USDA Natural Resources Conservation Service

Ecological site R022BI206CA
Cryic Lacustrine 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 a small meandering Rosgen "E" type channel
Slopes: 0 to 4 percent
Landform: Relict glacial lakes
Soils: Very deep glaciolacustrine deposits; varying depths of organic horizons; stratified layers of buried A horizons
Temp regime: Cryic
MAAT: 3.3 to 5 degrees C (38 to 41 degrees Fahrenheit)
MAP: 57 to 111 inches (1,448 to 2,819 mm)
Soil texture: Silty clay loam or organic material
Surface fragments: 0 to 25 percent gravel
Vegetation: Several montane meadow plant communities dominated by graminoid species.

Associated sites

F022AE008CA	**Frigid Loamy Moraine Slopes** This wet Sierra lodgepole forest borders the meadows.

R022AE213CA	**Steep Rubbly Slope** This is a riparian complex associated with the larger and steeper channels below this site.

Similar sites

R022BI202CA	**Frigid Alluvial Flat** This is a lower elevation, frigid meadow site associated with year-round springs.
R022BI217CA	**Frigid Lacustrine Flat** This frigid meadow site is associated with relic glacial lakes at lower elevations.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Carex utriculata* (2) *Carex nebrascensis*

Physiographic features

This site is located on relic glacial lakes in wide valleys between 6,280 and 7,510 feet in elevation. Slopes are generally 0 to 4 percent, but may reach up to 8 percent.

Table 2. Representative physiographic features

Landforms	(1) Glacial lake (relict)
Flooding duration	Long (7 to 30 days)
Flooding frequency	Rare to frequent
Ponding duration	Long (7 to 30 days) to very long (more than 30 days)
Ponding frequency	Rare to frequent
Elevation	6,280–7,510 ft
Slope	0–8%
Ponding depth	0–10 in
Water table depth	0–60 in
Aspect	Aspect is not a significant factor

Climatic features

This site receives between 57 to 111 inches (1,448 to 2,819 mm) of precipitation a year (PRISM data). The majority of this precipitation falls in the form of snow. Approximately 80% of the total precipitation falls from October through April; July and August have the lowest levels of monthly precipitation. The mean annual air temperature ranges from 38 to 41 degrees F (3.3 to 5 degrees C). The frost free (>32F) period is from 50 to 85 days, and the freeze free (>28F) period is from 60 to 110 days.

There are no representative climate stations for this site. The nearest is Manzanita Lake (5,800 feet in elevation), approximately 10 miles northwest to most of this site.

Table 3. Representative climatic features

Frost-free period (average)	85 days
Freeze-free period (average)	110 days
Precipitation total (average)	111 in

Influencing water features

The majority of this site is classified as a Palustrine Emergent Wetland, with a small Rosgen "E" type channel meandering through the site. This area will pond and flood during and after spring snow melts.

Soil features

This ecological site has been correlated with very deep, poorly and very poorly drained soils that formed primarily in glaciolacustrine deposits from volcanic parent material. These soils formed in glacial-valley floors, with minor sediment re-deposition from small stream channels.

These soils have had several episodes of burial, indicated by the stratification in the profiles. There are 1 to 2 sequences of buried soils. The buried surface soils have dark silty clay loam textures and 10 to 30 percent organic matter. At the bottom of the buried soils, are coarse sandy loam textures. The progression of lake filling, channel migrations and flood events may be responsible for these layers. There is an uneven distribution of water in the soil layers due to the soil texture. In October the silty clay loam textures were moist at the surface and the lower depths. Artesian water tables were encountered in the lower coarse-textured horizons that upwelled when the silty clay loam "cap" was opened.

The water table is at or above the surface after snow melt, dropping through summer to about 20 inches below surface in the lowest and -wettest areas to around 55 inches in the higher positions.

These soils are in the cryic temperature regime, characterized by a mean annual soil temperature below 8 degrees Celsius and a difference in mean annual summer to winter temperatures of less than 6 degrees. Other variables to affect this regime are soil saturation and the presence or absence of an O horizon. For a complete description of the cryic temperature regime please refer to the Keys to Soil Taxonomy (USDA, 2010).

The two taxonomic soil classes associated with this site are:
1. Ashy skeletal, glassy, nonacid Aquandic Cryaquents
2. Loamy over ashy or ashy pumiceous, aniso, isotic over glassy, nonacid, Vitrandic Cryofluvents.

The Aquandic Cryaquents have silty clay loam surface textures with gleyed soil colors at the surface, indicating prolonged periods of saturation. These soils have a buried A horizon at 20 to 28 inches. There is 5 to 10 percent organic matter in the surface horizon and 10 to 30 percent organic matter in the buried surface horizon. The buried surface horizon has a mucky silty clay loam texture. The upper silty clay loam horizons and the mucky silty clay loams are above very gravelly ashy clay loam horizons. An artesian water table was found at a depth of 28 inches (October 10, 2006) and filled the pit to 20 inches. The surface pH was 6.5 and remained relatively consistent though the profile.

The Vitrandic Cryofluvents have an organic horizon from 0 to 3 inches, a gravelly ashy sandy loam from 3 to 8 inches, and a very gravelly ashy coarse sand from 8 to 11 inches. From 11 to 13 inches is a buried A horizon with a mucky clay loam texture. Silty clay loams and gravelly ashy coarse sandy loam horizons are above another buried A horizon at 36 to 55 inches. The lower buried horizon has an ashy silt loam texture with extremely gravelly coarse sand below. An artesian water table was encountered at 55 inches and filled the pit to 8 inches. The surface pH was 6.5 in the organic horizon but dropped to 5.2 in the A horizon, increasing slightly with depth to a pH of 6.5 at 36 inches.

Aquandic Cryaquents soils have a higher water table and a slightly lower position within the meadow, so they subsequently pond and/or flood for longer durations. Both of these soils support the Northwest Territory Sedge Community (PCC1) and Nebraska Sedge Community (PCC2). Other soils are present in these meadows but are considered minor components or are too limited in distribution to warrant description for this project.

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

Map Unit, Component, Percent
139 Aquandic Cryaquents, 15
139 Vitrandic Cryofluvents, 3

163 Aquandic Cryaquents, 30
163 Vitrandic Cryofluvents, 65
175 Vitrandic Cryofluvents, 15
175 Aquandic Cryaquents, 3

Table 4. Representative soil features

Surface texture	(1) Silty clay loam
Family particle size	(1) Loamy
Drainage class	Poorly drained to very poorly drained
Permeability class	Very slow to slow
Soil depth	60 in
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	5.4–8.4 in
Soil reaction (1:1 water) (0-40in)	5.1–6.5
Subsurface fragment volume <=3" (Depth not specified)	0–45%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

This ecological site is found on glacial valley floors with low relief. Small meandering channels that weave their way through the meadows regularly overflow their banks. Several different plant communities are found within theses meadows. Their presence and distribution are directly linked to the hydrology of the meadows and the stream system. In pristine properly functioning systems, these meadows have an "E" type channel (Rosgen stream classification system). Thick mats of sedge roots stabilize channel banks and help maintain a low channel width-to-depth ratio and high stream sinuosity. Large portions of these meadows remain flooded or saturated to the surface for most of the summer.

"E" type channels are often considered stable systems but they respond quickly to disturbances, which may cause channel incision or bank erosion. This can shift an "E" type channel towards a "C" type channel. Upper Kings Meadow, Lower Kings Meadow and Dersch Meadow are included within this ecological site. The “E” channel concept is based on Upper Kings Meadow, with an educated assumption that Dersch Meadow has started to shift towards a “C” type channel. Limited vegetation and stream channel data has been collected for this ecological site. Standard protocols for collecting data on riparian ecological sites are currently being developed. In the future, stream and valley cross sections, stream bed particle size, and channel sinuosity will be measured to classify the steam type. This data will help determine the status of the stream channel, in relation to steam succession. Vegetation and soil data will be collected along representative zones along the cross section, such as the floodplain or terrace. If possible, this data could be collected in the future and used to fully describe this riparian ecological site.

This ecological site is a complex of riparian plant community components that 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, rather than focusing on the succession of one plant community.

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

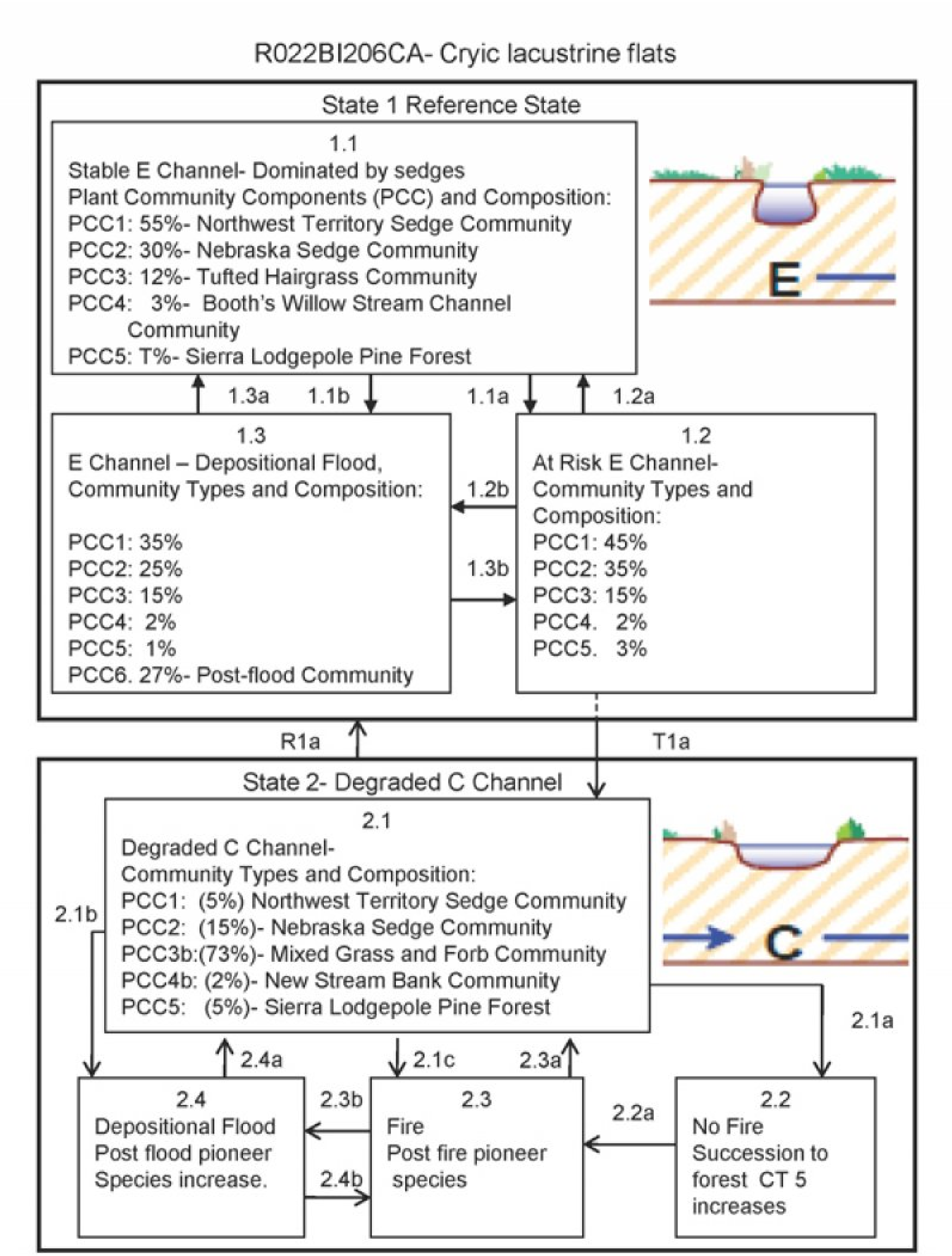

Figure 2. Cryic Lucustrine Flat Model

State 1
Reference State

State 1 represents the reference state for this meadow system, a stable “E” type channel. The reference state is similar to the historic state, but may have been lightly affected by grazing and road construction. In a stable “E” channel, a stream’s velocity is balanced with its sediment transport capability. The stream banks are stable and protected with a dense mat of sedge roots and rhizomes. These channels are deeper than they are wide and have a high sinuosity. The stream frequently overtops the channel and floods onto the expansive floodplain.

Community 1.1
Stable E Channel

Figure 3. Reference State

This community has developed with a stable “E” channel system that seasonally floods and ponds. The area has a high water table throughout most of the summer. Rhizomatous peat-forming sedges dominate this site because they can withstand long durations of total inundation. In summer they rely upon the shallow water table to survive. Even though these are peat-forming sedges there is not a thick peat layer in these meadows. Since the water table drops to below 20 inches at the end of summer, it is likely the organic matter decomposes. Several plant community components are associated with this community phase and their distribution is related to water table depth. The most hydrophytic plant communities are found along the stream channel and in the lowest positions of the meadow. Drier plant communities are found as the meadow slopes upward. Plant Community Components and Composition: PCC1: 55% Northwest Territory Sedge Community This community is found in the wettest zone of the meadow. Northwest Territory sedge (*Carex utriculata*) and/or blister sedge (*Carex vesicaria*) provide 50 to 80 percent cover in this community, with some mosses and organic matter on the surface. These sedges are able to withstand total inundation for several months, and produce dense rhizamotous root mats. Annual production ranges from 919 to 1,540 lbs/acre. PCC2: 30% Nebraska Sedge Community This community is found adjacent to the Northwest Territory Sedge Community, just above the wettest part of the meadow. Nebraska sedge (*Carex nebrascensis*) dominates with tundra aster (*Oreostemma alpigenum* var. alpigenum, formerly Aster alpigenus). Other plants include water sedge (*Carex aquatilis*), swordleaf rush (*Juncus ensifolius*), and mountain rush (*Juncus arcticus* ssp. littoralis). Nebraska sedge is a heavily rhizomatous wetland plant capable of forming almost monotypic stands that can survive total inundation for 3 months (Hoag, 1998). Total canopy cover ranges from 40 to 60 percent, and annual production ranges from 360 to 696 lbs/acre. In some cases a high cover of tundra aster indicates a disturbance, but it is a natural native component as well. PCC3: 11% Tufted Hairgrass Community Tufted hairgrass (*Deschampsia cespitosa*) distinguishes this community and is found along the drier margins of the meadows. Other common plants include mountain rush (*Juncus arcticus* ssp. Littoralis, formerly Juncus balticus), tundra aster (*Oreostemma alpigenum* var. alpigenum), longstalk clover (*Trifolium longipes*), tinker's penny (*Hypericum anagalloides*), and Rydberg's penstemon (*Penstemon rydbergii*). Total canopy cover ranges from 50 to 70 percent and annual production ranges from 400 to 771 lbs acre. PCC4: 3% Booth’s Willow Stream Bank Community This plant community lies immediately adjacent to the stream channel. It is sometimes referred to as the green-line community, which exists just above the bank-full water level. It has created a small hump of vegetation that is slightly higher than the nearby plant communities. Booth's willow (*Salix boothii*) is a low-lying shrub found intermittently along the channel. Greater diversity exists along the upper channel than in the surrounding flats. Common plants include alpine shootingstar (*Dodecatheon alpinum*), elephanthead lousewort (*Pedicularis groenlandica*), seep monkeyflower (*Mimulus guttatus*), Oregon saxifrage (*Saxifraga oregana*), and various mixed sedges (Carex spp.). In some areas the Northwest Territory Sedge Community comes right to the stream edge or is interspersed with this community. Total canopy cover is around 90 percent and annual production ranges from 291 to 774 lbs/ acre. PCC5: 1% Sierra Lodgepole Pine Forest Although this plant community is generally located adjacent to the meadow on drier outwash terraces, it can be present within the meadow in some areas. Sierra lodgepole pine (*Pinus contorta* var. murrayana) dominates this forest with moist understory associates such as blue wildrye (*Elymus glaucus*) and California false hellebore (*Veratrum californicum*). Tree canopy ranges from 10 to 60 percent with 15 to 30 percent understory cover.

Community 1.2
Dry At Risk E Channel

This community phase develops over time when prolonged drought and/or a natural drying of the meadow create a shift in the plant communities. The water table becomes lower during the growing season due to diminished water supply or channel downcutting. With a lower water table, the less hydrophytic vegetation can establish in the lower and normally wetter areas of the meadow. The stream banks remain stable and vegetated with sedges, but if the water table remains low the sedges will eventually die-out and shift this community to State 2. The same plant communities described above in Community 1.1 are present in this community phase as well, but their relative proportions have shifted toward the drier plant community components. Community Types and Composition: PCC1. (45%) - Northwest Territory Sedge Community PCC2. (35%) - Nebraska Sedge Community PCC3. (15%) - Tufted Hairgrass Community PCC4. (2%) - Booth’s Willow Stream Bank Community PCC5. (3%) - Sierra Lodgepole Pine Forest

Community 1.3
Depositional Flood

This community phase has developed because of a depositional flood. Although “E” type channels do not typically generate catastrophic floods, they can experience large snow melts or rain-on-snow events. These events transport sediment that settles-out as the water spreads across these wide low-gradient basins. The soils have layers of 8 to 25 inches of deposition; however these events may be more related to post- glacial activity than modern depositional events and a deposition of 1 to 2 inches seems more likely at this time. After a shallow depositional flood event, sedge communities can resprout from rhizomes and recover quickly. Other community types may take longer to recover, and a new community type of pioneer species may be present for a short period post-flood. If a thick layer of deposition alters the stream channel and water depth, the distribution of plant community components could change. The same plant communities described above in Community 1.1 are present in this community phase as well, but there is a new pioneer plant community. Plant Community Component and Composition: PCC1. (35%) – Northwest Territory Sedge Community PCC2. (25%) – Nebraska Sedge Community PCC3. (15%) – Tufted Hairgrass Community pCC4. (2%) – Booth’s Willow Steam Channel Community PCC5. (1%) – Sierra Lodgepole Pine Forest PCC6. (27%) – Post-flood Pioneer Plant Community – Data is lacking on this post-flood pioneer plant community. Species would vary depending upon the water table depth but may include lupines (Lupinus spp.), buckwheats (Eriogonum spp.), and rabbitbrush (Ericameria spp.)

Pathway 1a
Community 1.1 to 1.2

This pathway is followed by natural processes that cause the meadow to become drier. Several years of drought may cause this. Also, the meadows are relic lake basins that are very slowly filling-in from sedimentation and the accumulation of organic matter, which is another natural process for creating drier sites. Additionally, the channel may be gradually downcutting to balance its gradient with that of the surrounding valley slope.

Pathway 1b
Community 1.1 to 1.3

This pathway is created when a flood deposits a layer of sediment deep enough to bury the existing vegetation, initiating regeneration.

Pathway 1.2a
Community 1.2 to 1.1

This pathway is created when the site becomes wetter for natural reasons. A drought cycle may end, or new springs may emerge.

Pathway 1.2b
Community 1.2 to 1.3

This pathway is created when a flood deposits a layer of sediments deep enough to bury the existing vegetation, initiating regeneration.

Pathway 1.3a
Community 1.3 to 1.1

This pathway is created with time and allows for the recovery of the plant communities after the flood event.

Pathway 1.3b
Community 1.3 to 1.2

This pathway is possible if the sediment deposition is deep enough to create changes in the plants' ability to reach the water table. Thick layers of sedimentation may lead to a drier, grass-dominated meadow for a period of time.

State 2
Degraded "C" Channel

This state represents the altered and degraded condition for this meadow complex. The stream has become unstable and readjusted itself to resemble a Rosgen "C" type channel. Several factors have caused this change. The triggers are discussed in Transition 1. The banks have eroded creating a wide, shallow channel with point bars. The channel is continually down-cutting, increasing the channel gradient and lowering the water table. The combination of the initial disturbances with the lower water table has shifted the plant composition toward drier community types, reducing the distribution of the beneficial sedges. The Rosgen Stream Succession diagram below shows a possible stream succession pathway for this ecological site. The STM above only incorporates the shifts from an "E" type channel to a "C" type channel. The lower reaches of this ecological site in Dersch Meadow may be going through later stages of stream succession, but channel measurements have not been taken to fully develop these concepts. Further down-cutting and the lowering of the water tables could trigger the development of later stages of stream succession. If the "C" type channel in State 2 continues to down-cut, an entrenched low gradient "Gc" type channel develops. This gully-like entrenched channel is unstable and will naturally begin to widen over time into an entrenched "F" type channel. These deeply incised channels ("Gc" and "F") generally lose the wetland obligate species and become dominated by upland grass, shrub and/or forest plant communities. The broadly entrenched "F" type channel allows for sediment deposition, which builds point bars and floodplains with a meandering channel. Riparian vegetation begins to reestablish on the new floodplains, which increases channel stability. An entrenched "C" type channel with a developed floodplain and a meandering channel will eventually develop within the entrenched "F" type channel. If conditions remain stable, the "C" type channel will narrow and deepen, creating an entrenched "E" type channel. This new "E" type channel may resemble the original "E" type channel with wetland plant communities, but it will be constrained by terraces to the lower floodplain area. The old floodplain becomes a terrace, disconnected from flood events. The terrace has a lower seasonally water table which supports upland plant communities.

Community 2.1
Degraded "C" Channel

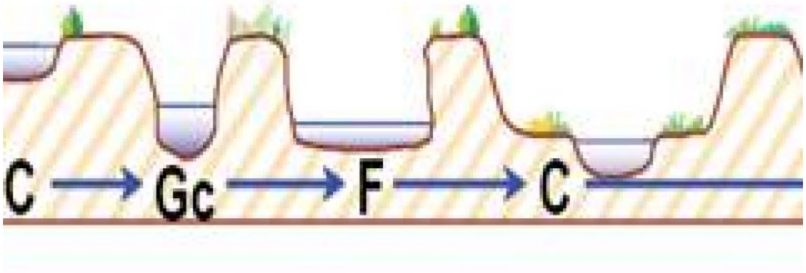

Figure 5. Rosgen Stream Succession Model

This community phase has a lower water table as a consequence of unnatural disturbances (see Transition 1 narrative). Non-native grasses may be present and the composition of the plant community components has shifted to favor the Mixed Grass and Forb Community Component PCC3b, rather than the wetter Northwest Territory Sedge Community PCC1. The steep banks have lost some of their stability because of the disintegration of the sedge roots that hold the soil in place and provide resistance to erosion by the stream. The plant community components described below are similar to the plant communities described in State 1, but the relative proportions have changed. Vegetation data was collected for this community phase, but was collected in one plot across the entire meadow. Total production is 1285 lbs/acre, which represents the overall production of community component PCC1, PCC2 and PCC3b. It is difficult to split production and cover by community component, from this plot. State 2 community components in this phase are very similar to State 1 community components. There are very few non-native species present. However there is an increase in native disturbance indicator species, such as tundra aster and mountain rush. Plant Community Components and Composition: PCC1. (5 %) - Northwest Territory Sedge Community - Northwest Territory sedge (*Carex utriculata*) and/or blister sedge (*Carex vesicaria*). This community has limited distribution in this state. PCC2. (15 %) - Nebraska Sedge Community - Nebraska sedge (*Carex nebrascensis*) dominates with a large component of tundra aster (*Oreostemma alpigenum* var. alpigenum). Other plants include: water sedge (*Carex aquatilis*), swordleaf rush (*Juncus ensifolius*), and mountain rush (*Juncus arcticus* ssp. littoralis), and Lemmon's Indian paintbrush (*Castilleja lemmonii*). PCC3b. (73 %) - Mixed Grass and Forb Community - This grass dominated community expands into areas that were dominated with sedges. It has changed from the State 1 CT3 because there is less overall cover, and more diversity of native pioneer species. Tufted hairgrass (*Deschampsia cespitosa*) is still dominant. Other common plants include: mountain rush (*Juncus arcticus* ssp. littoralis), tundra aster (*Oreostemma alpigenum* var. alpigenum), longstalk clover (*Trifolium longipes*), tinker's penny (*Hypericum anagalloides*), Rydberg's penstemon (*Penstemon rydbergii*), mat muhly (*Muhlenbergia richardsonis*), pullup muhly (*Muhlenbergia filiformis*), primrose monkeyflower (*Mimulus primuloides*), and violet (Viola sp.). PCC4b. (2 %) - New Stream Bank Community - This plant community is immediately adjacent to the stream channel, and replaces the Booth's willow stream bank community. The dynamics of the channel have changed, leaving eroded banks and point bars. The new substrate is more suitable for pioneer forbs, possibly mountain alder and lemons willow. Instead of the Northwest Territory sedge (*Carex utriculata*) community adjacent to this community the mixed grass and forb community is present. More data is needed on this community type. PCC5. (5 %) - Sierra Lodgepole Pine Forest - This plant community is adjacent to the meadow on the drier outwash terraces, but has moved into the meadow in some areas. Sierra lodgepole pine (*Pinus contorta* var. murrayana) dominates this forest with moist understory associates such as blue wildrye (*Elymus glaucus*) and California false hellebore (*Veratrum californicum*).

Community 2.2
No fire

Because of a lower water table, Sierra lodgepole pine (*Pinus contorta* var. murrayana) is able to establish in the meadow. Fire could be important in maintaining the open meadow by removing the fire intolerant Sierra lodgepole pine seedlings. The sedge and grassland communities generally recover quickly after fire. Fire may initiate in the surrounding forest and burn into these meadows. California red fir (*Abies magnifica*) forests are present on the nearby hillslopes and have a fire frequency from 10 to 65 years (Bancroft, 1979; Taylor et al., 1991). Jeffrey pine (*Pinus jeffreyi*) and white fir (*Abies concolor*) forests are present at the lower elevations of this site and experience more frequent fire cycles. The fire frequency for the adjacent Sierra lodgepole pine forest may be longer than usual because this area is often wet and does not easily ignite. The Sierra lodgepole pine community may live for 100 years or more. As the forest ages, the trees become more vulnerable to diseases and bark beetle attacks. Mountain pine bark beetle (Dendroctonus ponderosae) may kill entire stands of forest, leaving standing dead trees. After a high mortality pest outbreak there is a high fuel load, which can fuel a high severity fire. This Sierra lodgepole pine forest encroaches primarily upon the grassland community. Because of the increase in water uptake by the trees and a subsequent loss through evapotranspiration, this forest may decrease the available water in the meadow and lower the water table even further. The same plant communities are present as mentioned in Community Phase 2.1, but Community Type 5, the Sierra Lodgepole Pine Community, will increase at the expense of Community Type 3b, the Mixed Grass and Forb Community.

Community 2.3
Fire

This community phase develops after fire. Over time the potential for fire will increase in this state. The water table is lower, and the duration and depth of ponding has decreased. There are more grasses, which provide fine flashy fuels that ignite easily and spread fire quickly. Large fuels from the Sierra lodgepole pine forest can drive more severe fires into the meadow from surrounding hillslopes. There may be a short-lived pioneer plant community after a fire. Many sedges and grasses resprout after fire and may recover quickly. The initial pioneer forbs that develop after a fire will slowly die out as the grasses and sedges regain dominance.

Community 2.4
Flood

This community phase has developed after a deposition flood. A flood impacting this degraded “C” type channel will cause more severe bank erosion and uneven deposition of sediments, unlike the broad settling of sediments in the stable “E” state. The flow in this “C” channel will be primarily self-contained and probably not extend into the major flood plain. The concentrated flow increases the hydraulic friction on the already unstable and poorly vegetated stream banks. These floods will principally affect the community components adjacent to the stream channel, creating new plant communities of pioneer forb and grass species.

Pathway 2.1a
Community 2.1 to 2.2

This pathway is followed in the absence of fire, which allows the Sierra lodgepole pine to encroach upon the meadow.

Pathway 2.1c
Community 2.1 to 2.3

This pathway is created when a fire burns into the meadow and initiates regeneration.

Pathway 2.1b
Community 2.1 to 2.4

This pathway is created when a flood creates erosion and deposition, leaving barren soil for early successional species to establish.

Pathway 2.2a
Community 2.2 to 2.3

This pathway is created when a fire burns into the meadow and initiates regeneration.

Pathway 2.3a
Community 2.3 to 2.1

This pathway is created with time and the recovery of the meadow community components.

Pathway 2.3b
Community 2.3 to 2.4

This pathway is created when a flood deposits a layer of sediment deep enough to bury the existing vegetation and initiate regeneration.

Pathway 2.4a
Community 2.4 to 2.1

This pathway is created with time and allows for the recovery of the plant communities after a flood event.

Pathway 2.4b
Community 2.4 to 2.3

This pathway is created by an unlikely fire event, which would initiate community regeneration.

Transition 1
State 1 to 2

This transition is often initiated by a disturbance that alters the hydrology of the site or impacts the vegetation along the stream bank. Alterations that can affect the hydrology of this site include channel realignment and/or confinement, culvert installations, and road construction. Previous cattle grazing may have reduced the vegetation along the stream banks and caused bank erosion with their hooves. Non-native grasses may have been seeded for forage. The alterations mentioned above have straightened the channel, eliminating its ability to meander. This increases the shear stress along the stream bank, which accelerates stream bank erosion, thereby increasing sediment supply and decreasing sediment transport capacity. This causes channel aggredation, in which the channel fills with sediment. As the channel fills it becomes wider and shallower, causing even more bank erosion and more sediment supply. This now-wider and shallower channel is more representative of a “C” type channel (Rosgen, 1996). As the channel straightens it has a shorter course down the valley, creating a steeper gradient. The stream may adjust by headcutting into the base level of the channel until it establishes a new gradient through the meadow. As the stream bed is lowered, so is the water table in the meadow. The new larger and steeper channel can contain more flow, reducing the frequency of flooding and the extent of the floodplain. Grazing can cause the same processes mentioned above, but uses a different trigger. The removal of the riparian vegetation by grazing and the trampling of the exposed stream banks cause bank erosion. The eroding banks create sediments that are deposited downstream, and the processes above are initiated.

Restoration pathway 2
State 2 to 1

The processes that have altered this stream system are not easy to restore. The goals are to raise the water table, increase the channel sinuosity, and re-establish riparian vegetation on the stream banks (particularly those sedges with thick root mats) to hopefully reduce bank erosion. Each segment of the stream channel should be surveyed to determine if the channel needs to be restored and, if so, will restoration be effective? Some questions to consider are: what caused the change in the hydrology; is the site cut off from its full water supply; is it getting excess flow; has the channel been manipulated and channelized; can the stream be reconstructed to its natural course or to a suitable alternative; is the channel headcutting and, if so, what is causing this and can it be restored?

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**grass/grasslike**			910–1540	
	blister sedge	CAVE6	*Carex vesicaria*	600–900	40–60
	Northwest Territory sedge	CAUT	*Carex utriculata*	300–600	20–40
	spikerush	ELEOC	*Eleocharis*	10–40	0–5
2	**grass/grasslike**			360–621	
	Nebraska sedge	CANE2	*Carex nebrascensis*	360–600	30–50
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	0–16	0–2
	sedge	CAREX	*Carex*	0–15	0–3
3	**Grass/grasslike**			400–746	
	tufted hairgrass	DECE	*Deschampsia cespitosa*	275–495	25–45
	sedge	CAREX	*Carex*	125–250	25–50
	bulrush	SCIRP	*Scirpus*	0–1	0–1
4	**grass/grasslike**			40–240	
	sedge	CAREX	*Carex*	25–200	3–25
	water sedge	CAAQ	*Carex aquatilis*	15–40	2–5
Forb					
2	**forbs**			0–65	
	tundra aster	ORALA3	*Oreostemma alpigenum var. andersonii*	0–40	0–5
	gentian	GENTI	*Gentiana*	0–15	0–3
	beardtongue	PENST	*Penstemon*	0–10	0–1
3	**forbs**			0–25	
	beardtongue	PENST	*Penstemon*	0–25	0–3
4	**forbs**			1–39	
	bigleaf lupine	LUPO2	*Lupinus polyphyllus*	0–10	0–1
	seep monkeyflower	MIGU	*Mimulus guttatus*	0–6	0–2
	elephanthead lousewort	PEGR2	*Pedicularis groenlandica*	0–5	0–1
	yampah	PERID	*Perideridia*	0–5	0–1
	Oregon saxifrage	SAOR2	*Saxifraga oregana*	0–5	0–1
	Chamisso arnica	ARCH3	*Arnica chamissonis*	0–3	0–1
	alpine shootingstar	DOAL	*Dodecatheon alpinum*	0–2	0–1
	Sierra bog orchid	PLDIL	*Platanthera dilatata var. leucostachys*	0–1	0–1
	sparse-flowered bog orchid	PLSP2	*Platanthera sparsiflora*	0–1	0–1
	western false asphodel	TROCO2	*Triantha occidentalis ssp. occidentalis*	0–1	0–1
Shrub/Vine					
4	**shrubs**			250–415	
	Booth's willow	SABO2	*Salix boothii*	250–400	5–8
	alpine laurel	KAMI	*Kalmia microphylla*	0–15	0–1

Animal community

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

Hydrological functions

The hydrological function of this meadow is to provide a catchment for water, sediments, and nutrients. The meadow allows sediment from melting spring snow to settle out and trap nutrients in surface and subsurface flows. This meadow also provides water storage, which is slowly released down the drainage throughout the year.

Recreational uses

These meadows provides open space for wildlife viewing, fishing and photographic opportunities.

Inventory data references

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

789182- Aquandic Cryaquents(near soil type location, 789181)
789183

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T31 N R5 E S33
UTM zone	N
UTM northing	4480081
UTM easting	629789
General legal description	The type location is about .38 miles north of Summit Lake, in Lassen Volcanic National Park.

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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):**

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

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:

17. **Perennial plant reproductive capability:**