas were included. If necessary, re-delineate the polygon on the printed map. If the polygon was drawn by you (a new polygon), check New Polygon and draw it on the printed map.

Open Water Present (optional)? Check whether there is a pond or small lake within the polygon. Include only perennial water features.

Floating Mat Present (optional)? Check whether there is a floating mat included within the polygon.

Channels Through Site (optional)? Record whether perennial water-courses are apparent that **cross through the polygon from one side to another**.

Shrub Fen Present (optional)? Are there portions of the fen that are dominated by shrubs (at > 10% cover)?

Treed Fen Present (optional)? Are there portions of the fen that are dominated by trees (at > 10% cover)?

Hummocks or Patterned Ground Present (optional)? Is the microtopography of the fen surface simple? If it is basically flat (whether sloped or not) or can be represented by a simple curve, the answer to this question would be "no". If there is a more complex relief to the fen surface, including definite hummocks, berms, or terraces, the answer is "yes". Note that the presence of stream channels or gullies does not necessarily make the ground patterned.

Terrace Present (optional)? A terrace is a raised feature in a fen, where peat has formed a berm and the ground surface is at different levels on either side of the berm.

Complexity of Microtopography (optional). Choose the best option. We want to capture the extent of micro-topographical diversity in the fen meadow (including hummocks, berms or terraces). If you answered "no" for the patterned ground question, the answer would be "none" here.

Water Source / Inflow (optional). Choose ALL that apply. For surface channels and observable springs (if they exist), record the number that are incoming.

- Subsurface, no incoming channel
- Surface channel inflow; # incoming: _____
- Spring(s) observed; # _____

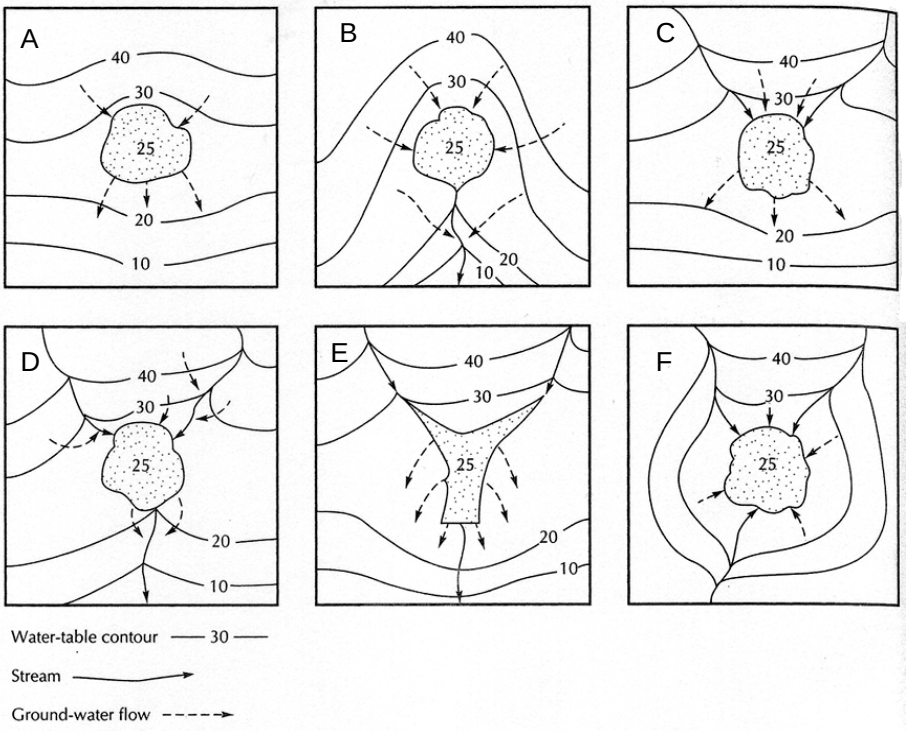
Water Outflow (optional). Choose ALL that apply. For surface channels, record the number that are outgoing.

- Subsurface, no outgoing channel
- Surface channel outflow; # out: _____
- Basin Topography, wetland surface below surrounding land along entire perimeter, No Outflow

Stream Frequency and Size (optional); Choose the best option. If Stream Frequency is None, than Stream Size is not recorded.

Gully Frequency and Gully Size (optional): Record gully frequency and size using the classes on the form. If Gully Frequency is None, then Gully Size is not recorded. A gully is a water channel that shows evidence of erosion (some sources say they are incised a foot or more below the ground surface).

Water Flow Pattern (Fetter Diagrams; optional). Circle the letter beside the diagram that best represents the water flow pattern into and from the polygon (Fetter 2001). See next page. Note that your answers to the Water Inflow and Outflow questions will determine the best diagram. Below the diagrams on the datasheet are descriptions of what they are meant to represent.



A. Groundwater dominated, both inflow and outflow are subsurface. No evidence of surface channels into or out of the wetland.
B. Groundwater inflow dominant. No surface channel inflow to wetland, but a surface channel outflow exists. Outflow may be perennial or intermittent.
C. Surface water inflow. No evidence of an outflow channel.
D. Surface water dominated. Evidence of both surface water inflow and outflow.
E. Impoundment, either man-made reservoir or natural fill associated with slumping or landslide. Similar to D. Reservoirs can not create a fen, but they may have inundated one.
F. Topographically a closed basin. Surface inflow, but no outflow. Do not confuse with A or C. Wetland surface is obviously lower than surrounding perimeter area.

----- END OF PAGE 1, CHARACTERISTICS OF ENTIRE MEADOW POLYGON -----
CONTINUES ON THE REVERSE

Hydrologic Alteration. (dikes, diversions, ditches, flow additions, or fill present in wetland that restricts or redirects flow) Choose best option. **If present, specify using disturbance categories in the following section.**

- **Low** = such as roads at or near grade, small diversion or ditches (< 30 cm deep) or small amount of flow additions
- **Moderate** = such as 2-lane road, low dikes, roads w/ culverts adequate for stream flow, medium diversion or ditches (30–100 cm deep) or moderate flow additions.
- **High** = such as 4-lane Hwy., large dikes, diversions, or ditches (>1 m deep) capable of lowering water table, large amount of fill, or artificial groundwater pumping or high amounts of flow additions

Disturbance in Polygon: Categories of disturbance are provided below the table to record if present. If there is no disturbance evident in the polygon, check "No Disturbance in Polygon" on the far right of the table. See a separate document which describes the different intensities of disturbance for each category.

Agent (optional): Record the agent(s) causing the disturbance only if known. Some of the known agents are listed below:

ATV	Four-Wheel-Drive Vehicle	Snowmobile
Beaver	Humans	State Roads Department
Cattle	Moose	Wind
County Roads Department	Motorcycle	Water
Deer	Natural	
Elk	Sheep	

Intensity: Fill in an Intensity for any disturbance noted in the polygon. Use the number scale provided to the right of the list of categories. See a separate document for descriptions of these intensities for each category that is listed.

Extent in Polygon: Fill in an Extent for any disturbance noted in the polygon. Use the number scale provided to the right of the Intensity list.

Discussion (optional): Adjacent to any listed impacts, describe it in more detail or record the condition that results from that particular impact. Take photos of the disturbance if possible and list them here as well. If a particular stand (recorded further down the data sheet) appears to be affected, include that information. For grazing and evidence of impact look for recent "urine scalds" and for cow pies, etc. If cattle are presently visible, how many are there? Look for evidence of grazing intensity like wallows, pulled up tufts of grass or sedges, etc.

Disturbance in Buffer: As in the previous table, use the categories of disturbance that are provided below the table. The Buffer is the area of the immediate watershed, up to 100 m from the edge of the meadow polygon. If there is no disturbance evident in the buffer zone, check "No Disturbance in Buffer" on the far right of the table. See a separate document which describes the different intensities of disturbance for each category.

Agent (optional): Record the agent(s) causing the disturbance only if known. Some of the known agents are listed below:

ATV	Four-Wheel-Drive Vehicle	Snowmobile
Beaver	Humans	State Roads Department
Cattle	Moose	Wind
County Roads Department	Motorcycle	Water
Deer	Natural	
Elk	Sheep	

Intensity: Fill in an Intensity for any disturbance noted in the buffer. Use the number scale provided to the right of the list of categories. See a separate document for descriptions of these intensities for each category that is listed. The descriptions for buffer disturbances may be different than those for wetland disturbances.

Extent in Polygon: Fill in an Extent for any disturbance noted in the polygon. Use the number scale provided to the right of the Intensity list.

Discussion (optional): Adjacent to any listed impacts in the buffer zone, describe the disturbance briefly or provide any relevant notes.

INCLUDE MAP BELOW. Space is provided below the disturbance section of the general meadow data sheet to list features of the meadow polygon if desired. Draw the map sketch on the grid page provided.

----- END OF PAGE 2, MAP SKETCH OF ENTIRE MEADOW POLYGON -----
CONTINUES ON PAGE 3

MAP SKETCH: Fill out the Meadow Name, Fen ID, and Date as provided on the cover sheet / first page. Please sketch a map of the entire fen meadow. It is helpful to include the scale in your drawing. Please mark with a North arrow if North is not the top of the page. Provide details of the fen meadow, such as the locations of soil samples, extent of vegetation stands surrounding soil samples, other photo points, and major features such as streams, boulder fields, terraces, dry areas, locations of disturbance, gullies or channels, and rare plant locations.

----- END OF PAGE 3, INDIVIDUAL STAND RECORDS FOLLOW ON -----
PAGE 4 AND UNNUMBERED PAGES

STAND/PLOT RECORD: All the items on this page of the data sheet pertain to a single stand location within the meadow. It is usually represented by a single point in the geodatabase, though one has the option of delineating the stand with a GPS or in GIS as a Fen_Stands_poly within the greater Fen_Meadows polygon. Recall that the fen stand should be defined by a single homogeneous stand of vegetation, and that it may be continuous with adjacent stands of vegetation that also meet the definition of a fen. There may be multiple stands/plots taken within one meadow complex.

Fen ID: This is a repeat of the Fen ID from the cover page in case the pages get separated from one another.

Date: This is also redundant from the cover page in case it gets separated.

GPS Coordinates: Record UTMs next to their appropriate indicators. The easting is six digits long and the northing is 7 digits long. The GPS point should be located within the stand. If you are using a defined plot within the stand to do the vegetation survey, you should choose a standard location to take the GPS point, such as the center of a circular plot describing the stand, or the SW corner of a square or rectangular plot.

UTM Zone: Circle the appropriate number.

GPS datum: Double check and record the datum from your GPS unit. NAD83 is the preferred datum for this project.

Plot Number: This will most often be a single digit number, some individuals may prefer to use a letter code. It will correspond to a single point on the map (given by the above coordinates). In combination with the FenID, it will provide a unique plot number for the sample location. For example, there were 2 samples recorded at Alkali Flat in 2006. They were numbered plot 1 and 2 in meadow “0504_52_Alkali_Mdw”. Therefore the unique PlotNums in the Geodatabase are “0504_52_Alkali_Mdw1” and ”0504_52_Alkali_Mdw2”. If there have been previous surveys at that general location (not the specific point), you may need to choose a higher number, so that plot 1 from 2006 is not confused with the first plot from 2007.

Fen Type: Circle the geomorphic type which best describes the point that you are sampling. The choices are explained below.

- **Basin** fens are generally in a topographic depression with no surface water inlet or outlet. They are flat, without slope or aspect.
- **Mound** fens are raised areas of peat caused by a single source of upwelling water, typically they have a surface water outlet.
- **Sloping** fens are the most common type, where groundwater comes to the surface in multiple locations along a slope.
- **Lava** fens are a specialized type of sloping fen which is caused by a lava discontinuity and appear to be restricted to the southern Cascades (Lassen and Modoc NFs).
- **Not-fen** is the option to circle if the field personnel decide that the sampling point does not represent a fen.

Slope: Record the average percent slope of the vegetation stand surrounding your sample point. Use a clinometer or compass to measure the slope. Flat stands will have a slope of 0%. Percent slope is the preferred unit that has been used in the geodatabase. If it is necessary to record the slope in degrees, it can be translated to percent slope for data entry.
Percent slope = tan (degrees slope)*100

Estimated size of Fen Stand: Limit your estimate to the homogenous stand of vegetation surrounding your sampling point. Unless surveyed, the adjacent vegetation stand may or may not be considered a fen. Circle the units used for your estimate. You may also use a GPS or GIS to delineate the size of the homogenous fen stand within the greater meadow polygon. In the Geodatabase the polygon which describes a fen stand is a Fen_Stands_poly.

Aspect: Record the general cardinal direction of the slope of the vegetation stand surrounding your sample point. Use a compass, adjusted for declination, to confirm the exposure. Flat stands will not have an aspect, so you would enter “n/a”. This field will be entered as text rather than degrees. You may use up to 3 letters to record the direction. The cardinal directions may be translated to degrees for analysis in the following manner.
N = 360 degrees, NE = 45 degrees, NNE = 30 degrees, NEE = 60 degrees.

Defined plot used?: There is now an option to make your vegetation data plot-based. Circle yes or no, to whether you limited your survey to a set plot size. We have found that 20 sq meters, which could be a 4 x 5 m rectangle or a circle with a radius of 2.5 m, will usually fit into a homogenous herbaceous fen stand and provide a suitable defined area for sampling. Because woody vegetation has larger individual plants, a larger plot size is recommended, e.g., 100 sq meters.

If yes, plot size (m^2): Since there may be variation in district needs and goals we provide other options in addition the recommended 20 sq m standard size plot.

Plot Pictures: Any photos which are specific to the plot in question should be recorded here. Include a photo of the soil core with a measuring tape alongside it as well as photos taken from the GPS point towards each cardinal direction, N, E, S, and W. Attempt to include the horizon line and any plot tapes or marker flags in the photos. If the photos from the GPS point don’t give a good view of the stand, choose a location that will and record the direction from which it was taken (the point from which it was taken can be marked on the map).

Photo number: Write in the JPEG number in the first column.

View: Record the cardinal direction (E, NE, etc.) that the photo was taken in. Therefore if the photographer is facing east, the photo is taken towards the east. “Close-up” or “above” might also be entered here for photos of plants or soil cores.

Description: Record any details here of the photos in question.

SOILS:

- **If it has already been proven to the satisfaction of the surveyor that a portion of the meadow polygon is fen, and that this stand/plot record has similar characteristics, this section may be skipped in the interest of reducing disturbance to the fen.**
- To complete this section, use a narrow shovel with at least a 40 cm blade to bring up a soil core at the GPS point. It is helpful to have a tarp to lay the core on, to separate it from the ground surface. Attempt to extract the 40 cm or greater column of soil/peat intact, or lay down pieces in the order they are brought up. As mentioned earlier, it is useful to photograph the column with a measuring tape along side it (place 0 cm at the surface portion of the column). The idea is to have a deep enough core to find 40 cm of peat, so the core may be up to 80 cm if necessary. However, if you have a large enough sample with a 40-50 cm core, do not dig further. If you have the resources for testing in a soil lab, take a soil sample from each distinct horizon.
- **NOTE that if one is fairly certain that you have enough peat to make it a fen, that a small trowel core (i.e. 10 cm deep) will allow you to complete some of this portion as well as test the water in the next section.**

Depth: In this column record any recognizable horizons or layers in the soil core. For example, there may be three different layers, 0-15 cm, 15-20, 20-40+ cm. If you stop measuring but know that there is more of the same below the last layer you measured, you should use a "+" sign to indicate that.

Color: Record the color of each layer, this may be somewhat subjective, but should be consistent by surveyor. The following colors can be used and are taken from the Munsell color charts: Pinkish white, Pink, Yellow, White, Pale Yellow, Reddish Yellow, Olive Yellow, Brownish Yellow, Gray, Pinkish Gray, Light Gray, Light Brownish Gray, Dark Gray, Very Dark Gray, Brown, Very Pale Brown, Pale Brown, Light Yellowish Brown, Light Brown, Light Olive Brown, Olive Brown, Grayish Brown, Dark Yellowish Brown, Dark Grayish Brown, Strong Brown, Dark Brown, Very Dark Grayish Brown, Very Dark Brown, and Black.

Texture: Five texture codes are provided. For further description of texture use the comment field to describe. Peat can be divided into two categories, described as **ONBD** (Organic Non-Broken Down) which is the classic fibrous brown or light brown material like you would get if you purchased peat at a garden center, while **OBD** (Organic Broken Down) is darker, without obvious plant parts, and may be deeper in the column. As a "field characteristic" such organic soil material tends to rub clean when rubbed between finger and thumb, in contrast to dark clay which tends to spread like grease and to remain on the fingers.

The non-organic texture options include **Sand**, which has the largest particle size of the three, where individual grains are easily seen and felt. Sand is gritty to the touch. The particle size ranges from 0.05 - 2.0 mm. **Silt** consists of soil particles that are coarser that clay, but finer than sand. The particle size ranges from 0.002 - 0.05 mm. **Clay** is the finest textured of all the soil classes. Clay particles are smaller than 0.002 mm in diameter. Clay usually forms extremely hard clods or lumps when dry and is extremely sticky and plastic when wet. When containing the proper amount of moisture, clay is malleable and can be formed into a ribbon with the hand.

Von Post Value (optional): (National Wetlands Working Group 1997)
Choose the best value for each distinctive layer of the core.

Organic Non-Broken Down

1. Undecomposed; plant structure unaltered; yields only clear water colored light yellow brown.
2. Almost undecomposed; plant structure distinct; yields only clear water colored light yellow brown.
3. Very weakly decomposed; plant structure distinct; yields distinctly turbid brown water, no peat substance passes between the fingers, residue not mushy.
4. Weakly decomposed; plant structure distinct; yields strongly turbid water, no peat substance escapes between the fingers, residue rather mushy.
5. Moderately decomposed; plant structure clear but becoming indistinct; yields much turbid brown water, some peat escapes between the fingers, residue very mushy.

Organic Broken Down

6. Strongly decomposed; plant structure somewhat indistinct but clearer in the squeezed residue than in the undisturbed peat; about one third of the peat escapes between the fingers, residue strongly mushy.
7. Strongly decomposed; plant structure indistinct but recognizable; about half the peat escapes between the fingers.
8. Very strongly decomposed; plant structure very indistinct; about two thirds of the peat escapes between the fingers, residue almost entirely resistant remnants such as root fibers and wood.
9. Almost completely decomposed; plant structure almost unrecognizable; nearly all the peat escapes between the fingers.
10. Completely decomposed; plant structure unrecognizable; all the peat escapes between the fingers.

Comments: Use this area to further describe the soil layer or record that a sample was taken for analysis.

Remarks: Use this area for remarks that pertain to the entire soil column. Description should include signs of alkaline or basic mineralization such as travertine deposits nearby, sulphurous smell, other mineral deposits, or surrounding rock type. **If the soils section is not fully completed, record that information here along with an explanation** (e.g., "soil core data taken at plot #1")

Soil Sample Collection and Preparation

adapted from Warren Young, Soil Scientist, Grand Mesa, Uncompahgre & Gunnison NF, & Rod Chimner, Wetland Ecologist, Michigan Tech. 5/13/2009

1. Field Sampling. If desired, take a soil sample from the center of each distinct soil layer in the column. Each sample should be about 1 Cup.

2. Field Preparation. Place the sample in a plastic bag and label with the sampling depth, collection date, fen meadow ID, stand ID, and GPS location. As soon as possible, begin air drying the sample. Retain the original sample tag, remove all live roots and leaves, spread on non-colored newspaper and break open to facilitate drying. When the sample has air dried, transfer it and all sample site information to a clean paper bag. Retain the original sample bag and place it in the paper bag.

HISTIC SOILS PRESENT?: Circle yes if the soil is primarily organic material (histic). This question is addressing whether there is enough organic material to be considered a fen. Our working definition for a fen is that there is at least 40 cm of peat or organics in the top 80 cm of soil. In the Geodatabase several cases have entered "no" to this question, but still have "yes" to the sampling point being a fen.

HYDROLOGY: This section is used to determine if soil is saturated for a good portion of the growing season. See **SOILS** section above for discussion of reasons to skip this section if hydrology has been previously tested. Note that if there is standing water at the GPS point, the required fields in this section can be filled out without digging a pit.

Depth of Surface Water: If there is no standing water above the ground surface, enter "n/a". Otherwise provide the depth of the water in cm above the ground surface.
Depth to Free Water in Pit (after ≥ 10 min): Different values will be reached depending on how long you wait for the water in the pit to equilibrate. Wait as long as possible (at least 10 minutes) to measure this, and do it as the last thing before you return the soil column to the pit. Measure depth in centimeters from the ground surface to the top of the standing water that has accumulated in the hole. "Ground surface" is the average level of the low-vegetation mat (often moss) at the rim of the hole. If no water collects at the bottom of the pit, enter "n/a", and specify this in the remarks section.

Depth to Saturated Peat: Measure from the ground surface to a level on the side of the hole where water appears to be seeping out. You are trying to measure the level of the water table in this and the previous field.

Distance to standing or running water (optional): Measure or estimate this distance in meters from the GPS point. A rangefinder may be useful for this purpose. Standing water may include small pools or puddles. If there is no above-ground water present in the area, enter "n/a".

pH (optional): Measure the pH of the water that accumulates in the hole with a pH meter. In general, pH meters should be calibrated often, using a standard buffer solution.

Electrical Conductivity (optional): Take this measurement in the standing water of the soil pit. Electrical conductivity (EC) is a measure of the dissolved-ion concentration of the fen waters. The unit of measure is "microsiemens/cm". Some pH meters also measure EC. They may also need to be calibrated frequently. Record the temperature at which the EC is taken, since the value is directly affected by temperature.

Root zone temperature (optional): Measure with a soil thermometer inserted so the sensor is at a depth of 15 to 20 cm. Circle C or F for the units of temperature used. The Bishops' have been persuasive in arguing that this is a more standard measure than the temperature of the water in the soil pit. Water temperature in the hole tends to be inconsistent since sometimes water runs in from a surface pond which is warmer than the saturating water, and sometimes it flows up from the bottom and is cooler than the saturating water.

Remarks (optional): Use this space to make any comments about the amount of soil saturation or any specifics about the measurements that you took. Record the length of time allowed before the depth to free water in pit was measured, or other observations about how water filled the pit. Also, if there is any information on the water source that is specific to the fen, and not the larger complex, you would write that here.

WETLAND HYDROLOGY PRESENT? Answer yes, if the depth to free water or saturated peat is <20 cm, or if you think they would be in a normal year. This is our working definition for necessary saturation to be considered a fen.

VEGETATION: In addition to recording the dominant plants of the stratum, surveyors may also make a complete species list. Mark one of three options completed, all of which include recording the stratum when estimating cover. The sampling options include:

1) recording the three dominant species of each stratum that is present in the homogeneous stand or plot surrounding the GPS point,
2) recording all plants found in the stand or plot along with its cover class, or
3) recording all of the plant taxa as well as estimating percent cover (not just the cover class).

% Surface cover (optional): Record the abiotic substrates that cover the ground surface (optional for use with more complete vegetation information). The observer imagines "mowing off" all of the live vegetation at the base of the plants and removing it to estimate what remains covering the surface. Note that non-vascular cover (lichens, mosses, cryptobiotic crusts) is not estimated in this section, but that the observer should decide whether the mosses etc. are growing on peat or mineral soil, or a combination of the two, and include that area in the appropriate field. **The total should sum to 100%.**

% Water: Estimate the percent surface cover of running or standing water, ignoring the substrate below the water.

% BA Stems: Percent surface cover of the plant basal area, *i.e.*, the basal area of stems at the ground surface. The basal area of mosses is negligible. Note that for most vegetation types BA is 1-3% cover.

% Litter: Percent surface cover of litter (unattached plant material), duff, or wood on the ground.

% Rock: Percent surface cover of all rock, from bedrock down to gravel > 2mm.

% Fines: Percent surface cover of bare ground and fine sediment (e.g. dirt) < 2 mm in diameter, including that portion covered by mosses.

% Bare Peat: Percent surface cover of peat exposed to the air.

% Cvrd Peat: Percent surface cover of peat that is not bare but covered by non-vascular or vascular plant growth.

Overall cover (optional): Provide an estimate of cover for the two following categories (optional for more complete vegetation survey). Record a specific number for the total aerial cover or "bird's-eye view" looking from above for non-vascular and for vascular plants, estimating cover for the living plants only. Unattached litter/duff should not be included in these estimates. It may be helpful to initially choose a cover class and then refine your estimate to a specific percentage for the two categories below.

% Total Non-Vasc cover: The total cover of all lichens and bryophytes (mosses, liverworts, hornworts) on substrate surfaces including downed logs, rocks and soil, but not on standing or inclined trees.

% Total Vasc Veg cover: The total cover of all vascular vegetation. This is an estimate of the absolute vegetation cover, disregarding overlap of the various tree, shrub, and/or herbaceous layers and species.

Plant species: Record the full scientific name of the taxa here. Use Jepson Manual nomenclature for the vascular plants. If you are uncertain of the identification, the unconfirmed portion of the name can be put in parentheses. For example, you are certain it is a Sphagnum and think that it is S. subsecundum you should write it as "Sphagnum (subsecundum)". If you take a collection to help you identify it later, it is helpful to mark the taxon name with a "c" (for collected) or an "*". Be sure to update the datasheet if you further identify the plant.

Strata: Use one of the 5 stratum codes displayed on the data sheet.

- **T** = Tree, for woody plants which tend to grow with a single stem and reach over 5 m in height when grown under good conditions.
- **S** = Shrub, for woody plants that tend to grow with multiple stems and are usually under 5 m in height.
- **F** = Forb, for broad-leaved herbaceous vascular plants which are not grass-like and are not woody.
- **G** = Graminoid, for grass or grass-like herbaceous plants.
- **M** = Moss / Lichen for any non-vascular plant, including liverworts.

Cvr: Estimate the % absolute aerial cover for each species listed. Choose the cover class from the list provided on the data sheet. Cover classes are:
T = Trace; **1** = 1-5%; **2** = 5-25%; **3** = 25-50%; **4** = 50-75%; **5** = 75-95%; **6** = 95-100%
If you choose to provide specific percentages, they can always be converted to cover classes later. The sum of all species percent covers may total over 100% because of overlap.

Remarks: Use this area to list additional species if you need more space. Include any significant comments about the vegetation in the stand or information about adjacent species. If you think the stand is a certain vegetation type, or notice that a lot of the species are not wetland plants, you could indicate that here.

IS THIS SAMPLING POINT A FEN ? Taking all the plot specific fields on this page of the data sheet into account, considering plants, soils, and hydrology, would you call it a fen or not? Does it have at least 40 cm of histic soils within the top 80 cm, a saturated water table less than 20 cm from the surface in most years, and wetland vegetation?

Disturbance Factors and Intensities for Use in Fens

Note that there is an implied Intensity Class 0 (zero), meaning "none" or "absent," that is usually not recorded.

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
Beaver Activity	Beaver	Wetland	One or a few small beaver dams in the past, now unused and the area behind the dams naturally revegetated; no side channels	One or a few small beaver dams currently being used with full ponds; or one medium-sized older dam now unused and the area behind the dam naturally revegetated; possibly a few old side channels	Many small (or one medium- to large-sized) beaver dams currently being used with full dams, or some of them breached and the ponds bare; a few side channels being built or used	Several medium- to large-sized beaver dams currently being used, some with full dams, and some of them breached and the ponds bare; side channels being built or used	
		Buffer	Few trees or shrubs cut and dragged from buffer in past; draglines revegetated with no erosion	Few trees or shrubs cut and dragged from buffer recently, draglines mostly revegetated but a little erosion into the wetland	Several to many trees or shrubs cut and dragged from buffer recently, some draglines revegetating but a few eroding into the wetland	Many shrubs or trees being cut and dragged from buffer currently or recently, most draglines not revegetating and eroding into the wetland	
Browsing (Woody Plants)	Elk, Deer, Moose, Cattle, Sheep	Wetland, Buffer	Clipping noticeable on up to half the shrubs, averaging light clipping (<¼ CYG); no shrub clipped >½ CYG; no reduction in natural height	More than half the shrubs moderately clipped (¼ -½ CYG), or all shrubs lightly to moderately clipped (¼-½ CYG); height reduction on a few shrubs	Most to all shrubs hedged (>½ CYG), or half the shrubs heavy hedged (>¾ CYG); height reduction noticeable on most shrubs	Most to all shrubs clubbed (growth turned inward), or all shrubs heavily hedged. Mostly >¾ CYG; height reduction obvious on most to all shrubs	CYG = Current Year's Growth; height reduction estimated as compared with mature unbrowsed shrubs
Grazing	Elk, Deer, Moose, Cattle, Sheep	Wetland, Buffer	Clipping noticeable on some graminoids and forbs, averaging light clipping (<¼ CYG); all herbaceous plants of normal vigor and height	Clipping obvious on more than half the graminoids and forbs, average ¼-½ CYG; some plants show reduction in vigor and height	Clipping obvious on most graminoids and forbs, average >½ CYG; most plants show reduction in vigor in height, average height up to ½ of normal	Most graminoid individuals grazed >¾ CYG; vigor noticeably reduced; average height ½ - ¾ of normal	CYG = Current Year's Growth; height reduction estimated as compared with mature unbrowsed plants
Small Mammal Activity	Mice, Voles, etc.	Wetland	Trace evidence of mammal activity including holes or burrowing. Low level of ground disturbance, <1% of the area	Evidence of mammal activity including holes or burrowing. Moderate amount of ground disturbance, 1-5% of the area	Evidence of mammal activity including holes or burrowing. High degree of ground disturbance, 5-25% of the area	Evidence of mammal activity including holes or burrowing. Very High degree of ground disturbance, >25% of the area	
Trails made by Foot Traffic	Elk, Deer, Moose, Cattle, Sheep, Humans	Wetland, Buffer	A few trails by animals or humans in past in 1-2 places, healing and becoming invisible; bare soil within to slightly above normal limits	Animal or human trails used nearly every year in a few places, getting deeper and wider each year; bare soil above normal limits across whole area	Animal or human trails used yearly or several times a year in several to many places, getting deeper and wider each year; bare soil well above normal limits across whole area	Animal or human trails common across whole area, used many times a year in several to many places, getting deeper and wider each year; bare soil well above normal limits across whole area	

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
Trampling / Hoof Punch	Elk, Deer, Moose, Cattle, Sheep	Wetland	Soil compaction noticeable in a few spots, water table near or somewhat below normal levels; a few post-holes or a few animal trails, occurring occasionally; no bare soil or hummocks apparent	Soil compaction noticeable in several large areas (or many small areas), covering ¼-½ of the area; water table somewhat below normal levels; a moderate amount of post-holing or animal trailing, occurring often; bare soil and hummocks visible	Soil compaction obvious in large areas, covering >½ of the area; water table below normal levels; post-holing and animal trails throughout the area, use occurring every year or two; bare soil and hummocks common, some trailing in hollows between hummocks	Soil compaction obvious, especially in hollows between hummocks; water table well below normal levels; post-holing common, occurring annually, animal trailing & bare soil common in hollows	Discussion of hummocks in Sanderson and March 1996, Cooper and MacDonald 2000, Lesica and Kannowski 1998
Trampling / Hoof Punch	Elk, Deer, Moose, Cattle, Sheep	Buffer	Soil mostly soft in rangelands and duff mostly intact in forests except for a few places; bare soil within to slightly above normal limits; a few pedestalled plants in rangelands	Soil hard in large areas of rangelands, duff missing in large areas of forests; bare soil above normal limits (>20% rangelands, >10% forests); pedestalled plants obvious	Soil hard in most rangelands, duff missing in most forests; bare soil well above normal limits (>30% rangelands, >15% forests); pedestalled plants common	Soil hard and unyielding in all rangelands, duff up to ½ missing in forests; bare soil much greater than normal (>40% rangelands, >20% forests); pedestalling of plants common or everywhere	
Exotic Plant Invasion		Wetland, Buffer	Some exotic plants evident, 2-10% total canopy cover of exotic plants	Exotic plants obvious, 10-20% total canopy cover of exotic plants	Exotic plants obvious, >20% total canopy cover of exotic plants	Exotic plants dominant or subdominant, >30% total canopy cover of exotic plants	See Kratz and others 2007
Fire	Natural, Humans	Buffer	One or a few burned spots >10 m from wetland edge, naturally revegetating	Several burned spots or one large burned area, >10 m from wetland edge, mostly revegetating naturally	Many burned spots or several large burned areas, some <10 m from wetland edge, some areas of bare soil and evident erosion	Many burned spots or several large burned areas, many <10 m from wetland edge, many areas of bare soil and evident erosion	See Kratz and others 2007
Camp Sites	Humans	Buffer	One or a few camp sites, used a few times a year, naturally revegetating, all sites and roads >10 m from wetland edge	One or a few camp sites, used every few weeks in season, some areas revegetating, some bare and eroding, most sites and roads >10 m from wetland edge but small areas <10 m	Several camp sites, used weekly in season, some areas revegetating, some bare and eroding, most sites and roads >10 m from wetland edge but small areas <10 m	Many camp sites, used weekly in season, most areas bare and eroding, large areas <10 m from wetland edge	
Litter / Dumping / Trash	Humans	Wetland, Buffer	Trace evidence of trash, <1% of the area	Evidence of trash affecting 1-5% of the area	Evidence of trash affecting 5-25% of the area	Evidence of trash affecting >25% of the area	
Off-Road Vehicle Tracks	ATV, Motorcycle, Snowmobile, 4WD	Wetland, Buffer	A few passes by vehicle evident in the past in 1-2 places, healing and becoming invisible; bare soil within to slightly above normal limits	Vehicle passes occurring every 3-5 years in 2-5 places, getting deeper and wider each time, not healing; bare soil somewhat above normal limits across whole area	Vehicle passes occurring every 1-2 years in >5 places, getting deeper and wider each time, not healing; bare soil well above normal limits across whole area	Vehicle passes occurring annually or several times each year in >10 places, getting deeper and wider each time, not healing; bare soil well above normal limits across whole area	

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
Buried Utility Corridors		Wetland	No buried utility lines in wetland, right-of-way covers part of wetland partially cleared, slight amount of human or ATV trailing in wetland from maintenance activities	Buried utility line across corner of wetland, trench for utility covered and revegetated and mostly healed, slight amount of human or ATV trailing in wetland from maintenance activities	Buried utility line across middle of wetland, trench for utility covered and partly revegetated but mostly not healed and some erosion, moderate amount of human or ATV trailing from maintenance activities in right-of-way in wetland	Buried utility line across middle of wetland, trench for utility partly covered but not revegetated, erosion is apparent, right-of-way continually used for maintenance	
		Buffer	Buried utility line crosses part of buffer, utility line and right-of-way all >10 m from wetland, right-of-way not cleared, slight amount of vehicle tracks or trails in buffer from maintenance activities	Buried utility line crosses buffer, utility line >10 m from wetland but part of right-of way <10 m from wetland, right-of-way partially cleared in buffer but > 10 m from wetland, moderate amount of vehicle tracks-trails-roads from maintenance activities in buffer	Buried utility line crosses buffer. utility line in part < 10 m from wetland and part of right-of-way <10 m from wetland, right-of-way cleared in buffer someplace <10 m from wetland, right-of-way with some bare soil and eroding, tracks-trails-roads from maintenance activities used often	Buried utility line crosses buffer, part of utility line and buffer <10 m from wetland, right-of-way cleared to wetland edge, right-of-way roads and trails actively eroding, tracks-trails-roads used often as part of maintenance	
Development in addition to roads or utilities		Buffer	Small structure (not a residence or full-size buliding) > 50 m from wetland complex edge	Small structure (not a residence or full-size building) within 50 m from wetland complex edge	Residence or Full-size building present in zone	Multiple buildings present in zone.	
Power Lines	Humans	Wetland	Power line over wetland, no structures in wetland, slight amount of human or ATV trailing from maintenance activities	Power line over wetland, no structures in wetland, moderate amount of human or ATV trailing from maintenance activities, some clearing activities in wetland	Power line over wetland, no structures in wetland, 4WD road in wetland from maintenance activities	Power line over wetland, structure in wetland	
		Buffer	Power line over buffer, no structures in buffer, slight amount of human or ATV trailing from maintenance activities, right-of-way not cleared in wetland	Power line over buffer, structure in buffer but >10 m from wetland, moderate amount of human or ATV trailing from maintenance activities, some clearing activities in buffer but >10 m from wetland	Power live over buffer, structure in buffer <10 m from wetland, 4WD road in buffer for maintenance, right-of-way intensively cleared to 10 m from wetland	Power line over buffer, structure in buffer at wetland edge, 4WD road in buffer right up to wetland edge, right-of-way intensively cleared right up to wetland edge	
Roads (constructed)	State, County, USFS	Wetland	N/A (presence of any road would be high or very high intensity)	N/A (presence of any road would be high or very high intensity)	Paved road with rock fill and gravel embankments crossing wetland, minimal erosion into wetland, somewhat disrupting water flow and dividing wetland into two parts	Gravel or fine-textured soil surface with fine-textured fill and embankments that erode regularly into wetland, disrupting water flow and dividing wetland into two parts	

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
		Buffer	One or two temporary natural-surface roads in past that were closed and revegetated, now restoring naturally, >10 m from wetland edge	One to several natural-surface or all-weather roads open and used several times a year, >10 m from wetland edge	Several natural-surface or all-weather roads open and used weekly; or one road <10 m from wetland edge	Several natural-surface or all-weather roads open and used several to many times a week; or one or more roads <10 m from wetland edge	All-weather road usually means gravel surface
Deposition (Sedimentation)		Wetland	Up to 2% of wetland covered by recent sediment deposit up to 1 cm thick	2 – 5% of wetland covered by recent sediment deposit 1 – 3 cm thick	5 – 15% of wetland covered by recent sediment deposit 3 – 5 cm thick	More than 15% of wetland covered by recent sediment deposit >5 cm thick	See Chimner and others 2008, Rocchio 2006a
		Buffer	Soil in rangelands mostly not moving from year to year and duff mostly intact in forests except for a few places; bare soil within to slightly above normal limits (<15% rangelands, <5% forests); a few pedestalled plants in rangelands, slight sediment margins around wetland in a few places	Soil in rangelands moving during large storms and runoff, duff missing in large areas of forests; bare soil above normal limits (>20% rangelands, >10% forests); pedestalled plants obvious, sediment margins around wetland obvious in several to many places	Soil in rangelands moving during large storms and runoff, duff missing in most forests; bare soil well above normal limits (>30% rangelands, >15% forests); pedestalled plants common; sediment margins around wetland obvious throughout	Soil in rangelands moving during storms of any size and during runoff, duff up to ½ missing in forests; bare soil much greater than normal (>40% rangelands, >20% forests); pedestalling of plants common or everywhere; sediment margins around wetland obvious throughout	
Ditches	Humans	Wetland	One or two shallow (<20 cm) ditches dug once in past, now beginning to restore naturally, water table at or slightly below normal levels (considering other factors, such as flooding)	One to several shallow ditches dug and maintained, still functional and draining water from wetland (or part of wetland), water table noticeably below normal levels, a few upland plants or weeds appearing in community being drained	One to several deeper (>20 cm) ditches dug and maintained, still functional and draining water from wetland (or part of wetland), water table noticeably below normal levels, upland plants or weeds obvious and beginning to share dominance with hydrophytes	One to several deeper (>20 cm) ditches dug and maintained, still functional and draining water from wetland (or part of wetland), water table well below normal levels, vegetation in community being drained very much drier – hydrophytes losing dominance to upland plants and weeds	
Erosion, (Channel Incision, Gullies, or Head Cuts)	Vehicles, Elk, Deer, Moose, Humans	Wetland	A few small eroding spots evident (trampling, trailing, tracks, etc.), beginning to revegetate, any channel < 20 cm wide and <5 cm deep	Several eroding spots obvious (trampling, wallows, trailing, tracks, etc.), some remaining exposed and eroding, any channel < 50 cm wide and <10 cm deep	Eroding spots large or common, or a gully or two 50-100 cm wide and 10-50 cm deep	Several gullies, some with headcuts, gullies > 1 m wide and > 50 cm deep	Headcuts are a type of erosion extending in an upstream direction.

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
Erosion	Vehicles, Elk, Deer, Moose, Humans	Buffer	A few rills >10 m from wetland, soil mostly covered in rangelands and duff mostly intact in forests except for a few places; bare soil within to slightly above normal limits (<15% rangelands, <5% forests); a few pedestalled plants in rangelands	A few to several apparent rills, a few <10 m from wetland, bare soil exposed in large areas of rangelands, duff missing in large areas of forests; bare soil above normal limits (>20% rangelands, >10% forests); pedestalled plants obvious	Many rills, often <10 m from wetland, possibly a headcut >10 m from wetland; soil hard in most rangelands, duff missing in most forests; bare soil well above normal limits (>30% rangelands, >15% forests); pedestalled plants common	Rills common, often < 10 m from wetland, or headcut eroding into wetland; soil hard and unyielding in all rangelands, duff up to ½ missing in forests; bare soil much greater than normal (>40% rangelands, >20% forests); pedestalling of plants common or everywhere	
Ground Disturbance (General)	Unknown	Wetland, Buffer	Low level of ground disturbance, <5% of the area	Moderate amount of ground disturbance, 5-15% of the area	High degree of ground disturbance, 15-25% of the area	Very High degree of ground disturbance, >25% of the area	May be used if the disturbance does not fit the other categories
Soil Removal (Peat Mining)	Humans	Wetland	Removal of upper soil horizons (including peat) in one or a few places in the past, now beginning to recover slowly	Peat mining of <10% of wetland, remainder of peat intact and functioning normally	Peat mining of >½ of wetland, remainder of peat intact and functioning normally, not floating or breaking loose from substrate	Peat mining of >¾ of wetland, remainder of peat dead or floating, no normally functioning peat remaining	See Kratz and others 2007
Soil Removal (Peat Mining)	Humans	Buffer	Removal of upper soil horizons in one or a few places, revegetated and beginning to naturally recover	Removal of upper soil horizons in one or a few places, leaving lower horizons bare and eroding	Removal of upper soil horizons in several to many places, leaving lower horizons bare and eroding	Removal of upper soil horizons common, leaving lower horizons bare and eroding	
Tree Cutting / Logging	Humans	Wetland	Most trees cut by hand in past, reduction in shade causing some increases in vascular plant and bryophyte cover, water table at or near natural levels	Trees cut by machinery, disruption of peat body and some erosion in a few small areas, water table at or near normal levels	Trees cut by machinery, disruption of peat body and evident erosion in one large area or a many small areas, water table changed from normal levels	Trees cut by machinery, disruption of peat body and evident erosion across much of wetland, water table very much changed from normal levels	If beaver have cut trees, use Disturbance 'Beaver Activity'
		Buffer	A few trees cut in a few patches >10 m from wetland margin, disturbance revegetating, no erosion into wetland	Large areas of buffer cut, a small area <10 m from wetland margin, disturbance mostly revegetating but some erosion into wetland	Large areas of buffer cut, a moderately large area <10 m from wetland margin, erosion into wetland obvious	Large areas of buffer cut, including most of area <10 m from wetland margin, erosion into wetland obvious and increasing	
De-watering	Humans	Wetland	[Dam or other structure has been breached in past], water is draining from wetland, but vegetation seems to be retaining water successfully and system appears stable, water table in wetland at or slightly below normal levels	[Dam or floodgate has been lowered or bypassed or breached], water is draining from wetland, water table noticeably below normal levels, a few upland plants or weeds appearing in community being drained, community losing stability	[Dam or floodgate has been lowered or bypassed or breached], water is draining from wetland, water table noticeably below normal levels, upland plants or weeds obvious and beginning to share dominance with hydrophytes, community obviously unstable, changing every year	[Dam or floodgate has been lowered or bypassed or breached], water is draining from wetland, water table well below normal levels, upland plants or weeds obvious and dominant with hydrophytes, community obviously unstable, changing every year	Lowering of water table

Disturbance Factor	Possible Agents	Impact Area*	Intensity Class 1 Low	2 Moderate	3 High	4 Very High	Comments
Groundwater pumping	Humans	Wetland, Buffer	Water is being removed from the water table beyond the 100 m buffer zone	Water is being removed from the water table between 50-100 m from the wetland.	Water is being removed from the water table < 50 m from the wetland.	Water is being removed from the water table inside the wetland.	Lowering of water table
Surface water diversion	Humans	Wetland, Buffer	Alteration of drainage pattern upslope that results in less water reaching the wetland. Estimated that less than 5% of surface inflow affected.	Alteration of drainage pattern upslope that results in less water reaching the wetland. Estimated that 5 to 25% of surface inflow affected.	Alteration of drainage pattern upslope that results in less water reaching the wetland. Estimated that 25-50% of surface inflow affected.	Alteration of drainage pattern upslope that results in less water reaching the wetland. Estimated that >50% of surface inflow affected.	Lowering of water table
Drainage from Above (Water Inflow Increase)	Humans	Wetland	One or two small drainage channels from road culverts or other drainage structures, most of water entering groundwater before reaching wetland, causing no apparent erosion into wetland, no apparent changes in wetland water table or vegetation	One to several small drainage channels, some surface water reaching wetland, some apparent erosion from these channels reaching wetland margins, water table near normal levels, changes in vegetation only along margins	One to several moderate to large drainage channels, surface water flowing into wetland, apparent erosion from these channels reaching wetland margins and beyond margins in a few places, water table above normal level, changes in vegetation along margins	One to several moderate to large drainage channels, surface water flowing into wetland, apparent erosion from these channels reaching wetland margins and into center of wetland, water table well above normal level, changes in vegetation along margins and in wetland center	
Flooding	Humans	Wetland	Floodgate, dam, or other structure has been permanently raised, or is being raised seasonally, water table 5-10 cm above normal levels, but vegetation seems to be stable and unchanged from normal	Floodgate, dam, or other structure has been permanently raised, or is being raised seasonally, water table 10-20 cm above normal levels, vegetation is changing to species characteristic of higher water tables	Floodgate, dam, or other structure permanently raised, water table >20 cm above normal levels, vascular plants drowned and dying, small pieces of peat dislodged and floating to surface	Floodgate, dam, or other structure permanently raised, water table >50 cm above normal levels, vascular plants drowned and dying, large pieces of peat dislodged and floating to surface	Raising of water table

APPENDIX 2. List of plants identified in fen or wet meadow vegetation surveys with scientific names for vascular plants and families according to The Jepson Manual, 2nd edition (Baldwin et al. 2012). Codes and common names are according to USDA-NRCS (2012). Codes that were not yet available, and therefore invented by us, are shown in bold. The last three columns indicate whether the plant was recorded in the Eddy's region or not (**X** = present), where **other =** South Fork Mountain or Saddle Gulch records, **Eddy's =** West Branch Crow Creek or 2011 surveys, and whether a collection was made and retained (**coll'11**). Plants are listed alphabetically by scientific name with non-vascular plants listed first. * = Species that were only recorded by Cooper and Wolf (2006).

Strata	Code	Scientific Name with Author	Common Name	Family	other	Eddy's	coll'11
Nonvascular	AMSE3	*Amblystegium serpens* (Hedw.) Schimp.	amblystegium moss	Amblystegiaceae		X	X
Nonvascular	ANPI7	*Aneura pinguis* (L.) Dumort.		Aneuraceae	X		
Nonvascular	AUPA70	*Aulacomnium palustre* (Hedw.) Schwägr.	aulacomnium moss	Aulacomniaceae	X		
Nonvascular	BRCO12	*Brachythecium collinum* (Schleich. ex Müll. Hal.) Schimp.	brachythecium moss	Brachytheciaceae		X	X
Nonvascular	BRFR70	*Brachythecium frigidum* (Müll. Hal.) Besch.	cold brachythecium moss	Brachytheciaceae	X		
Nonvascular	BRYUM2	*Bryum* Hedw.	bryum moss	Bryaceae	X	X	X
Nonvascular	CAMU21	*Calypogeia muelleriana* (Schiffn.) Müll. Frib.		Calypogeiaceae	X		
Nonvascular	CAPO17	*Campylium polygamum* (Schimp.) C.E.O. Jensen	campylium moss	Amblystegiaceae		X	X
Nonvascular	CAST51	*Campylium stellatum* (Hedw.) C.E.O. Jensen	star campylium moss	Amblystegiaceae	X	X	X
Nonvascular	CEDID2	*Cephaloziella divaricata* (Sm.) Schiffn.var. *divaricata*	liverwort	Cephaloziellaceae		X	X
Nonvascular	CHILO2	*Chiloscyphus Corda, nom. cons.*		Geocalycaceae	X		
Nonvascular	CHPA43	*Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dumort.		Geocalycaceae	X		
Nonvascular	COCO31	*Conardia compacta* (Müll. Hal.) H. Rob.	compact conardia moss	Amblystegiaceae		X	
Nonvascular	CRFI70	*Cratoneuron filicinum* (Hedw.) Spruce	cratoneuron moss	Amblystegiaceae		X	X
Nonvascular	DIAM5	*Ditrichum ambiguum* Best	ambiguous ditrichum moss	Ditrichaceae		X	
Nonvascular	MARCH	*Marchantia* L.		Marchantiaceae	X		
Nonvascular	MNIUM2	**Mnium* Hedw.	mnium calcareous moss	Mniaceae	X		
Nonvascular	**MPAFA**	*Palustriella falcata* (Brid.) Hedenäs	palustriella moss	Amblystegiaceae		X	X
Nonvascular	PHFO6	*Philonotis fontana* (Hedw.) Brid.	philonotis moss	Bartramiaceae	X	X	X
Nonvascular	PHFOA	*Philonotis fontana* (Hedw.) Brid. var. *americana* (Dism.) Flow.	American philonotis moss	Bartramiaceae	X	X	X
Nonvascular	PHFOF	*Philonotis fontana* (Hedw.) Brid. var. *fontana*	philonotis moss	Bartramiaceae	X		
Nonvascular	PHFOP	*Philonotis fontana* (Hedw.) Brid. var. *pumila* (Turner) Brid.	philonotis moss	Bartramiaceae		X	X
Nonvascular	PLME4	*Plagiomnium medium* (Bruch & Schimp.) T. Kop.	intermediate plagiomnium moss	Mniaceae	X		
Nonvascular	PONU70	*Pohlia nutans* (Hedw.) Lindb.	pohlia moss	Bryaceae		X	X
Nonvascular	POHLI2	*Pohlia* Hedw.	pohlia moss	Bryaceae		X	X
Nonvascular	POJU70	*Polytrichum juniperinum* Hedw.	juniper polytrichum moss	Polytrichaceae		X	X
Nonvascular	**MPTPS**	*Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay	common green bryum moss	Bryaceae	X	X	X

Strata	Code	Scientific Name with Author	Common Name	Family	other	Eddy's	coll'11
Nonvascular	RHMA12	*Rhizomnium magnifolium* (Horik.) T. Kop.	grandleaf rhizomnium moss	Mniaceae	X	X	
Nonvascular	SCUNU4	*Scapania undulata* (L.) Dumort. var. *undulata*		Scapaniaceae	X		
Nonvascular	SCAG70	*Schistidium agassizii* Sull. & Lesq.	Agassiz's schistidium moss	Grimmiaceae	X		
Nonvascular	2MOSS		unknown moss		X	X	
Tree	ABMA	*Abies magnifica* A. Murray	California red fir	Pinaceae		X	
Herb	ACMI2	*Achillea millefolium* L.	common yarrow	Asteraceae		X	X
Herb	ACCO4	*Aconitum columbianum* Nutt.	Columbian monkshood	Ranunculaceae	X	X	
Herb	AGOSE	*Agoseris* Raf.	agoseris	Asteraceae		X	X
Graminoid	AGEX	*Agrostis exarata* Trin.	spike bentgrass	Poaceae		X	X
Graminoid	AGHU	*Agrostis humilis* Vasey	alpine bentgrass	Poaceae		X	X
Graminoid	AGID	*Agrostis idahoensis* Nash	Idaho bentgrass	Poaceae	X	X	
Graminoid	AGPA8	*Agrostis pallens* Trin.	seashore bentgrass	Poaceae		X	X
Herb	ALPEP2	*Allium peninsulare* Lemmon ex Greene var. *peninsulare*	peninsula onion	Alliaceae		X	
Herb	ALLIU	*Allium* L.	onion	Alliaceae		X	
Herb	ALVA	*Allium validum* S. Watson	Pacific onion	Alliaceae	X	X	X
Shrub	ALINT	*Alnus incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung	thinleaf alder	Betulaceae		X	
Shrub	AMAL2	*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roem.	Saskatoon serviceberry	Rosaceae		X	
Shrub	ARCTO3	*Arctostaphylos* Adans.	manzanita	Ericaceae		X	
Herb	ASTEXX	*Asteraceae* L.	unknown Asteraceae	Asteraceae	X		
Herb	BIBI5	*Bistorta bistortoides* (Pursh) Small	American bistort	Polygonaceae	X	X	X
Graminoid	CAKO	*Calamagrostis koelerioides* Vasey	fire reedgrass	Poaceae		X	X
Tree	CADE27	*Calocedrus decurrens* (Torr.) Florin	incense cedar	Cupressaceae	X	X	
Herb	CALE4	*Caltha leptosepala* DC.	white marsh marigold	Ranunculaceae	X	X	
Herb	CAQU2	*Camassia quamash* (Pursh) Greene	small camas	Agavaceae	X	X	
Herb	CARO2	*Campanula rotundifolia* L.	bluebell bellflower	Campanulaceae		X	
Graminoid	CAAU3	*Carex aurea* Nutt.	golden sedge	Cyperaceae		X	
Graminoid	CACU5	*Carex cusickii* Mack. ex Piper & Beattie	Cusick's sedge	Cyperaceae		X	X
Graminoid	CAEC	*Carex echinata* Murray	star sedge	Cyperaceae	X	X	X
Graminoid	CAHA5	*Carex hassei* L.H. Bailey	salt sedge	Cyperaceae		X	X
Graminoid	CAJO	*Carex jonesii* L.H. Bailey	Jones' sedge	Cyperaceae		X	X
Graminoid	CAREX	*Carex* L.	sedge	Cyperaceae	X		X
Graminoid	CALA13	*Carex laeviculmis* Meinsh.	smoothstem sedge	Cyperaceae	X		

Strata	Code	Scientific Name with Author	Common Name	Family	other	Eddy's	coll'11
Graminoid	CALEI	*Carex lenticularis* Michx. var. *impressa* (L.H. Bailey) L.A. Standl.	lakeshore sedge	Cyperaceae		X	
Graminoid	CALU7	*Carex luzulina* Olney	woodrush sedge	Cyperaceae	X	X	X
Graminoid	CAME5	*Carex mendocinensis* Olney	Mendocino sedge	Cyperaceae	X		
Graminoid	CASC14	*Carex scabriuscula* Mack.	Siskiyou sedge	Cyperaceae		X	X
Graminoid	CASCB	*Carex scopulorum* T. Holm var. *bracteosa* (L.H. Bailey) F.J. Herm.	mountain sedge	Cyperaceae	X	X	X
Graminoid	CASI2	*Carex simulata* Mack.	analogue sedge	Cyperaceae		X	X
Graminoid	CASU6	*Carex subfusca* W. Boott	brown sedge	Cyperaceae		X	X
Graminoid	CAUT	*Carex utriculata* Boott	Northwest Territory sedge	Cyperaceae	X	X	X
Graminoid	CAVE6	*Carex vesicaria* L.	blister sedge	Cyperaceae		X	X
Herb	CAMIM5	*Castilleja miniata* Douglas ex Hook. ssp. *miniata*	giant red Indian paintbrush	Orobanchaceae	X	X	
Herb	CASTI2	*Castilleja* Mutis ex L. f.	Indian paintbrush	Orobanchaceae	X		
Herb	CEARS2	*Cerastium arvense* L. ssp. *strictum* (L.) Ugborogho	field chickweed	Caryophyllaceae		X	X
Herb	CIDOB2	*Cirsium douglasii* DC. var. *breweri* (A. Gray) D.J. Keil & C.E. Turner	Douglas' thistle	Asteraceae		X	
Herb	CUSCU	*Cuscuta* L.	dodder	Convolvulaceae	X		
Graminoid	CYPEXX	Cyperaceae Juss.				X	
Herb	CYCA4	*Cypripedium californicum* A. Gray	California lady's slipper	Orchidaceae	X		
Graminoid	DACA3	*Danthonia californica* Bol.	California oatgrass	Poaceae		X	
Graminoid	DAIN	*Danthonia intermedia* Vasey	timber oatgrass	Poaceae		X	X
Graminoid	DAUN	*Danthonia unispicata* (Thurb.) Munro ex Macoun	onespike danthonia	Poaceae		X	X
Herb	DACA5	*Darlingtonia californica Torr.*	California pitcherplant	Sarraceniaceae		X	X
Shrub	DAFR6	*Dasiphora fruticosa* (L.) Rydb.	shrubby cinquefoil	Rosaceae		X	X
Graminoid	DECE	*Deschampsia cespitosa (*L.*)* P. Beauv.	tufted hairgrass	Poaceae	X	X	X
Graminoid	DEDA	*Deschampsia danthonioides* (Trin.) Munro	annual hairgrass	Poaceae		X	
Graminoid	DEEL	*Deschampsia elongata (*Hook.) Munro	slender hairgrass	Poaceae		X	X
Herb	DOJE	*Dodecatheon jeffreyi* Van Houtte	Sierrra shootingstar	Primulaceae		X	
Herb	DODEC	*Dodecatheon* L.	shootingstar	Primulaceae		X	X
Herb	DRRO	*Drosera rotundifolia* L.	roundleaf sundew	Droseraceae	X	X	X
Graminoid	ELDE2	*Eleocharis decumbens* C.B. Clarke	decumbent spikerush	Cyperaceae	X	X	X
Graminoid	ELPA3	*Eleocharis palustris* (L.) Roem. & Schult.	common spikerush	Cyperaceae		X	X
Graminoid	ELQU2	**Eleocharis quinqueflora* (Hartmann) O. Schwarz	fewflower spikerush	Cyperaceae	X		
Graminoid	ELGL	*Elymus glaucus* Buckley	blue wildrye	Poaceae		X	
Graminoid	ELHI6	*Elymus hispidus* (Opiz) Melderis	intermediate wheatgrass	Poaceae		X	

Strata	Code	Scientific Name with Author	Common Name	Family	other	Eddy's	coll'11
Graminoid	ELTRT	*Elymus trachycaulus* (Link) Gould ex Shinners ssp. *trachycaulus*	slender wheatgrass	Poaceae		X	X
Herb	EPCI	*Epilobium ciliatum* Raf.	fringed willowherb	Onagraceae		X	X
Herb	EPCIG	*Epilobium ciliatum* Raf. ssp. *glandulosum* (Lehm.) Hoch & P.H. Raven	fringed willowherb	Onagraceae		X	X
Herb	EPHA	**Epilobium halleanum* Hausskn.	glandular willowherb	Onagraceae	X		
Herb	EPILO	*Epilobium* L.	willowherb	Onagraceae	X	X	X
Herb	EPOR	*Epilobium oreganum Greene*	Grants Pass willowherb	Onagraceae	X		
Herb	EQHYA2	*Equisetum hyemale* L. var. *affine* (Engelm.) A.A. Eaton	scouringrush horsetail	Equisetaceae		X	X
Graminoid	ERCR4	*Eriophorum crinigerum (*A. Gray) Beetle	fringed cottongrass	Cyperaceae	X	X	
Shrub	FRCAC6	*Frangula californica* (Eschsch.*)* A. Gray ssp. *crassifolia* (Jeps.) Kartesz & Gandhi	California buckthorn	Rhamnaceae	X		
Herb	GECA	*Gentiana calycosa* Griseb.	Rainier pleated gentian	Gentianaceae		X	X
Herb	GENEN	*Gentiana newberryi* A. Gray var. *newberryi*	alpine gentian	Gentianaceae		X	
Herb	GEAM3	*Gentianella amarella* (L.) Böerner	autumn dwarf gentian	Gentianaceae		X	X
Herb	GESI3	*Gentianopsis simplex* (A. Gray) Iltis	oneflower fringed gentian	Gentianaceae		X	X
Herb	GEMA4	*Geum macrophyllum* Willd.	largeleaf avens	Rosaceae		X	X
Graminoid	GLGR	*Glyceria grandis* S. Watson	American mannagrass	Poaceae	X		
Graminoid	GLST	*Glyceria striata* (Lam.) Hitchc.	fowl mannagrass	Poaceae	X		
Herb	HAAL2	*Hastingsia alba* (Durand) S. Watson	white rushlily	Agavaceae	X	X	
Herb	HEBI	*Helenium bigelovii* A. Gray	Bigelow's sneezeweed	Asteraceae	X	X	X
Graminoid	HOBR2	*Hordeum brachyantherum* Nevski	meadow barley	Poaceae		X	
Herb	HOPI	*Hosackia pinnata* (Hook.) Abrams	meadow bird's-foot trefoil	Fabaceae	X	X	X
Herb	HYAN2	*Hypericum anagalloides* Cham. & SchltdL.	tinker's penny	Hypericaceae	X	X	
Graminoid	JUARB5	*Juncus arcticus* Willd. var. *balticus* (Willd.) Trautv.		Juncaceae		X	X
Graminoid	JUEN	*Juncus ensifolius* Wikstr.	swordleaf rush	Juncaceae	X	X	
Graminoid	**xJUEX**	*Juncus exiguus* (Fernald & Wiegand) Snogerup & Zika	lamp rush	Juncaceae	X	X	
Graminoid	JUHO	*Juncus howellii* F.J. Herm.	Howell's rush	Juncaceae		X	X
Graminoid	JUNCU	*Juncus* L.	rush	Juncaceae		X	
Graminoid	JUNE	*Juncus nevadensis* S. Watson	Sierra rush	Juncaceae	X	X	X
Shrub	JUCO6	*Juniperus communis* L.	common juniper	Cupressaceae		X	
Shrub	KAPO	*Kalmia polifolia* Wagenh.	alpine laurel	Ericaceae		X	
Herb	KYBO	*Kyhosia bolanderi (*A. Gray*) B.G. Baldw.*	Bolander's madia	Asteraceae		X	
Herb	LIGR	*Ligusticum grayi* J.M. Coult. & Rose	Gray's licorice-root	Apiaceae		X	X
Herb	LILIXX	Liliaceae				X	

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Herb	LILIU	*Lilium* L.	lily	Liliaceae	X	X	
Shrub	LOCO5	*Lonicera conjugialis* Kellogg	purpleflower honeysuckle	Caprifoliaceae		X	
Graminoid	LUCO6	*Luzula comosa* E. Mey.	Pacific woodrush	Juncaceae	X		
Graminoid	LUMU2	*Luzula multiflora* (Ehrh.) Lej.	common woodrush	Juncaceae	X		
Graminoid	LUZUL	*Luzula* DC.	woodrush	Juncaceae	X		
Herb	MARA7	*Maianthemum racemosum* (L.) Link	feathery false lily of the valley	Ruscaceae	X		
Herb	METR3	*Menyanthes trifoliata* L.	buckbean	Menyanthaceae		X	
Herb	MIGU	*Mimulus guttatus* DC.	seep monkeyflower	Phrymaceae		X	
Herb	MIMO3	*Mimulus moschatus* Douglas ex Lindl.	muskflower	Phrymaceae	X		
Herb	MIPR	*Mimulus primuloides* Benth. var. *primuloides*	primrose monkeyflower	Phrymaceae	X		
Herb	MIPRL2	*Mimulus primuloides* Benth. var. *linearifolius* A.L. Grant	primrose monkeyflower	Phrymaceae		X	X
Graminoid	MUAN	*Muhlenbergia andina* (Nutt.) Hitchc.	foxtail muhly	Poaceae	X	X	X
Graminoid	MUFI2	*Muhlenbergia filiformis* (Thurb. ex S. Watson) Rydb.	pullup muhly	Poaceae		X	
Herb	NACA2	*Narthecium californicum* Baker	California bog asphodel	Nartheciaceae	X	X	
Herb	NOTR2	*Nothocalais troximoides* (A. Gray) Greene	sagebrush false dandelion	Asteraceae		X	X
Herb	NUPO2	*Nuphar polysepala* Engelm.	Rocky Mountain pond-lily	Nymphaeaceae		X	
Herb	ORALA3	*Oreostemma alpigenum* (Torr. & A. Gray*)* Greene var. *andersonii (*A. Gray) G.L. Nesom	tundra aster	Asteraceae	X	X	X
Herb	OXOC	*Oxypolis occidentalis* J.M. Coult. & Rose	western cowbane	Apiaceae		X	
Herb	PACII	*Parnassia cirrata* Piper var. *intermedia* (Rydb.) P.K. Holmgren & N.H. Holmgren	fringed grass of Parnassus	Parnassiaceae		X	
Herb	PAPA8	*Parnassia palustris* L.	marsh grass of Parnassus	Parnassiaceae	X	X	X
Herb	PARNA	*Parnassia* L.	grass of Parnassus	Parnassiaceae		X	
Herb	**xPEBR**	*Pectiantia brewer*i (A. Gray) Rydb.	Brewer's miterwort	Saxifragaceae	X		
Herb	PEAT	*Pedicularis attollens* A. Gray	little elephantshead	Orobanchaceae		X	
Herb	PEDIC	*Pedicularis* L.	lousewort	Orobanchaceae		X	
Herb	PEPA21	*Perideridia parishii* (J.M. Coult. & Rose) A. Nelson & J.F. Macbr.	Parish's yampah	Apiaceae		X	X
Herb	PHPR	*Phacelia pringlei* A. Gray	Pringle's phacelia	Boraginaceae		X	
Graminoid	PHAL2	*Phleum alpinum* L.	alpine timothy	Poaceae		X	
Tree	PINAXX	Pinaceae	pine	Pinaceae	X	X	
Tree	PICOM	*Pinus contorta* Douglas ex Louden var. *murrayana* (Balf.) Engelm.	Sierra lodgepole pine	Pinaceae		X	
Tree	PIJE	*Pinus jeffreyi* Balf.	Jeffrey pine	Pinaceae	X	X	

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Herb	PLDIL	*Platanthera dilatata* (Pursh) Lindl. ex Beck var. *leucostachys* (Lindl.) Luer	Sierra bog orchid	Orchidaceae		X	
Herb	PLATA2	*Platanthera* Rich.	fringed orchid	Orchidaceae	X	X	
Herb	PLSP2	*Platanthera sparsiflora* (S. Watson) Schltr.	sparse-flowered bog orchid	Orchidaceae	X		
Graminoid	POACXX	Poaceae				X	X
Herb	POLYXX	Polygonaceae			X		
Herb	PODO4	*Polygonum douglasii* Greene	Douglas' knotweed	Polygonaceae	X		
Herb	PODR	*Potentilla drummondii* Lehm.	Drummond's cinquefoil	Rosaceae		X	
Herb	POGR9	*Potentilla gracilis* Douglas ex Hook.	slender cinquefoil	Rosaceae		X	X
Herb	POTEN	*Potentilla* L.	cinquefoil	Rosaceae		X	X
Herb	PRVU	*Prunella vulgaris* L.	common selfheal	Lamiaceae		X	X
Herb	PSJA2	*Pseudostellaria jamesiana* (Torr.) W.A. Weber & R.L. Hartm.	tuber starwort	Caryophyllaceae		X	X
Herb	PTAQ	*Pteridium aquilinum* (L.) Kuhn	western brackenfern	Dennstaedtiaceae	X	X	
Shrub	QUVA	*Quercus vacciniifolia* Kellogg	huckleberry oak	Fagaceae		X	
Herb	RAPR	*Raillardella pringlei* Greene	showy raillardella	Asteraceae		X	
Herb	RAAL	*Ranunculus alismifolius* Geyer ex Benth.	plantainleaf buttercup	Ranunculaceae		X	
Shrub	**xRHCO**	*Rhododendron columbianum* (Piper) Harmaja	western Labrador tea	Ericaceae		X	
Shrub	RHOC	*Rhododendron occidentale (*Torr. & A. Gray*)* A. Gray	western azalea	Ericaceae	X	X	X
Herb	RUKL	*Rudbeckia klamathensis* P. Cox & Urbatsch	Klamath coneflower	Asteraceae		X	X
Graminoid	SCCO	*Scirpus congdonii* Britton	Congdon's bulrush	Cyperaceae		X	X
Graminoid	SCMI2	*Scirpus microcarpus* J. Presl & C. Presl	panicled bulrush	Cyperaceae		X	X
Herb	SENEC	*Senecio* L.	ragwort	Asteraceae	X	X	
Herb	SETR	*Senecio triangularis* Hook.	arrowleaf ragwort	Asteraceae	X	X	
Herb	SIOR	*Sidalcea oregana* (Nutt. ex Torr. & A. Gray) A. Gray	Oregon checkerbloom	Malvaceae	X	X	
Herb	SIORS	*Sidalcea oregana* (Nutt. ex Torr. & A. Gray) A. Gray ssp. *spicata* (Regel) C.L. Hitchc.	Oregon checkerbloom	Malvaceae		X	X
Herb	SIDAL	*Sidalcea* A. Gray	checkerbloom	Malvaceae		X	
Herb	SIBE	*Sisyrinchium bellum* S. Watson	western blue-eyed grass	Iridaceae	X	X	
Herb	SIEL3	*Sisyrinchium elmeri* Greene	Elmer's blue-eyed grass	Iridaceae		X	
Herb	SIID	*Sisyrinchium idahoense* E.P. Bicknell	Idaho blue-eyed grass	Iridaceae		X	
Herb	SOMU	*Solidago multiradiata* Aiton	Rocky Mountain goldenrod	Asteraceae		X	X
Herb	SPSP2	*Spiraea splendens* Baumann ex K. Koch	rose meadowsweet	Rosaceae		X	
Herb	STRI	*Stachys rigida* Nutt. ex Benth.	rough hedgenettle	Lamiaceae	X		
Herb	STCR2	*Stellaria crispa* Cham. & Schltdl.	curled starwort	Caryophyllaceae	X		

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Herb	SYSP	*Symphyotrichum spathulatum* (Lindl.) G.L. Nesom	western mountain aster	Asteraceae	**X**	**X**	**X**
Herb	TROCO2	*Triantha occidentalis* (S. Watson) Gates ssp. *occidentalis*	western false asphodel	Tofieldiaceae	**X**	**X**	
Herb	TRCY	*Trifolium cyathiferum* Lindl.	cup clover	Fabaceae		**X**	
Herb	TRLO	*Trifolium longipes* Nutt.	longstalk clover	Fabaceae		**X**	**X**
Herb	TRLOE	*Trifolium longipes* Nutt. ssp. *elmeri* (Greene) J.M. Gillett	Elmer's clover	Fabaceae		**X**	**X**
Herb	TRIFO	*Trifolium* L.	clover	Fabaceae	**X**	**X**	
Herb	TRHY3	*Triteleia hyacinthina* (Lindl.) Greene	white brodiaea	Themidaceae		**X**	**X**
Herb	UTMA	*Utricularia macrorhiza* Leconte	common bladderwort	Lentibulariaceae		**X**	
Shrub	VACE	*Vaccinium cespitosum* Michx.	dwarf bilberry	Ericaceae		**X**	
Herb	VECA2	*Veratrum californicum* Durand	California false hellebore	Melanthiaceae	**X**	**X**	
Herb	VEAM2	*Veronica americana* Schwein. ex Benth.	American speedwell	Plantaginaceae	**X**		
Herb	VESEH2	*Veronica serpyllifolia* L. ssp. *humifusa* (Dicks.) Syme	brightblue speedwell	Plantaginaceae		**X**	**X**
Herb	VIOLA	*Viola* L.	violet	Violaceae	**X**	**X**	**X**
Herb	2FORB		unknown forb			**X**	