USDA Natural Resources Conservation Service

Ecological site R022BI202CA
Frigid Alluvial Flat

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 022B–Southern Cascade Mountains

Site Concept –
Riparian Complex: Hydrologically connected by multiple springs, flows, and seasonal snow melt. Slopes: Generally 1 to 3 percent but can have up to 5 percent slopes.
Landform: stream terrace.
Soils: Very deep alluvium, with varying depths of organic horizons.
Temp regime: Frigid.
MAAT: 5.5 to 6.1 degrees C. (42 to 43 degrees F.).
MAP: 1,295 to 1,753 mm (51 to 69 inches).
Soil texture: muck to gravelly ashy fine sandy loam.
Surface fragments: 0 to 10 percent gravel
Commonly Associated with: R022BI211CA Spring Complex and R022BI210CA Frigid Loamy Flood Plain Floodplain
Vegetation: several montane meadow plant communities dominated by graminoid species with some willow and mountain alder.

Associated sites

F022BI120CA	**Frigid Gravelly Sandy Loam Outwash-Stream Terraces** This white fir- Sierra lodgepole pine forest surrounds the meadow.
R022BI211CA	**Spring Complex** This site is a spring complex which provides water to the meadow.

Similar sites

R022BI210CA	**Frigid Loamy Flood Plains** This riparian site is associated with Hot Springs Creek.
R022BI217CA	**Frigid Lacustrine Flat** This meadow site is associated with relic glacial lakes and alluvial terraces, without major spring influences.
R022BI206CA	**Cryic Lacustrine Flat** This meadow site is found at higher elevations, and is associated with small meandering streams.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Salix lemmonii* (2) *Alnus incana ssp. tenuifolia*
Herbaceous	(1) *Carex nebrascensis* (2) *Carex simulata*

Physiographic features

This ecological site is presently mapped between 5,440 and 5,790 feet in elevation, but the elevation range may be extended if found outside the park. This site is on stream terraces. Slopes are generally 1 to 3 percent but may be up to 5 percent.

Table 2. Representative physiographic features

Landforms	(1) Stream terrace
Flooding duration	Extremely brief (0.1 to 4 hours) to long (7 to 30 days)
Flooding frequency	Rare to frequent
Ponding duration	Brief (2 to 7 days) to very long (more than 30 days)
Ponding frequency	Occasional to frequent
Elevation	1,658–1,765 m
Slope	1–5%
Water table depth	0–152 cm
Aspect	Aspect is not a significant factor

Climatic features

This ecological site receives most of its annual precipitation in the form of snow from November to April. The mean annual precipitation ranges from 51 to 69 inches (1,295 to 1,753 mm). The mean annual temperature ranges from 42 to 43 degrees F (5.5 to 6.1 degrees C). The frost free (>32 degrees F) season is 70 to 90 days. The freeze free (> 28 degrees F) season is approximately 80 to 200 days.

Table 3. Representative climatic features

Frost-free period (average)	90 days
Freeze-free period (average)	200 days
Precipitation total (average)	1,753 mm

Influencing water features

This site has wetland and non-wetland features; further delineation would be needed to locate the wetland boundaries. The drier portions of this meadow complex are seasonally saturated for short durations after the spring snowmelt. The wettest areas are saturated to the surface throughout the entire year, due to continual input of water from springs that emerge just upslope from the meadow.

Soil features

The soil components associated with this meadow ecological site are Terric Haplohemists, Histic Humaquepts, Aquandic Humaquepts, and Aquandic Endoaquepts. These are all very deep, very poorly to somewhat poorly drained soils that formed in alluvium.

The wettest part of this meadow fits the criteria for a fen because it has at least 40 cm of organic soil within the upper 80 cm of soil, supports hydrophytic vegetation, and its soil is saturated to the surface for a least one month each year (Cooper and Evan, 2006). Incised ditches and the removal of Lemmon's willow (*Salix lemmonii*) and other shrubs have altered the vegetation, threatening the characteristics of the fen. The soil in this part of the meadow are Terric Haplohemists, which has 20 inches of organic muck over a 10 inch ashy silty clay loam textured horizon. The lower horizons have ashy silty loam and ashy silty clay loam textures. The water table fluctuates from 0 to 24 inches during the dry season. The vegetation is dominated by analogue sedge (*Carex simulata*), Northwest Territory sedge (*Carex utriculata*), and Nebraska sedge (*Carex nebrascensis*), along with other hydrophytic vegetation (PCC1b).

The Nebraska sedge (*Carex nebrascensis*) community (PCC2b) is found in slightly drier locations surrounding the fen and is associated with the Histic Humaquepts soil component. These soils have 9 inches of organic material over 19 inches of ashy loam textured A and B horizons. The C horizons have extremely cobbly ashy sandy clay loam and very cobbly ashy coarse sandy loam textures. The water table is at the surface in early summer then fluctuates from 10 to 60 inches during the dry season.

A mixed sedge and grassland community (PCC3b) is found throughout the meadow and is associated with the Aquandic Humaquepts soil component. These soils have 4 inches of ashy mucky peat over an ashy very fine sandy loam textured horizon. The subsurface textures are very gravelly, extremely gravelly, and gravelly ashy sandy loams. The water table is near the surface in early summer and fluctuates from 10 to 60 inches in the dry season. Common plants include widefruit sedge (*Carex angustata*), tufted hairgrass (*Deschampsia cespitosa*), Kentucky bluegrass (*Poa pratensis*), and timothy (Phleum pretense).

The driest part of the meadow is associated with the Aquandic Endoaquepts soil component. These soils formed in bar deposits. They do not have an organic horizon, due to the aerobic conditions created by these soils as water flows through them. This creates oxygenated conditions for most of the year that allow organic matter to decompose rather than form peat. The surface texture is a gravelly ashy fine sandy loam surface texture. Subsurface textures include ashy very fine sandy loams, ashy loamy fine sand, and ashy loam coarse sand, and gravelly ashy loam coarse sand. This soil has a high percentage of surface gravels and bare ground, compared to the rest of the meadow. Sedges (Carex spp.) and mountain rush (*Juncus arcticus* ssp. littoralis) provide about 70 percent cover of the vegetation cover (PCC4b).

This ecological site has been correlated with the following map units and soil components in the Lassen Volcanic National Park Soil Survey (CA789):

Map Unit Component /Component percent
165 Aquandic Humaquepts / 35
165 Histic Humaquepts / 25
165 Aquandic Endoaquepts / 20
165 Terric Haplohemists / 15

Table 4. Representative soil features

Family particle size	(1) Loamy
Drainage class	Very poorly drained to somewhat poorly drained
Permeability class	Moderately slow to moderate
Soil depth	152 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	9.65–23.88 cm
Soil reaction (1:1 water) (0-101.6cm)	5.6–7.3
Subsurface fragment volume <=3" (Depth not specified)	0–75%
Subsurface fragment volume >3" (Depth not specified)	0–40%

Ecological dynamics

This ecological site is a montane meadow-fen complex. One representative location of this ecological site is the Drakesbad Meadow in Lassen Volcanic National Park. The following description is based on data and research from Drakesbad Meadow, however this site may be found and mapped elsewhere within the MLRA.

This ecological site complex has an assemblage of plant communities and soil types dependent upon dependent upon stream deposit characteristic, micro-topography, hydrologic characteristics, and human-influenced alterations. An extensive study of the hydrology of the lower part of Drakesbad Meadow, by Lindsay Patterson, determined that 99 percent of the hydrologic input during the summer months comes from the associated spring complex ecological site, R022BI211CA located almost 200 feet above the meadow. These spring complexes can be created by groundwater seeping out at a contact between an older andesite flow and a more recent dacite flow, which is the case in Lassen Volcanic National Park. These springs are from a regional aquifer that is recharged by a high winter snowfall. The spring flow reaches the meadow by surface flow and creates a flow- through system in the meadow (Patterson, 2005). There is also a small tributary to Little Hot Springs Creek bisects Drakesbad Meadow. It effectively intercepts the spring flow before it reaches the upper portion of the meadow, where fen characteristics have not developed. The riparian ecological site: Frigid Loamy Flood plains R022BI210CA, is often associated with this ecological site. An example of this site in Lassen Volcanic National Park would be Hot Springs Creek, which is on the lower, south side of this valley. This site may or may not be supplying hydrologic support to this ecological site, and in Lassen Volcanic National Park. Hot Springs Creek stays mainly in its channel and does not regularly overflow into the meadow, and is thus of secondary hydrologic importance.

There is little known about the use of these meadows by the Native Americans. The Mountain or Northeastern Maidu were seasonal inhabitants in the Warner Valley prior to European settlers and it is likely they harvested plant materials for consumption and for weaving material. They hunted game, although their impact was probably minimal.

The recent history of Drakesbad Meadow in particular has been well documented in several papers, with nice photo pairs showing the changes over time. Edward Drake arrived in Warner Valley around 1875 and was the first documented settler in the area. In 1894 he finally purchased or had a government patent for the upper Warner Valley, including Drakesbad Meadow. By this time he had improved the dirt road from Chester, built a house and a barn, and fenced and planted his pasture with timothy grass. As many as 100 horses may have been passing through Drakesbad Meadow at one time (Hoke, et al., 2005; Bozeman). The Sifford family bought the ranch from Edward Drake in 1900. The Siffords began a campground and guest house for tourists visiting the nearby hot springs. They spent many long and arduous days removing willows and alders from the meadow west of the lodge. They also dug ditches to drain the wettest areas there, and tried to divert the water to drier areas (Hoke, et al. 2005). Between 1942 and 1951, the Siffords ran about 100 head of cattle as many as 30 horses passing through Drakesbad Meadow at any one time. During the cattle ranching period, fencing was expanded and timothy seed was spread in the pastures. Drakesbad Meadow and the surrounding areas became part of Lassen National Volcanic Park in 1958 and cattle grazing ceased, although horses are still corralled near the meadow.

The hydrology, soil development and history of this site and Drakesbad Meadow in particular, play important roles in the distribution and composition of the plant communities present. The constant flow of water and the subsequent prolonged saturated soil conditions has allowed peat to develop from sedge roots by creating anaerobic conditions that inhibit organic matter decomposition. Peat accumulation is a slow process with accumulation rates of approximately 20 cm per thousand years, as cited in Patterson's report (Patterson 2005, and Chimner and Cooper, 2003). Peat from the southeast portion of Drakesbad Meadow has been dated from 4200 years BP (White, et. al 2001). Once peat dries out it can decompose quickly. Presently only the wettest areas of the meadow have deep organic soils. The drier areas of the meadow have mineral soils and support a larger composition of upland plant species.

This ecological site is a complex of plant communities which are interrelated by hydrology. This is a relatively new concept for ecological sites. The state and transition diagram below illustrates the change in plant community component composition as a result of disturbance or change in the water table, rather than focusing on the succession of one plant community.

Fire is not included in the successional dynamics for this ecological site. Under natural conditions this meadow would be too wet to burn. The drier upper meadow could burn, but the native perennial grasses would resprout and recover quickly.

There is a potential serious threat from fire in State 2, if the peat dries out. It could burn and restoration of the fen would be nearly impossible.

Although there is considerable qualitative experience supporting the pathways and transitions within the State and Transition Model (STM), there is no quantitative information to specifically identify threshold parameters that distinguish between natural equilibrium and altered states in this ecological site. For information on STMs, see the following citations: Bestelmeyer el al. 2003, Bestelmeyer et al. 2009, and Stringham and Shaver 2003.

State and transition model

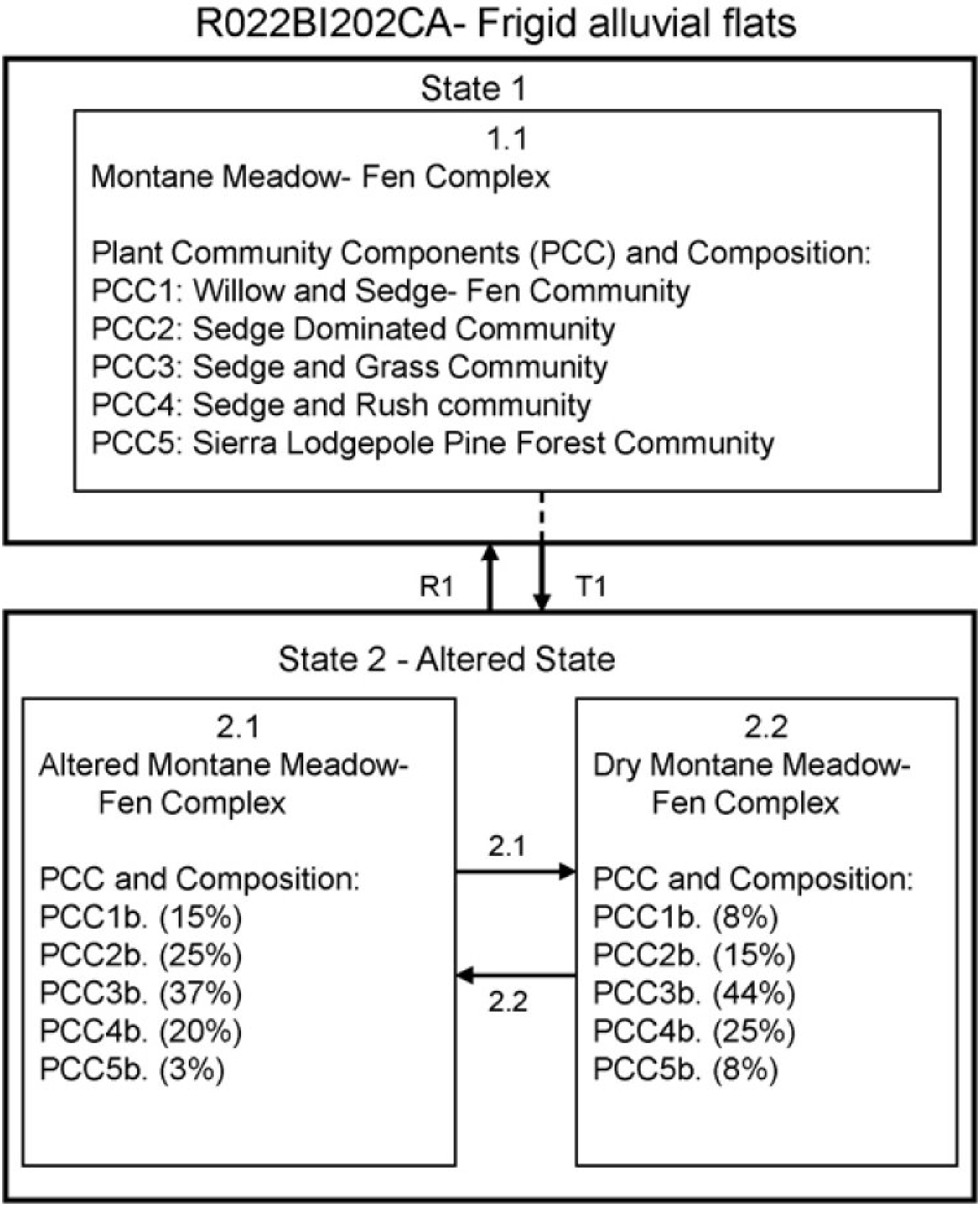

Figure 3. Frigid alluvial flats

State 1
State 1

This state represents the natural conditions for this meadow complex. It is based on historical accounts and photos of the meadow from the early 1900’s (Hoke, et al, 2005, Bozeman, and Patterson, 2005).

Community 1.1
Montane Meadow- Fen Complex 1.1

The native plant communities that were present in this meadow before human alterations may have been somewhat similar to the respective plant communities described in State 2. Historical photos indicate that PCC1 and PCC2 had a large component of shrubs, most likely Lemmon's willow and mountain alder. The shrubs may have been in areas with oxygenated surface flow or elevated patches of peat. Patterson reported a 96 percent decrease in shrubs from 1952 and 2003 (determined by photo interpretation). This actually includes about a 3 percent increase in shrubs since the meadow became part of the national park (Patterson, 2005). The presence and distribution of the plant communities are related to water table depth and duration of soil saturation. The wettest portions of this meadow have developed with a constant, steady flow of water from the springs upslope and seasonal snow melt. This system is relatively stable with few natural disturbances to change the distribution and proportion of the plant communities within the meadow. The plant community borders, however, may shift if the site gets drier or wetter due to drought, flood, or a change in drainage patterns (i.e. sedge roots build up, block a channel and the channel changes course). The following community components are associated with this state of the montane meadow-fen complex, described from wettest to driest: PCC1: A relict of this plant community is still present today in the wettest part of the fen. It has peat-forming sedges such as analogue sedge (*Carex simulata*), Northwest Territory sedge (*Carex utriculata*), Nebraska sedge (*Carex nebrascensis*), and other wetland species. Historical photos show this area was dominated by shrubs, most likely Lemmon's willow (*Salix lemmonii*) and/or thinleaf alder (*Alnus incana* ssp. tenuifolia). Literature and photos indicate that this community was once more extensive in the lower part of Drakesbad Meadow. PCC2: The Nebraska sedge (*Carex nebrascensis*) community borders the wettest area of the meadow. Historical photos indicate high shrub cover where this community is present today. Lemmon's willow (*Salix lemmonii*) may have been more prevalent in the open meadow, where water drainage is slower. Thinleaf alder would tend to prefer areas with more water movement, such as near channels or concentrated surface flow. Seed bank studies indicate that this community may have been less extensive when water tables were higher, prior to hydrologic alterations (Patterson, 2005). PCC3: This community existed in the upper portion of the meadow, which does not receive direct spring flow. Native plants such as tufted hairgrass (*Deschampsia cespitosa*), widefruit sedge (*Carex angustata*), other mixed sedges (Carex spp.) and mountain rush (*Juncus arcticus* ssp. littoralis) are still present today. Native species that tend to increase with surface disturbance are meadow barley (*Hordeum brachyantherum*), Chamisso arnica (*Arnica chamissonis*), longstalk clover (*Trifolium longipes*), cinquefoil (Potentilla spp.), and Rydberg's penstemon (*Penstemon rydbergii*). Non-native grasses, primarily timothy (Phleum pretense) and Kentucky bluegrass (*Poa pratensis*), are a significant component of this plant community today. PCC4: This is the driest plant community. It is associated with the topographically higher bar deposits within the meadow, that were a result of past flooding dynamics of the associated Frigid Loamy Floodplains ecological site. There is less vegetative cover and a higher percentage of surface gravels compared to the rest of the meadow. Because of its convex mound topography and course textures, this area drains water rapidly. The lack of an organic horizon indicates that this area does not experience the prolonged saturated conditions suitable for peat development. This area is presently dominated by mixed sedges (Carex spp.), mountain rush (*Juncus arcticus* ssp. littoralis), and Columbia needlegrass (*Achnatherum nelsonii*). It is difficult to determine species composition changes in this plant community since the early 1900's. Because this area is drier than the rest of the meadow it may have been heavily used in the past. PCC5: This is a Sierra lodgepole pine (*Pinus contorta* var. murrayana) forest found along the edge of the meadow. White fir (*Abies concolor*) and Jeffrey pine (*Pinus jeffreyi*) may be present. This forest is open with a grassy understory. Native understory species present in the bordering forest today are Columbia needlegrass (*Achnatherum nelsonii*), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), common yarrow (*Achillea millefolium*), strawberry (Fragaria sp.), and Ross' sedge (*Carex rossii*). Natural fluctuations which raise the water table would favor PCC1 and PCC2, while a lower water table would favor Community Types PCC3, PCC4, and PCC5.

State 2
Altered state

This state represents the existing altered condition and the potentially severely degraded phase for this ecological site. It is based on literature review, and recent soil and vegetation data collected by NRCS from 2006 to 2008.

Community 2.1
Altered Montane Meadow- Fen complex

Figure 4. Frigid Alluvial Flat

This community phase has some similar plant community components as the undisturbed state, but the willow component has been reduced, and the hydrology has been altered due to incised ditches. Non-native plants have become established. The incised ditches have lowered the water table in some areas, which alters the distribution of the plant community components. PCC1b: This community is dominated by peat-forming sedges such as Northwest Territory sedge (*Carex utriculata*), analogue sedge (*Carex simulata*) and Nebraska sedge (*Carex nebrascensis*), with an occasional Lemmon's willow (*Salix lemmonii*) and thinleaf alder (*Alnus incana* ssp. tenuifolia). This community is found in areas that are saturated to the surface for several months during the growing season and water tables don't drop below 6 inches. The sedges form a tightly woven organic surface with their extensive root systems. The root mats do not decay in these saturated conditions, so dead roots, rhizomes, and stolons develop into a thick organic peat layer. These plants have several adaptations which enable them to survive these anoxic saturated conditions, such as aerenchyma tissue in the roots and stems. This tissue has well-developed air spaces between the cells which allow for gas exchange. PCC2b: This community is dominated by Nebraska sedge (*Carex nebrascensis*). It is found adjacent to the fen community, but does not always have the depth of organic soil required to meet the fen criteria (40cm with in the upper 80cm). Nebraska sedge is a heavily rhizomatous wetland plant that can form almost monotypic stands. It can survive total inundation for 3 months (Hoag, 1998.). It is not generally found in areas where the water table drops to more than 1 meter below the surface late in the growing season (Hoag, et al. 2007). This community may be expanding into the fen community in those areas where the water table has dropped below the surface. PCC3b: This community is dominated by native sedges and non-native grasses. The dominant sedge appears to be widefruit sedge (*Carex angustata*). Tufted hairgrass (*Deschampsia cespitosa*) is the dominant native grass. Non-native grasses are Kentucky bluegrass (*Poa pratensis*) and timothy (Phleum pretense). There is high cover of mountain rush (*Juncus arcticus* ssp. littoralis), Chamisso arnica (*Arnica chamissonis*), and longstalk clover (*Trifolium longipes*). Other plants include meadow barley (*Hordeum brachyantherum*), fringed willowherb (*Epilobium ciliatum*), three-petal bedstraw (*Galium trifidum*), California false hellebore (*Veratrum californicum* var. californicum), cinquefoil (Potentilla sp.), Rydberg's penstemon (*Penstemon rydbergii*), Lemmon's yampah (*Perideridia lemmonii*), longstalk starwort (*Stellaria longipes*) and other sedges (Carex spp.). PCC4b: This is the droughtiest plant community which is found on bar deposits within the meadow, as described above in State 1, PCC4. Mixed sedges (Carex spp.) and mountain rush (*Juncus arcticus* ssp. littoralis) dominate with lesser amounts of Columbia needlegrass (*Achnatherum nelsonii*), Bolander's bluegrass (*Poa bolanderi*), spreading groundsmoke (*Gayophytum diffusum*), longstalk clover (*Trifolium longipes*), aster (Aster sp.), clover (Trifolium sp.), slender cinquefoil (*Potentilla gracilis*), and common dandelion (*Taraxacum officinale*). PCC5b: This is a Sierra lodgepole pine forest found along the driest portions of the meadow. Sierra lodgepole pine creates an open forest with a grassy understory. Data was not collected for this community component, but it was collected on a nearby drier site where species include California brome (*Bromus carinatus*), Columbia needlegrass (*Achnatherum nelsonii*), blue wildrye (*Elymus glaucus*), timothy (Phleum pretense), Kentucky bluegrass (*Poa pratensis*), common yarrow (*Achillea millefolium*), strawberry (Fragaria sp.), and Ross' sedge (*Carex rossii*). The percent composition for the community components during this phase are approximately: PCC1b: 15% PCC2b: 25% PCC3b: 37% PCC4b: 20% PCC5b: 3% The production values in the tables below, for groups 1 and 4, represent ocular estimates which were calibrated based on actual clipped production from plots nearby.

Community 2.2
Dry Montane Meadow-Fen Complex

This community phase has the same community components as describe in Community Phase 2.1, but the composition of the plant communities may change if water tables continue to drop. PCC1b and PCC2b are most at risk if the water table drops and the fen community could disappear, permitting the more upland communities to dominate. It is unclear if Drakesbad Meadow has developed into this community or if it remains a potential phase for the future. Should water be diverted from this site and ditches continue to incise, water tables will drop. Prolonged drought can exacerbate this situation. The percent composition for the community components during this phase are approximately: PCC1b: 8% PCC2b: 15% PCC3b: 44% PCC4b: 25% PCC5b: 8%

Pathway 1
Community 2.1 to 2.2

This community pathway is created if water tables continue to lower.

Pathway 2
Community 2.2 to 2.1

This pathway may be created by raising the level of the water table by natural or artificial means.

Transition 1
State 1 to 2

Using Drakesbad Meadow as the example illustrating the transitions that can occur in this ecological site, the transition was initiated in the early 1900's when the meadow hydrology was altered and shrubs were manually removed. Non-native grasses were seeded to improve forage for livestock. A threshold was crossed when the hydrology of the site was altered, and non-native plant species established. Spring flow was diverted down a road, away from the meadow. Ditches were created in the meadow to drain the wet areas and redirect flow to drier areas. The ditches captured surface water flow, subsequently causing the water table to drop in the surrounding areas. The lower water tables allowed other plant communities to establish on the recently dried fen habitat. Additional drainage channels may have formed when the dominant vegetation shifted from sedges, which form dense stable root mats, to grasses, which offer less protection against soil erosion. In low slope meadows dominated by sedge, surface flow generally sheets across the surface and infiltrates as subsurface flow without true channels, but in areas where grasses are dominant and the soil is less tightly bound, the surface flow can scour channels. Shrub removal has left the meadow dominated by graminoid species and now lacks the valuable wildlife habitat provided by shrub cover. Willows have not reestablished their former cover in the meadow. The physical impact from grazing horses and cattle is not documented, but it's conceivable they may have altered species composition due to selective herbivory and/or soil compaction. Introduced grasses have created plant communities that did not exist prior to European settlement. It is possible for fen soils to dry to a sufficient depth and duration to allow for the decomposition of the organic material in the upper soil horizons. This is a real concern, but soils here do not indicate that this process is occurring at this time. As stated earlier, the development of organic fen soils takes thousands of years, but they can decompose in a decade when dried out. When the organic material decomposes the fibrous peat disintegrates and becomes amorphous. This causes the peat to shrink, reducing hydraulic conductivity and increasing bulk density (Patterson, 2005). The process of decay is a combination of complex chemical and biological processes. Many of these processes are inhibited in anaerobic conditions (lack of oxygen). When water tables drop in fen habitats, peat is exposed to oxygen and begins to decay. The exposure of the peat to air can increases carbon mineralization, which creates a loss of carbon into the atmosphere in the form of carbon dioxide (CO_2). The process of nitrogen mineralization (decay) is also affected by changes in the water table, but the process seems to be complex and dependent upon the depth of the water table and other variables. Nitrogen mineralization (decay) creates ammonium ions (NH_4^+) that attach to the negatively charged clay particles. The ammonium can be utilized by plants or processed further to form nitrate via nitrification. Nitrification requires oxygen and creates negatively charged nitrate ions (NO_3^-) that are leached out of the soil, leaving positively charged hydrogen ions (H^+) which, in turn, decrease the pH of the soil. The extent of the impact from these processes in the areas where the peat has been drained for almost 100 years is unclear and could use more study.

Restoration pathway 1
State 2 to 1

Several restoration practices were implemented during the summer of 2003. The dirt road that leads to the water tank dissects and diverts spring flow, so culverts were placed across this road at 21 points to allow the springs to cross at their natural course. Shortly after, the largest ditch in the meadow was blocked with 5 sheet- metal dams. The restoration of the road increased the water table in the meadow, but the placement of the sheet dams seemed to have had a more significant impact by raising the water table over a larger area of the meadow. One year after treatment, there was a significant increase in the fen-forming sedges (Carex spp.), and a reduction in the drier type grasses. This was considered a pilot study, with positive results, and further similar treatments are recommended. Shrub seeds were absent in the seed bank, so the shrubs may need to be reintroduced. Lemmon's willow (*Salix lemmonii*) can be reintroduced from seed or from cuttings from nearby shrubs. Thinleaf alder (*Alnus incana* ssp. tenuifolia) may also have been present in some of this area (Patterson, Lindsay S. 2005). Removing the non-native grasses and invasive plant species from the meadow will require an ongoing commitment by physically removing the undesired plants and reseeding or encouraging the native species. Complete removal of non-native grasses in the upper meadow is probably not practical.

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)

Table 6. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**shrubs**			0–112	
	thinleaf alder	ALINT	*Alnus incana ssp. tenuifolia*	0–84	0–1
	Lemmon's willow	SALE	*Salix lemmonii*	0–56	0–1
	alpine laurel	KAMI	*Kalmia microphylla*	0–22	0–2
Grass/Grasslike					
1	**grass/grasslike**			1569–3133	
	Northwest Territory sedge	CAUT	*Carex utriculata*	605–897	20–30
	Nebraska sedge	CANE2	*Carex nebrascensis*	319–785	15–25
	analogue sedge	CASI2	*Carex simulata*	280–560	10–20
	spikerush	ELEOC	*Eleocharis*	235–353	10–15
	panicled bulrush	SCMI2	*Scirpus microcarpus*	179–280	8–12
	Bolander's bluegrass	POBO	*Poa bolanderi*	40–101	2–5
	bentgrass	AGROS2	*Agrostis*	39–78	1–2
	California brome	BRCA5	*Bromus carinatus*	39–78	1–2
2	**grass/grasslike**			1704–2937	
	Nebraska sedge	CANE2	*Carex nebrascensis*	1681–2802	80–95
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	22–112	5–28
	tufted hairgrass	DECE	*Deschampsia cespitosa*	0–11	0–1
	meadow barley	HOBR2	*Hordeum brachyantherum*	0–11	0–1
3	**grass/grasslike**			1961–3486	
	widefruit sedge	CAAN15	*Carex angustata*	1345–2466	50–70
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	560–785	65–75
	tufted hairgrass	DECE	*Deschampsia cespitosa*	56–224	5–15
	meadow barley	HOBR2	*Hordeum brachyantherum*	0–11	0–1
4	**grass/grasslike**			1195–1810	
	sedge	CAREX	*Carex*	673–897	30–40

	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	448–673	50–70
	Bolander's bluegrass	POBO	*Poa bolanderi*	40–140	2–7
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	34–101	1–3
20	**non-native grasses CT3**			261–504	
	Kentucky bluegrass	POPR	*Poa pratensis*	260–392	8–12
	timothy	PHPR3	*Phleum pratense*	1–112	1–10
Forb					
1	**native forbs**			67–291	
	longstalk clover	TRLO	*Trifolium longipes*	11–112	1–5
	Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	34–90	2–4
	longstalk starwort	STLO2	*Stellaria longipes*	11–56	1–3
	Douglas' thistle	CIDO2	*Cirsium douglasii*	11–34	0–1
2	**native forbs**			0–29	
	Rydberg's penstemon	PERY	*Penstemon rydbergii*	0–13	0–1
	slender phlox	MIGRG4	*Microsteris gracilis var. gracilis*	0–11	0–1
	knotweed	POLYG4	*Polygonum*	0–1	0–1
	longstalk clover	TRLO	*Trifolium longipes*	0–1	0–1
	violet	VIOLA	*Viola*	0–1	0–1
	rose thistle	CIAN	*Cirsium andersonii*	0–1	0–1
3	**native forbs**			337–854	
	Chamisso arnica	ARCH3	*Arnica chamissonis*	336–740	25–55
	Rydberg's penstemon	PERY	*Penstemon rydbergii*	1–67	0–5
	California false hellebore	VECAC2	*Veratrum californicum var. californicum*	0–22	0–1
	threepetal bedstraw	GATR2	*Galium trifidum*	0–11	0–5
	cinquefoil	POTEN	*Potentilla*	0–11	0–3
	longleaf starwort	STLO	*Stellaria longifolia*	0–1	0–1
	fringed willowherb	EPCI	*Epilobium ciliatum*	0–1	0–1
4	**native forbs**			2–62	
	spreading groundsmoke	GADI2	*Gayophytum diffusum*	1–34	1–5
	aster	ASTER	*Aster*	1–11	0–2
	longstalk clover	TRLO	*Trifolium longipes*	0–11	0–2
	slender cinquefoil	POGR9	*Potentilla gracilis*	0–6	0–1
30	**non-native forbs CT1**			0–67	
	bull thistle	CIVU	*Cirsium vulgare*	0–34	0–1
	common dandelion	TAOF	*Taraxacum officinale*	0–34	0–1

Animal community

This site provides valuable wildlife resources, such as water, forage, and cover. The leaves, stems, and seeds of Nebraska sedge, tufted hairgrass, and other grasses and sedges provide forage for wildlife and livestock. The sedges and bunchgrasses provide nesting habitat for waterfowl and cover for small mammals.

Songbird mist-netting studies have been conducted in Drakesbad for the last 10 years. The results indicate above average songbird productivity. A complete list of netted songbirds can be viewed on their report (Lassen Volcanic

National Park, 2006).

Hydrological functions

The hydrologic function of this meadow is to provide a catchment for water, sediments, and nutrients. The meadow allows sediments from spring snow melt to settle out and traps nutrients in surface and subsurface flows. The meadow provides water storage that slowly releases down the drainage throughout the year. This meadow also provides a broad abandoned flood plain which may take on overflow from Hot Springs Creek in the event of a very large flood event. Access to this flood plain would reduce erosion downstream and allow for sediment deposition.

Recreational uses

This meadow provides open space for wildlife viewing, photographic opportunities, historical features, access to hot springs, and easy level nature trails. Trails should be constructed in appropriate areas to avoid water diversion or soil compaction.

Other products

Mountain rush was and may still be used for basketry and food by native Americans.

Inventory data references

The following NRCS vegetation plots were used to describe this ecological site:

789168- Aquandic Humaquepts (CT3)
789204- Histic Humaquepts (CT2)
789286- Aquandic Endoaquents (CT4)
789348- Terric Haplohemist (CT1)

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Contributors

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
