USDA Natural Resources Conservation Service

Ecological site R009XY501OR
Low Slope Alluvial Valley Riparian Complex

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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): 009X–Palouse and Nez Perce Prairies

Palouse and Nez Perce Prairies.
The majority of this MLRA lies within the Walla Walla Plateau Section of the Columbia Plateaus Province of the Intermountain Plateaus. A portion of this MLRA in the southeastern area is in the Blue Mountain Section of the Colombia Plateau Province. This MLRA is characterized by an undulating, highly-dissected basalt plateau. Streams are deeply cut into the plateaus, with elevations for major stream bottoms of approximately 650 feet (198 meters), while the plain elevation ranges from 2,000 to 4,000 feet (610 to 1220 meters). The average annual precipitation typically ranges from 13 to 28 inches (300 to 710 mm), but may be as high as 43 inches (1,090 mm) in the south. Precipitation is evenly distributed between fall, winter, and spring, with winter precipitation typically occurring as snow. Summers are typically dry. The average annual temperature ranges from 47 to 57 F (8 to 12 degrees C), but can be as low as 40 degrees F (5 degrees C) at higher elevations in the south. The freeze-free period averages 165 days, and ranges from 100 to 230 days.

Ecological site concept

This riparian complex occurs on Strahler 5th order or greater streams in gently sloping, wide, alluvial fill valleys. Drainage area is between 90,000 and 150,000 acres, and the watershed is composed of mountains and lava plateaus. Valley slope is typically less than 3 percent, and stream channel gradient is less than 2 percent. Stream channel potential is a Rosgen C type channel, with a braided Rosgen D type channel phase. Plant communities are dominated by black cottonwood (*Populus balsamifera* ssp. trichocarpa), black hawthorn (*Crataegus douglasii*), basin wildrye (*Leymus cinereus*), and other native grasses. Soils have developed in recent alluvium from basalt.

Associated sites

R009XY031OR	**Shallow South 14+ PZ** This ecological site occurs on the adjacent shallow, south-facing hillslopes. Bluebunch wheatgrass and Idaho fescue are dominant.
R009XY040OR	**North 14-17 PZ** This ecological site occurs on adjacent, moderately deep, north-facing hillslopes. Idaho fescue is dominant, with bluebunch wheatgrass.

Similar sites

R009XY504OR	**Moderately Sloping Plateau Riparian Complex** This ecological site is associated with small stream channels on gentle terraces at the edge of the Colombia Plateau. Channel gradients are between 2 and 5 percent, and flow may intermittent.
R009XY505OR	**Moderately Sloping Confined Intermittent Riparian Complex** This ecological site occurs on first and second order streams in dissected lava plateaus. Flow is intermittent. Slopes range from 5 to 15 percent.
R009XY503OR	**Moderately Sloping Narrow Alluvial Valley Riparian Complex** This ecological site occurs on second and third order streams with channel gradients between 2 and 4 percent.
R009XY502OR	**Low Slope Alluvial Mountain Valley Riparian Complex** This ecological site occurs at higher elevations, with a ponderosa pine community on the upper terrace.

Table 1. Dominant plant species

Tree	(1) *Populus balsamifera subsp. trichocarpa* (2) *Alnus rhombifolia*
Shrub	(1) *Crataegus douglasii* (2) *Prunus virginiana*
Herbaceous	Not specified

Physiographic features

This ecological site occurs on floodplains and stream terraces. Valley slopes range from 0 to 3 percent, and elevations range from 1,550 to 1,950 feet.

There are 4 fluvial surfaces associated with this riparian complex. They are the gravel bar, floodplain, and stream terraces.

Gravel Bar-active channel (CC1)
Water table depth 0 to 40 inches.
Flooding is Frequent and Brief

Floodplain (CC2)
Water table depth 15 to 40 inches.
Flooding is Occassional and Brief.

Stream terrace (CC3)
Water table depth 50 to 60+ inches
Flooding is rare

Stream terrace (CC4)
Water table greater than 60 inches
Flooding is rare

Table 2. Representative physiographic features

Landforms	(1) Flood plain (2) Stream terrace (3) Channel
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Frequent to none
Ponding frequency	None
Elevation	1,500–1,950 ft
Slope	0–3%
Water table depth	0–60 in
Aspect	Aspect is not a significant factor

Climatic features

This ecological has a xeric moisture regime, with moist winters and dry summers. Precipitation occurs as rain in the fall and spring, and snow in winter. There is very little rain in the summer months. Mean annual precipitation (MAP) ranges from 16 to 24 inches (406 to 610 millimeters). Mean annual air temperature (MAAT) ranges from 50 to 55 degrees F (10 to 12.8 degrees C). The frost-free period ranges from 120 to 160 days, and the freeze-free period ranges from 140 to 210 days.

Data for the Frost Free table and the Monthly Precipitation and Temperature Distribution table from the Pendleton Climate Station, which is located at a lower elevation, with slightly warmer MAAT and slightly lower MAP, than where this ecological site is located. Mean annual and temperature precipitation ranges in the narrative are from PRISM data.

Table 3. Representative climatic features

Frost-free period (average)	122 days
Freeze-free period (average)	154 days
Precipitation total (average)	17 in

Climate stations used

- (1) PENDLETON BR EXP STN [USC00356540], Pendleton, OR

Influencing water features

This site occurs on floodplains and terraces subject to frequent to rare flooding.

The blue area in the cross section diagram represents water level at time of survey, and the dashed blue line represents the level of flow at 1.5 times the bank full depth.

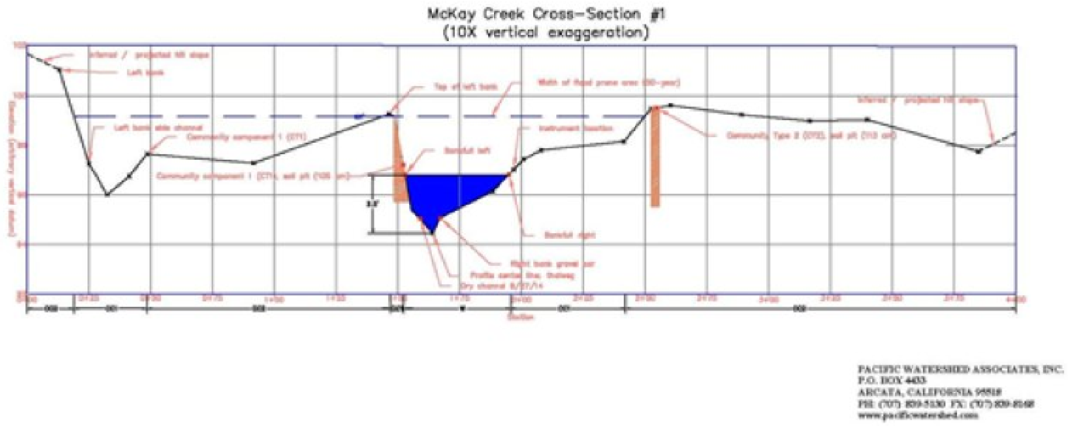


Figure 6. McKay XS1

Soil features

There are several soils associated with this ecological site. They are associated with different fluvial surfaces, and vary in wetness and textures. These soils are all very deep, and formed in alluvium predominantly derived from basalt parent material. The soil moisture regime is xeric and the soil temperature regime is mesic.

Gravel bar, active floodplain, frequently flooded (CC1)

The Joseph soils associated with this landform are in active channels and on gravel bars, which are subject to frequent flooding. These soils are typically somewhat poorly drained, but depending upon the topography of the hummocky gravel bars, they may be moderately well or poorly drained. The surface texture is extremely gravelly loamy sand and subsurface textures are extremely cobbly sand, extremely cobbly coarse sand, and extremely gravelly loamy sand. There is very little soil development and a high percentage of gravels and cobbles. These soils are classified as Sandy-skeletal, mixed, mesic, Oxyaquic Xerofluvents. Surface rock cover < 3 inches (gravels) typically would be 55 percent, and rock fragments > 3 inches (cobbles and stones) typically would be 26 percent. Subsurface rock fragments < 3 inches range from 50 to 65 percent, and > 3 inch fragments range from 15 to 30 percent by volume.

Floodplain, occasionally flooded (CC2)
The Joseph soils associated with this landform are on floodplains which are subject to occasional flooding. These soils are moderately well drained. The surface texture is loam, and subsurface textures are extremely gravelly loamy sand, extremely gravelly loamy sand, and extremely gravelly loamy coarse sand. These soils are classified as Sandy-skeletal, mixed, mesic, Oxyaquic Xerofluvents. Surface rock cover < 3 inches (gravels) ranges from 0 to 5 percent, and rock fragments > 3 inches (cobbles and stones) are typically absent. Subsurface rock fragments < 3 inches range from 0 to 75 percent, and > 3 inch fragments range from 0 to 20 percent (cobbles) by volume.

Floodplain step, rarely flooded (CC3)
The Patit Creek soils are associated with this component, and occur on floodplains or abandoned floodplains (terraces) that are subject to rare flooding and are well drained. These soils are classified as Coarse-loamy, mixed, superactive, mesic, Cumulic Haploxerolls. The surface texture is loam, and subsurface textures are loam, fine sandy loam, sandy loam, and gravelly fine sandy loam. Surface rock fragments are typically absent. Subsurface rock fragments < 3 inches range from 0 to 25 percent, and > 3 inch fragments range from 0 to 10 percent by volume.

Stream terrace, rarely flooded (CC4)
The Voats soils, with a silt loam surface phase, are associated with this community component and occur on rarely flooded stream terraces. They are somewhat excessively drained. These soils are classified as Sandy-skeletal, mixed, mesic, Fluventic Haploxerolls. Surface texture is silt loam or loam, and subsurface textures are very or extremely gravelly sandy loam, fine sandy loam, gravelly loam, extremely gravelly loamy coarse sand, and extremely cobbly loamy sand. Surface rock fragments < 3 inches range from 0 to 10 percent, and > 3 inches are typically absent. Subsurface rock fragments < 3 inches range from 10 to 85 percent, and > 3 inch fragments range from 0 to 30 percent by volume.

Table 4. Representative soil features

Parent material	(1) Alluvium–basalt
Surface texture	(1) Loam (2) Loamy sand
Family particle size	(1) Loamy
Drainage class	Somewhat poorly drained to somewhat excessively drained
Soil depth	60 in
Surface fragment cover <=3"	0–55%
Surface fragment cover >3"	0–26%
Subsurface fragment volume <=3" (Depth not specified)	0–85%
Subsurface fragment volume >3" (Depth not specified)	0–30%

Ecological dynamics

Scale and stream classification system:
Lotic ecological sites describe portions of valley sections with similar reaches, defined by slope, valley width, Strahler stream order, and similar associated fluvial landforms and vegetation. Lotic ecological sites are tied to the scale of the NRCS soil survey. The Umatilla County Soil Survey for this area was mapped at Order 3, with map unit size ranging from 1.6 to 16 hectares (Soil Survey Division Staff 1993). The closest equivalent scale for stream classification is the valley segment, which ranges from 0.1 to 10,000 hectares (Montgomery and Buffington 1993). Soil surveys may have different map units for a valley section, based on slope classes and changes in composition of soil components, which often corresponds to changes in stream classification. Lotic ecological sites incorporate Rosgen stream classification (Rosgen 1994) to identify the channel morphology and the stream succession scenarios. The stream succession scenarios are used to develop state-and-transition models based on morphological changes of stream channels over time.

Site concept:
This riparian complex occurs on Strahler fifth order or greater streams, in gently sloping, wide, alluvium filled, valleys. Drainage area is between 90,000 and 150,000 acres, and the watershed is composed of mountains and lava plateaus. Stream gradients are typically 0.5 to 0.9 percent, but may be up to 2 percent. Valley bottom width ranges from 400 to 1,600 feet, with floodplain widths typically between 150 and 820 feet. Bank full channel widths range from 35 to 95 feet, with average depths between 1.5 and 3.0 feet. Channel morphology alternates between reaches of moderately-entrenched, single-thread Rosgen C type channels and reaches of braided Rosgen D type channels (Rosgen 2006). Reaches with transitional G or F type morphology rarely occur. There are four community components laterally associated with this ecological site. Starting from the stream they are: Gravel bar-frequently flooded, Floodplain-occasionally flooded, Floodplain step-rarely flooded, and Stream Terrace-rarely flooded. The gravel bar component occurs in the active channel and is associated with poorly-developed soils, which are subject to frequent flooding and reworking. This component is vegetated by pioneer forb species, of which the majority are invasive, and non-native. The floodplain components (CC2 and CC3) occur within the flood zone. Depending upon duration of stability, these components may have young soils or more developed soils with a thick A horizon from organic matter accumulation. Black cottonwood (*Populus balsamifera* ssp. trichocarpa) and black hawthorn (*Crataegus douglasii*) dominate, with a variety of associated species. The original floodplain components may become abandoned in the altered entrenched states. The floodplain becomes abandoned when the channel is cut deeper and becomes larger, which lowers the water table and reduces flooding frequency onto the floodplain. Plant species that are dependent on a shallow water table or flooding, such as black cottonwood and white alder (*Alnus rhombifolia*), may become decadent and decline over time. The fourth community component exists on stream terraces typically above the 50-year flood prone area. The water table is only above 60 inches for a short period in spring. This community is often altered for cultivation or pasture. Remnant native species include black hawthorn, western chokecherry (*Prunus virginiana*), and basin wildrye (*Leymus cinereus*).

Disturbance Factors:
This ecological site is developed based on lower McKay Creek within the boundaries of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). It may be used in the future for similar areas outside of the CTUIR boundary, so disturbances are discussed in generality, rather than from specific locations. After the 1855 Treaty between the US government and the CTUIR, tribal people were moved to the reservation. People farmed the valleys and horses grazed the hillslopes. Additional incentives to secure land allotments drew more Indian and non-Indian settlers. Land use intensified, and cattle and sheep grazing increased (CTUIR 2014). Highest stocking rates occurred from the 1880s to the 1920s. The tribes possessed 20,000 horses and 3,000 cattle by 1890, and non-Indian settlers and travelers brought several thousand additional cattle (BIA and CTUIR 2007). Today, grazing by cattle and feral horses still occurs in these riparian corridors. In the upper watershed the U.S. Forest Service logged conifer forests in the early 1900s, but logging has declined in recent years. Past logging practices and unplanned road building have decreased soil stability and caused increased susceptibility to erosion when affected by flooding or fire (Colombaroli and Gavin 2010). In the lower watershed historic, overgrazing caused a decline in vegetative cover on the steep hillslopes from foraging and hoof trampling (BIA and CTUIR 2007). The exposed and disturbed soils became highly susceptible to water and wind erosion. Sheet, rill, and gully erosion transported sediments to the streams, especially during extreme rain events. Historic grazing along the stream channels impacted and altered riparian vegetation by selective herbivory and physical trampling of the stream banks. This resulted in a decline in bank stability due to the loss of root structure and an increase in exposed, bare soil. The exposed hillslopes and riparian areas were poorly structured for large flood events. Large flood events occurred in 1881-1882, 1947-1948, and 1964-1965, with smaller floods in 1997 and 2011 (USGS 2015). Large flood events erode the hillslopes and unstable banks, which can leave deep sediment deposits in channels and floodplains. Although this is a natural process, the scale of sedimentation may be increased by anthropogenic disturbances. These large flood events are the primary drivers of dramatic changes in stream morphology. In this area, the valley bottom may be cultivated, used for pasture, or developed as residential areas. It is difficult to determine the reference stream conditions and channel morphology, due to these complex interactions of natural and anthropogenic disturbances. Based on channel evolution models, valley type, and valley slope, the reference condition for this stream should be a meandering C type channel, but D type channels may also be a natural feature in certain reaches or after depositional flood events.

Beavers were abundant in these watersheds prior to 1840. The fur trade was a major industry in Oregon in the early 1800s, and beaver were highly desired for their thick, smooth pelts. From 1820 to 1830, the Hudson Bay Company initiated a practice of exterminating beaver from areas south and east of the Columbia River to eliminate competition. This purposeful, detrimental practice, along with other trapping, caused a severe decline in beaver populations by 1825 and a near extinction of beaver by 1900 (Harrison 2009). Since the 1900s, there has been a gradual increase in beaver populations. Beavers are present in these streams today, but have few well developed dams. Beaver dams create ponds, which slow water flow and raise surface flow. Beaver dams, raise water tables and allow for more frequent flooding onto floodplains. A higher water table and increased flooding can change species composition to wetland obligate species, and increases growth rates and abundance of existing riparian vegetation. Below the beaver dam, stream flow may be reduced for short to long durations. Beaver can be detrimental to vegetation if the vegetation does not produce forage fast enough for beaver consumption. Although beavers are a natural part of the ecology for these streams, beaver dams may have detrimental impacts on developed landscapes by eroding or flooding railroads, roads, and other structures built adjacent to streams. Some agencies are attempting to reintroduce or enhance existing beaver dams to improve habitat for steelhead. Initial results have shown an increase in density and survival rates of young steelhead (Pollock, Jordan et al. , Pollock, Beechie et al. 2007).

In addition to land use disturbance, physical barriers and alterations from railroad and road development in flood plains or at stream crossings have confined or redirected stream channel flow, causing changes in channel gradient, sinuosity, and morphology. An earthen dam at McKay Reservoir is a migration barrier for summer steelhead (Oncorhynchus mykiss). The Oregon Department of Fish and Wildlife listed McKay dam as Group 1, in the top 10 priority list for restoring fish passage (Loffink 2013).

Invasive weeds and non-native species are a concern for this ecological site. Non-native forbs common on the gravel bars include lesser burdock (*Arctium minus*), annual ragweed (*Ambrosia artemisiifolia*), chicory (*Cichorium intybus*), Fuller’s teasel (*Dipsacus fullonum*), Jerusalem oak goosefoot (Dysphania botrys), common St. Johnswort (*Hypericum perforatum*), sweetclover (*Melilotus officinalis*), Scotch cottonthistle (*Onopordum acanthium*), narrowleaf plantain (*Plantago lanceolata*), sulphur cinquefoil (*Potentilla recta*), curly dock (*Rumex crispus*), and common mullein (Verbascum thapus). Himalayan blackberry (*Rubus armeniacus*) is common on the floodplains and terraces and can create dense, impenetrable thickets, which outcompete native species. Non-native grasses, such as tall oatgrass (*Arrhenatherum elatius*), ripgut brome (*Bromus diandrus*), cheatgrass (*Bromus tectorum*), bulbous bluegrass (*Poa bulbosa*), medusahead (*Taeniatherum caput-medusae*), intermediate wheatgrass (*Thinopyrum intermedium*), tall wheatgrass (*Thinopyrum ponticum*), North Africa grass (*Ventenata dubia*), and fescue (Vulpia sp.) dominate the upper terraces.

Information regarding the historical fire regime on the Colombia plateau or in associated riparian areas is limited. Fires may be less common today than historically due to fire suppression and barriers, such as road, croplands, and residential areas. The shrubs associated with this ecological site are adapted to fire. They have the ability to re-sprout from the root crown or from rhizomes after being top-killed by fire. Shrubs which re-sprout after fire include black hawthorn, western chokecherry, Woods' rose (*Rosa woodsii*), and common snowberry (*Symphoricarpos albus*), Saskatoon serviceberry (*Amelanchier alnifolia*), Lewis' mock orange (*Philadelphus lewisii*), and the non-native Himalayan blackberry (*Rubus armeniacus*). Native bunchgrasses, such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and basin wildrye may have been reduced on this site due to overgrazing, erosion, and exclusion of low intensity fires. The presence of cheatgrass in the area poses a threat for this site to transition to an altered, non-native, grassland state. Cheatgrass increases flammability and fire frequency. Frequent burns can eliminate shrub cover. Black cottonwood is injured by fire, but can also re-sprout from the root crown, and may regenerate well from seed in the freshly exposed soil if there is sufficient moisture (Steinberg 2001). White alder is often killed by severe fire, and reestablishes poorly from seed or by sprouting from the root crown. It may take decades for white alder to reestablish (Fryer 2014). In the absence of fire, dense development of mid-canopy layers may occur. Upland cycles are not included in the state and transition model for this riparian complex, due to the complexity of the model that would be needed to consistently incorporate these concepts.

Hydrologic factors:

This ecological site incorporates the longitudinal, lateral, and to some extent the vertical connectivity of the stream. Longitudinally, the stream includes reaches of differing channel morphology. The channel may include reaches that are more confined by bedrock hillslopes, impacted by human alterations, or are less confined with a broad accessible floodplain. The valley bottom is typically wide (300 to 800 feet) throughout. Laterally, there may be braided side channels, active floodplains, and terraces. The variation in the hyporheic zone, and the relationship between surface water and ground water is at too fine a scale for this ecological site. The hyporheic zone associated with these streams has a complex pattern of upwelling and downwelling, which impacts the aquatic community and is important for fish spawning. Areas of downwelling may occur in sediment-laden sections or above steps created by woody debris or bedrock. Upwelling is likely to occur where subsurface flow reenters the stream channel. Upwelling ground water is often cooler and more nutrient-rich, which is preferable for fish spawning and creates a unique habitat for aquatic organisms.

Although historic information is lacking, the valley type and valley slope combined with current conditions indicate the potential for a non-entrenched C and D type channel complex. A C type channel is a slightly entrenched, single meandering channel with a well-defined floodplain. The channel has moderate to high sinuosity with less than two percent channel gradient. These channel types generally have a width to depth ratio greater than 12, which means they are moderately wide and shallow. They are often found in broad valleys with well-developed alluvial floodplains and terraces. These channels typically flood over bank two years out of three. In an un-degraded state, a 50-year flood event should overflow onto the floodplain. C type channels are constantly in the process of transporting and storing sediments from upstream sources or bank erosion. As the particle- size of the channel bottom material decreases, the sediment supply generally increases, as does the erosion potential. The channels on this site support gravel (C4) reaches, which have a very high erosion potential and are very sensitive to disturbance. Vegetation such as white alder and willows exert a very high controlling influence on C type channel dynamics (Rosgen 1994).

C type channels can become unstable due to disturbances that impact stream bank vegetation, change the flow regime, sediment loads, or alter channel morphology. These channels respond quickly to such disturbances, exhibiting channel aggradation, channel incision, and/or bank erosion. This can shift a C type channel to a D, G, or F type channel. Overgrazing and excessive trampling by livestock can reduce streambank stability by reducing the vegetative cover or by physically trampling the banks. Increased sedimentation can fill the channel, thereby causing erosion of streambanks. This results in a wider and shallower channel, which initiates a transition to a D type channel.

D type channels are low slope, braided channels with barren or partially vegetated gravel bars and mid channel islands that are exposed during low flow and are typically flooded at bankfull flows. D channels are typically considered unstable systems that have an excessive sediment load, but may occur at equilibrium in some systems. Factors that may contribute to an increased sediment load are large flood events, excessive hillslope erosion, loss of riparian vegetation, change in flow regime, and channel or floodplain alterations (Leopold and Wolman 1957, Rosgen 1996).

Braided channels develop as sediments deposit in low velocity areas of the stream and form incipient bars. Additional sediments may accumulate behind this initial bar, developing larger and wider gravel bars. As mid-channel bars develop, the divided stream flow is deflected into the outer stream banks, which typically erodes (especially if there is poor root structure on the banks), and the channel becomes wider and shallower over time.

G and F type channels are often temporary or occur in short sections along the stream. G type channels occur as a stream headcuts or downcuts into sediments, creating a deep narrow channel. F type channels typically develop as bank erosion widens the narrow G type channel. In this site, the F type channel will develop into a C or D type channel.

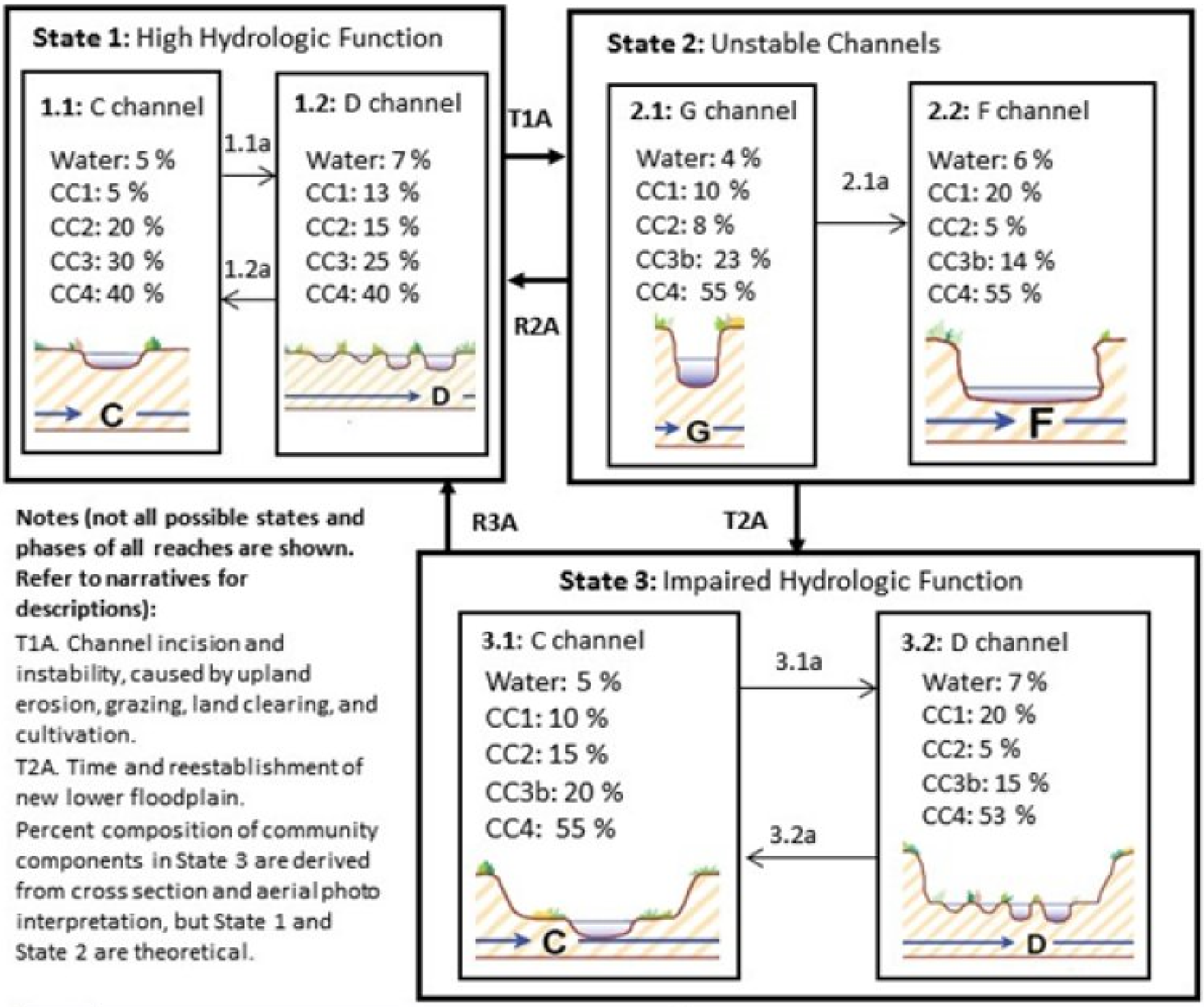
Climate change
Climate records for the Northwest United States show that average annual temperature has increased 1.5 degree F in the last 100 years, and it is predicted to increase by 3 to 10 degrees F in the next century (U.S. Environmental Protection Agency 2013). Precipitation predictions are less clear, but warmer temperatures are expected to cause more winter precipitation to come as rain instead of snow, and cause the reduced snowpack to melt 20 to 40 days earlier in spring (EPA, 2013). The snowpack is currently the primary water source for late spring and summer flows in these streams. A greater proportion of rain and earlier snow melt could increase flood severity and frequency in winter and spring, and reduce flow in summer and fall. The change in timing of flooding could impact the migration and spawning of the anadromous fish that utilize these creeks; in fact, increased flooding in the winter months could flush eggs and young fish from the streams (EPA, 2013). The Meacham Creek USGS station has already shown a significant increase in flow during March (Chang and Jones 2010), likely due to earlier snow melt from warmer temperatures.

State and transition model

R009XY501OR: Low slope, Alluvial Valley Riparian Complex

Populus balsamifera spp. *trichocarpa*) - (*Alnus rhombifolia*) / (*Crataegus douglasii*) - (*Prunus virginiana*) / (*Leymus cinereus*)

Black cottonwood –white alder/ Black hawthorn-western chokecherry/Basin wildrye



I.D.	Plant Association	Fluvial Surface/Landform
1	Pioneer forbs, willows	Gravel bar
2	White alder, black cottonwood, Lewis' mock orange	Floodplain, occasionally flooded
3	Black cottonwood, black hawthorn	Floodplain step, rarely flooded
3b	Black hawthorn, black cottonwood, common snowberry	Floodplain step, abandoned, rarely flooded
4	Basin wildrye, black hawthorn, western chokecherry	Stream Terrace, rarely flooded

Figure 7. R009XY501OR STM

State 1
High Hydrologic Function

The historic or unaltered condition for this ecological site is based on current conditions and expected stream development in the associated alluvial valley type and valley slope (<2 percent). High hydrologic function infers good floodplain connectivity, stable stream banks, areas of episaturation, higher water tables than are currently present, and stream habitat complexity. C type channels are expected in pristine conditions, but D type channels are a natural phase for this ecological site. Historically, a larger proportion of the reaches associated with this ecological site may have exhibited C type channel morphologies rather than the D type channel that is more common today. Although reaches with a C or D type channels may transition from one to the other, they may also perpetually exist due to valley constraints or bedrock features that create a semi-stable condition. It is presumed that historic channels were less incised, and had broader and more frequent overbank flow onto floodplains. Beaver dams may have been important structural features historically. Most of this ecological site has been disturbed by floodplain manipulations, grazing, cultivation, non-native species, and other disturbances, so it is difficult to find data to describe reference state or its phases.

Community 1.1
C Channel

This community phase is at equilibrium with the sediment supply and transport capability. It is a gently-sloped, meandering, un-incised C type channel, which can access the floodplain every two to three years during moderate flood events. Flood energy is dissipated across the broad floodplain, leaving fresh nutrients and sediments and instigating seed establishment of flood-dependent species. The channel is rich with structural features, such as side channels, pools, and woody debris. The canopy cover across the stream is high, due to the well-developed riparian vegetation and relatively narrow channel. This phase is similar to phase 3.1, which is an incised C channel that is present today. Phase 3.1 has a lower water table and less connectivity to the floodplain. Historically, the coverage of the white alder and cottonwood community (CC2) was greater, due to higher water tables, stable stream banks, and floodplain connectivity. The upper terrace community may have been subject to large flood events, which would favor more cottonwood development. Plant Community Components I.D., Plant Association/Fluvial Surface/Landform1/ Composition (%) W, Water, Water, Channel, 5% CC1, Pioneer forbs, willows, Gravel Bar, Frequently flooded, 5 % CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain, Occasionally flooded, 20% CC3, Black cottonwood, black hawthorn, Floodplain step, Rarely flooded, 30% CC4, Basin wildrye, black hawthorn, western chokecherry, Terrace, Rare to no flooding, 40%

Community 1.2
D Channel

The D type channel historically occurred less frequently than is present today. This channel type is wide and shallow with multiple braided channels or mid channel bars. Channel avulsion may occur when the original channel is obstructed, and flow is directed into a side channel which captures the main flow. Community component 1 increases in this phase due to the increased width of the channel at the expense of the floodplain community (CC2). The terrace (CC4) may be eroded as the channel widens. Canopy cover along the stream is reduced, due the development of the wide channel. The stream in this phase is dominated by riffles, but pools can develop behind mid-channel bars. Plant Community Components I.D., Plant Association, Fluvial Surface, Landform1, Composition (%) W, Water, Water, Channel, 7% CC1, Pioneer forbs, willows, Gravel Bar- Frequently flooded, 13% CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain- Occasionally flooded, 15% CC3, Black cottonwood, black hawthorn, Floodplain step- Rarely flooded, 25% CC4, Basin wildrye, black hawthorn, western chokecherry, Terrace- Rare to no flooding, 40 %

Pathway 1A
Community 1.1 to 1.2

This pathway occurs with sediment deposition, which causes channel aggradation. This may be associated with large flood events and/or increased sediment supply from unstable hillslopes and stream banks. Mid-channel bars develop and create an overall wider and shallower channel (D type channel).

Pathway 2A
Community 1.2 to 1.1

This pathway occurs with time, with the transport of sediment and development of a deeper, meandering channel

(C type channel).

State 2
Unstable Channels

This state is defined by unstable, incised, transitional G and F type channels. As channel incision occurs, the water table is lowered across the floodplain and flow is contained within the channel, which reduces over bank flooding onto the floodplain. G type channels are narrow and deep, with reduced sinuosity. The unstable banks of the G type channel erode rapidly into a wider and shallower entrenched F type channel. Stream velocity and confined flow often flush structural elements from the stream, causing a decline in habitat diversity. Riffle-pool sequences may develop into more continuous riffles.

Community 2.1
G Channel

This channel is unstable, deep and narrow, with reduced sinuosity. Stream banks are unstable and erode rapidly. Bedrock restricts channel incision in some areas, causing the channel to widen into F or D type channels instead of incising. The community components are similar to those described in State 1, but the disconnected floodplain community (CC2) begins to decline, and species composition transitions to upland species typical in CC3b. The composition of the community components are based on theoretical changes. Plant Community Components I.D., Plant Association, Fluvial Surface- Landform, Composition (%) W, Water, Water, Channel, 4% CC1, Pioneer forbs, willows, Gravel Bar- Frequently flooded, 10% CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain-Occasionally flooded, 8% CC3b, Black hawthorn, black cottonwood, Floodplain step- Rarely flooded, 23% CC4, Basin wildrye, black hawthorn, western chokecherry, Terrace- Rare to no flooding, 55%

Community 2.2
F Channel

The F type channel is a wide, incised channel with nearly vertical eroding banks. Flow is contained within the large channel, and the original floodplain is hydrologically disconnected from 50-year flood events. The floodplain community (CC2) declines as the gravel bar (CC1) and terrace communities (CC3b) increase. The composition of the community components are based on theoretical changes. Plant Community Components I.D., Plant Association, Fluvial Surface-Landform, Composition (%) W, Water, Water, Channel, 6% CC1, Pioneer forbs, willows, Gravel Bar- Frequently flooded, 20% CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain-Occasionally flooded, 5% CC3b, Black hawthorn, black cottonwood Floodplain step- Rarely flooded, 14% CC4, Basin wildrye, black hawthorn, western chokecherry, Terrace- Rare to no flooding, 55%

Pathway 1A
Community 2.1 to 2.2

This pathway occurs with time and lateral bank erosion, which creates a wider and shallower channel (F type channel).

State 3
Impaired Hydrologic Function

This state develops as new, lower floodplains develop along the entrenched channel. The new floodplains are at a lower elevation than the original floodplain and are more confined. The majority of this ecological site currently exists in this state. Hydrologic function has been impaired by channel incision and a disconnection from the floodplain. Stream banks are unstable, stream canopy cover is low, and floodplains are endosaturated. This state may have C or D type channel morphology.

Community 3.1
Entrenched C Type Channel

Figure 8. CC3

Figure 9. CC4

Figure 10. CC1 soil

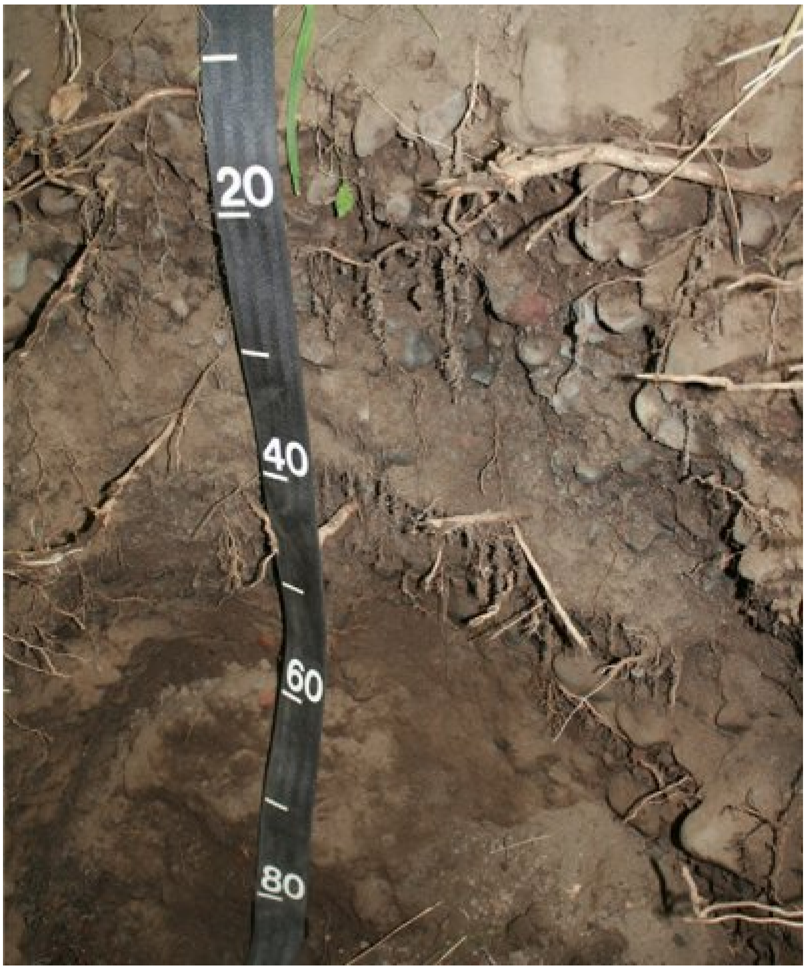


Figure 11. CC2 soil

Figure 12. CC3 soil

Figure 13. CC4 soil


Figure 14. CC1

Figure 15. CC2

The entrenched C type channel has re-established a new floodplain at a lower elevation than the historic floodplain, but remains contained by the abandoned floodplain or terraces. The C channel has greater sinuosity than the D channel phase, with the development of point bars and increased meander. Pools are common in bends and along bedrock-scoured sections. The floodplain community (CC2) establishes on the low floodplain, where water tables remain within 100 cm throughout the year. The gravel bar community (CC1) is present, but restricted to point bars and the active channel when the gravels are exposed at low flow. The abandoned floodplain community (CC3b) is dominated by upland species, but some relict floodplain species such as black cottonwood are present. Black cottonwood will decline over time in the absence of flooding, because requires flooding for dispersal and regeneration of seeds. The terrace community (CC4) has been heavily altered by land uses such as grazing or cultivation for crops. Plant Community Components I.D., Plant Association, Fluvial Surface- Landform, Composition (%) W, Water, Water, Channel, 5% CC1, Pioneer forbs, willows, Gravel Bar- Frequently flooded, 10% CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain- Occasionally flooded, 15% CC3b, Black hawthorn, black cottonwood, Floodplain step- Rarely flooded, 20% CC4, Basin wildrye, black hawthorn, western chokecherry, Terrace- Rare to no flooding, 55% Community Component Narratives Plant Community Component 1 Community component 1 occurs on gravel bars, mid-channel islands and areas recently affected by flooding, such as recent sediment deposits or side channels on floodplains. Non-native forbs and grasses dominate. Historically, this community may have been less extensive due to floodplain stability and the establishment of white alder and willow species along the water edge. Native forbs, grasses, and sedges may have been more abundant. Presently there is low cover of native species, including woodrush (Luzula sp.), witchgrass (*Panicum capillare*), white sagebrush (*Artemisia ludoviciana*), dove weed (*Croton setigerus*), willowherb (Epilobium sp.), gumweed (Grindelia sp.), silverleaf phacelia (*Phacelia hastata*), popcornflower (Plagiobothrys sp.), knotweed (Polygonum sp.), and common selfheal (*Prunella vulgaris*). Willows and black cottonwood in our plots were browsed to short, multi-stemmed shrubs. In the absence of grazing from cattle and wild horses, these shrubs may increase with time. Currently non-native forbs dominate this community, including annual ragweed, lesser burdock, chicory, Fuller's teasel, Jerusalem oak goosefoot, common St Johnswort, sweetclover, Scotch cottonthistle, narrowleaf plantain, sulphur cinquefoil, curly dock, common mullein, tall oatgrass, compact brome, cheatgrass, barnyard grass, and North Africa grass (*Ventenata dubia*). Annual production ranges from 0 to 200 lbs. per acre with an average of 120 lbs. per acre. This community is within the active channel at high flows, which expose gravels and cobbles during low flow. It is subject to frequent scouring and depositional events, making it difficult for longer-lived species to establish. The community is dominated by annual and short-lived perennial species whose seeds are deposited by floods, wind, or animals. Willows, white alder, and black cottonwood may establish in areas with relative stability and absence of grazing. Plant Community Component 2 This community occurs on frequently-flooded floodplains, typically adjacent to the gravel bar community. In some areas it occurs at the bankfull position, which may also be the greenline community. The water table typically remains within the upper 100 centimeters throughout the year. The species associated with this community are predominantly wetland or facultative wetland species. These species are adapted to and dependent upon flooding for seed dispersal and germination. This community is dominated by an overstory of white alder and black cottonwood. A moderate shrub component is present with Saskatoon serviceberry (*Amelanchier alnifolia*), black hawthorn, Lewis' mock orange, chokecherry, willows, blue elderberry (*Sambucus nigra* ssp. cerulea), and common snowberry. Native understory species include white sagebrush, western white clematis (*Clematis ligusticifolia*), bedstraw (Galium sp.), fernleaf biscuitroot (*Lomatium dissectum*), mayflower (Maianthermum sp.), coastal manroot (*Marah oreganus*), silverleaf phacelia (*Phacelia hastata*), and blue wildrye (*Elymus glaucus*). Reed canarygrass (*Phalaris arundinacea*) is present in some areas. It is native to riverine systems in Idaho, Montana, and Wyoming. In Oregon, this species is believed to be a European cultivar, which was developed for high growth rates (Tu 2004). This species usually becomes weedy or invasive in some habitats, and it excludes desirable vegetation in time (USDA NRCS 2012). Non-native species are more prominent in the early seral stages, after flood events have created conditions of open sunlight and poorly developed soils. In additions to non-native species listed in CC1, poison hemlock (*Conium maculatum*), gypsyflower (*Cynoglossum officinale*), Queen Anne's lace (*Daucus carota*), Fuller's teasel (*Dipsacus fullonum*), common viper's bugloss (*Echium vulgare*), and catnip (*Nepeta cataria*) are present. With increased canopy shading, many invasive species decline. However, Himalayan blackberry can form impenetrable thickets in the understory, outcompeting native species. White alder is a facultative wetland species (FACW), meaning it typically occurs in wetlands, but may occur in uplands. White alder forms thin, linear stands along the bankfull line, or on side channels and depressions where its roots can access the shallow water table. White alder requires moist soil for seedling development and survival. Seedlings will not survive in soils that dry in summer. The timing of seed production and high water flows are crucial. The seeds may be dispersed by water, wind, or animals, and develop best in areas after flood waters recede (Fryer, 2014). Mature white alder typically needs a seasonal water table within three meters in order to survive, and can withstand seasonal inundation. After flood events and stem breakage, white alder can re-sprout or reproduce by layering. White alder develops best on soils that are coarse-textured and have well-aerated, subsurface water flow. It has nitrogen-fixing nodules, which help develop soil nutrients. White alder's roots develop dense matrices along stream banks that help armor the soil from erosion and capture fine sediments. With continued stability, soils under white alder develop darker, nutrient-rich, and fine-textured surface horizons. Black cottonwood may be more widely dispersed across the floodplain, because it is less dependent upon a shallow water table. It is a facultative species (FAC), meaning it may occur equally in wetland or upland habitats. Black cottonwood produces a high volume of seed every spring, but seeds are only viable for a few weeks. Once the seeds become wet they begin to germinate and need a suitable substrate in order to survive. Seedling survival is highest on mineral soil that remains moist near the surface for at least a month. If the water table and soil moisture drop to deeper layers and the young roots cannot access the water, they will succumb to drought. Short seed viability and specific moisture requirements for germination mean that in order for regeneration to occur, seed production and flood events need to occur in the same time frame. Seedlings develop best in open sunlight, and seldom regenerate under existing black cottonwood forest or other vegetative cover. Regeneration from seed typically occurs in pulses with large flood events. After damage from flood events, black cottonwood can re-sprout from buried stems or develop root succors after stem damage. Twigs broken by flood events can re-sprout if buried in moist sediments with leaves still attached (Steinberg 2001). This is more common in areas with moist summers. Mature cottonwoods need to have roots in a perennial water table, but because roots may penetrate to depths of seven meters, they can persist on higher floodplains and terraces (CC3 and CC4). Willow species also produce seeds annually that are only viable for a short period of time and require moist substrates for germination and seedling survival. Willows can withstand long periods of inundation, and their flexible stems enable them to bend with water flows. If stems are damaged, they can re-sprout from the roots or the lower stem. Some species of willow, such as narrowleaf willow (*Salix exigua*), can form dense, clonal colonies from sprouting of root shoots. Broken branches and root pieces can re-sprout if lightly buried in fresh flood deposits (Uchytil 1989, Anderson 2006). This floodplain community has a successional trend when recovering from erosive or depositional flood events. Large flood events can uproot or break the stems of mature white alder and cottonwoods and leave a path of exposed gravel and cobble deposits. During this early successional period, the vegetation of this component is similar to the gravel bar (CC1) component and is dominated by pioneer species and short-lived forbs. At this time, willow, white alder and black cottonwood seedlings also establish. With time, the white alder, and black cottonwood develop into tree form, and riparian woodlands develop. Willows are less shade-tolerant, and may be shaded out with the development of the overstory canopy. The soils also develop with increased accumulation of organic matter and fine sediments. Plant Community

Component 3 and 3b This community component was historically (CC3) within the active floodplain. Today (CC3b), it typically is present is above the 50-year flood influence, and the water table may drop below 100 centimeters in the summer and fall. Historically, a broader extent of this area may have resembled CC2, with white alder in side channels and depressions. Black cottonwood was likely more extensive, with multiple age classes related to flood events. Under present conditions, black cottonwood is often over-mature and decadent. Seedling regeneration is absent, due to a lack of flooding, which provides the suitable moist substrate for germination and survival. The water table is too deep in the summer to support white alder and willows, except in occasional low depressions. As this landform becomes drier, it is less influenced by the channel hydrology and more influenced by upland disturbances, such as fire. This community is currently dominated by black hawthorn and a patchy cover of black cottonwood. Other shrubs are Lewis' mock orange, chokecherry, smooth sumac (*Rhus glabra*), Woods' rose (*Rosa woodsii*), blue elderberry, and common snowberry. The understory can be heavily infested by the non-native Himalayan blackberry. The understory forbs and grasses are typically sparse, but may include blue wildrye (*Elymus glaucus*), bentgrass (Agrostis sp.), bedstraw, mayflower, and coastal manroot. Non-native understory species listed in in CC1 and CC2 are present. Tall oatgrass may have up to 35 percent cover, and Canada thistle may have up to 15 percent cover. Cover of other non-native species is typically less than 1 percent. Community Component 4 This community component occurs on terraces above the active floodplain. Flooding frequency is rare. The water table is typically below six feet. The vegetation is currently dominated by non-native grasses and forbs. These terraces are typically cultivated or grazed, so natural vegetation is difficult to find. Based on historical information and remnant native vegetation, these terraces may have been dominated by basin wildrye and patches of shrubs composed of black hawthorn, western chokecherry, Wood's rose, and Saskatoon serviceberry. Idaho fescue and bluebunch wheatgrass are common at the base of the hillslopes. Non-native grasses include tall oatgrass, ripgut brome, cheatgrass, bulbous bluegrass, medusahead, intermediate wheatgrass, tall wheatgrass, North Africa grass, and fescue. Non-native forbs include Canada thistle, Queen Anne's lace, Fuller's teasel, redstem stork's bill (Erodium circutarium), Scotch cottonthistle, common plantain, sulphur cinquefoil, and common mullein.

Community 3.2
Entrenched D Type Channel

The entrenched D type phase is a common condition for this ecological site. The D type channel has a very wide active channel width (100 to 150 feet), with shallow mean depths (typically < 1 to 2 feet). The D channel is typically associated with high sediment yields and channel aggradation. Stream velocity is diffused it is spreads across the wide channel. Mid-channel bars develop as coarse sediments are deposited in slack water. As bars develop, the flow is directed outward, eroding stream banks. Active and abandoned side channels may be present on floodplains and terraces. A few instances of channel avulsion are evident in historic photos. Braided channels and gravel bars frequently reshape, migrate, disappear, and reform. The wide channel dries in summer, leaving broad exposed gravel or cobble bars, which are often dominated by non-native invasive forbs and grasses (CC1). The floodplain community (CC2) is restricted to a margin along the edge of the active channel, which quickly transitions to the abandoned floodplain (CC3b) or terrace (CC4) community. Because of the wide channel, canopy shading of the stream is poor. Plant Community Components I.D., Plant Association, Fluvial Surface- Landform, Composition (%) W, Water, Water, Channel, 7% CC1, Pioneer forbs, willows, Gravel Bar- Frequently flooded, 20 CC2, White alder, black cottonwood, Lewis' mock orange, Floodplain- Occasionally flooded, 5% CC3b, Black hawthorn, black cottonwood, Floodplain step- Rarely flooded, 15% CC4, Basin wildrye, black hawthorn, western chokecherry, Stream Terrace- Rarely flooded, 53%

Pathway 1A
Community 3.1 to 3.2

This pathway occurs with sediment deposition, which causes channel aggradation. This may be associated with large flood events, and/or increased sediment supply from unstable hillslopes and stream banks. Mid-channel bars develop and create an overall wider and shallower channel (D type channel).

Pathway 2A
Community 3.2 to 3.1

This pathway occurs with time and the resorting of sediments, which develops a meandering channel (C type channel) with point bars and access to a new, lower floodplain.

Transition 1A
State 1 to 2

This transition occurs with changes in stream flow or sedimentation rates. The imbalance causes channel adjustments. Down-cutting or head-cutting of the channel bed may occur when a stream becomes confined or straightened due to obstructions in the floodplain or loss of structural elements in the channel, such as woody debris and beaver dams. Flood events can deposit thick sediments, and normal stream flows may rapidly incise these sediments. A transitional, confined, entrenched, and unstable state develops. Stream gradient and velocity increases and G or F type channel phases develop.

Restoration pathway 2A
State 2 to 1

Restoration from State 2 to State 1 would involve intensive stream surveying in order to determine the best restoration approach. Restoration methods may include channel redesign to increase meander. These streams have very little large woody debris and may benefit with the planned placement of large woody debris to improve the diversity of pool habitat. Riparian vegetation may be enhanced by cattle exclusion or herding to reduce duration in riparian corridors. Reestablishment and enhancement of riparian vegetation might allow the existing beavers to establish larger, more permanent dams, which might increase pool habitat and increase the overbank flows onto the floodplains (Pollock, Beechie et al. 2007). Riparian vegetation may be planted in reaches with suitable water tables for establishment (not on incised, eroded banks). Channel restoration on Meacham Creek has proved to be beneficial (CTUIR 2014, Lambert 2014)

Transition 2A
State 2 to 3

This transition occurs with increased channel widening and greater access to a new, lower floodplain within an entrenched C or D channel type. D type channels are braided and may still be in a period of transition. C type channels develop as sediments build up point bars, and increase meander and riffle-pool formation. Habitat conditions for this state improve with the development of structural elements in the channel, such as pool formations from root wads. The channels in this state do not access the entirety of their former floodplain.

Restoration pathway 3A
State 3 to 1

Restoration from State 3 to State 1 is similar to restoration from State 2 to State 1. It would involve intensive stream surveying in order to determine the best restoration approach. Restoration methods may include channel redesign to increase meander. These streams have very little large woody debris and may benefit with the planned placement of large woody debris to improve the diversity of pool habitat. Riparian vegetation may be enhanced by cattle exclusion or herding to reduce duration in riparian corridors. Reestablishment and enhancement of riparian vegetation might allow the existing beavers to establish larger, more permanent dams, which might increase pool habitat and increase the overbank flows onto the floodplains (Pollock, Beechie et al. 2007). Riparian vegetation may be planted in reaches with suitable water tables for establishment (not on incised, eroded banks). Channel restoration on Meacham Creek has proved to be beneficial (CTUIR 2014, Lambert 2014)

Additional community tables

Table 5. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Tree					
1	**Trees**			0–25	
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–25	0–2
2	**Trees**			0–250	
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–175	15–30

			trichocarpa		
	white alder	ALRH2	*Alnus rhombifolia*	15–150	10–80
	black locust	ROPS	*Robinia pseudoacacia*	0–50	0–12
3	**Trees**			5–150	
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	5–150	5–35
4	**Trees**			0–15	
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–15	0–5
Shrub/Vine					
1	**Shrubs**			0–95	
	willow	SALIX	*Salix*	0–75	0–5
	narrowleaf willow	SAEX	*Salix exigua*	0–20	0–2
2	**Shrubs**			270–400	
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	5–250	0–55
	cutleaf blackberry	RULA	*Rubus laciniatus*	0–55	0–3
	Lewis' mock orange	PHLE4	*Philadelphus lewisii*	5–50	1–8
	Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	0–50	0–5
	chokecherry	PRVI	*Prunus virginiana*	5–45	1–8
	common snowberry	SYAL	*Symphoricarpos albus*	0–40	0–6
	black hawthorn	CRDO2	*Crataegus douglasii*	0–20	0–2
	willow	SALIX	*Salix*	0–15	0–2
	blue elderberry	SANIC5	*Sambucus nigra ssp. cerulea*	0–15	0–2
3	**Shrubs**			5–85	
	black hawthorn	CRDO2	*Crataegus douglasii*	400–800	20–40
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	3–110	1–35
	Lewis' mock orange	PHLE4	*Philadelphus lewisii*	0–60	0–2
	blue elderberry	SANIC5	*Sambucus nigra ssp. cerulea*	10–35	1–3
	common snowberry	SYAL	*Symphoricarpos albus*	10–35	1–3
	chokecherry	PRVI	*Prunus virginiana*	0–25	0–3
	smooth sumac	RHGL	*Rhus glabra*	0–20	0–2
	Woods' rose	ROWO	*Rosa woodsii*	0–10	0–1
4	**Shrubs**			5–85	
	Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	0–35	0–5
	chokecherry	PRVI	*Prunus virginiana*	0–30	0–3
	black hawthorn	CRDO2	*Crataegus douglasii*	0–18	0–2
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	0–10	0–1
	Woods' rose	ROWO	*Rosa woodsii*	0–5	0–1
Grass/Grasslike					
1	**Grass and grasslike**			0–9	
	bentgrass	AGROS2	*Agrostis*	0–1	0–1
	tall oatgrass	AREL3	*Arrhenatherum elatius*	0–1	0–1
	compact brome	BRMA3	*Bromus madritensis*	0–1	0–1
	cheatgrass	BRTE	*Bromus tectorum*	0–1	0–1
	barnyardgrass	ECCR	*Echinochloa crus-galli*	0–1	0–1

	woodrush	LUZUL	*Luzula*	0–1	0–1
	witchgrass	PACA6	*Panicum capillare*	0–1	0–1
	North Africa grass	VEDU	*Ventenata dubia*	0–1	0–1
2	**Grass and grasslike**			45–110	
	bentgrass	AGROS2	*Agrostis*	0–100	0–18
	orchardgrass	DAGL	*Dactylis glomerata*	0–60	0–2
	tall oatgrass	AREL3	*Arrhenatherum elatius*	0–25	0–3
	blue wildrye	ELGL	*Elymus glaucus*	0–16	0–2
	reed canarygrass	PHAR3	*Phalaris arundinacea*	0–1	0–1
	ripgut brome	BRDI3	*Bromus diandrus*	0–1	0–1
	soft brome	BRHO2	*Bromus hordeaceus*	0–1	0–1
3	**Grass and grasslike**			30–310	
	tall oatgrass	AREL3	*Arrhenatherum elatius*	0–300	0–35
	blue wildrye	ELGL	*Elymus glaucus*	0–35	0–4
	bentgrass	AGROS2	*Agrostis*	0–5	0–1
	orchardgrass	DAGL	*Dactylis glomerata*	0–1	0–1
4	**Grass and grasslike**			1800–5450	
	tall wheatgrass	THPO7	*Thinopyrum ponticum*	0–5350	0–80
	basin wildrye	LECI4	*Leymus cinereus*	0–150	0–3
	intermediate wheatgrass	THIN6	*Thinopyrum intermedium*	0–117	0–6
	cheatgrass	BRTE	*Bromus tectorum*	0–105	0–20
	ripgut brome	BRDI3	*Bromus diandrus*	0–80	0–15
	bulbous bluegrass	POBU	*Poa bulbosa*	0–35	0–8
	blue wildrye	ELGL	*Elymus glaucus*	0–10	0–2
	medusahead	TACA8	*Taeniatherum caput-medusae*	0–5	0–2
	tall oatgrass	AREL3	*Arrhenatherum elatius*	0–5	0–1
	North Africa grass	VEDU	*Ventenata dubia*	0–1	0–1
	fescue	VULPI	*Vulpia*	0–1	0–1
Forb					
1	**Forbs**			25–75	
	Jerusalem oak goosefoot	DYBO	*Dysphania botrys*	0–25	0–5
	common mullein	VETH	*Verbascum thapsus*	0–25	0–3
	lesser burdock	ARMI2	*Arctium minus*	0–15	0–3
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–10	0–2
	narrowleaf plantain	PLLA	*Plantago lanceolata*	0–4	0–2
	knotweed	POLYG4	*Polygonum*	0–2	0–1
	sulphur cinquefoil	PORE5	*Potentilla recta*	0–1	0–1
	common selfheal	PRVU	*Prunella vulgaris*	0–1	0–1
	curly dock	RUCR	*Rumex crispus*	0–1	0–1
	clover	TRIFO	*Trifolium*	0–1	0–1
	annual ragweed	AMAR2	*Ambrosia artemisiifolia*	0–1	0–1
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–1	0–1
	chicory	CIIN	*Cichorium intybus*	0–1	0–1

	dove weed	CRSE11	*Croton setigerus*	0–1	0–1
	willowherb	EPILO	*Epilobium*	0–1	0–1
	gumweed	GRIND	*Grindelia*	0–1	0–1
	common St. Johnswort	HYPE	*Hypericum perforatum*	0–1	0–1
	trefoil	LOTUS	*Lotus*	0–1	0–1
	sweetclover	MEOF	*Melilotus officinalis*	0–1	0–1
	Scotch cottonthistle	ONAC	*Onopordum acanthium*	0–1	0–1
	silverleaf phacelia	PHHA	*Phacelia hastata*	0–1	0–1
	popcornflower	PLAGI	*Plagiobothrys*	0–1	0–1
2	**Forbs**			55–145	
	coastal manroot	MAOR3	*Marah oreganus*	0–102	0–2
	bedstraw	GALIU	*Galium*	0–25	0–8
	gypsyflower	CYOF	*Cynoglossum officinale*	0–15	0–3
	poison hemlock	COMA2	*Conium maculatum*	0–15	0–2
	common viper's bugloss	ECVU	*Echium vulgare*	0–5	0–2
	catnip	NECA2	*Nepeta cataria*	0–2	0–1
	silverleaf phacelia	PHHA	*Phacelia hastata*	0–1	0–1
	common mullein	VETH	*Verbascum thapsus*	0–1	0–1
	Queen Anne's lace	DACA6	*Daucus carota*	0–1	0–1
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–1	0–1
	fernleaf biscuitroot	LODI	*Lomatium dissectum*	0–1	0–1
	mayflower	MAIAN	*Maianthemum*	0–1	0–1
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–1	0–1
	chicory	CIIN	*Cichorium intybus*	0–1	0–1
	leather flower	CLEMA	*Clematis*	0–1	0–1
3	**Forbs**			105–300	
	coastal manroot	MAOR3	*Marah oreganus*	10–300	1–25
	Canada thistle	CIAR4	*Cirsium arvense*	0–50	0–15
	gypsyflower	CYOF	*Cynoglossum officinale*	0–5	0–2
	common viper's bugloss	ECVU	*Echium vulgare*	0–5	0–2
	bedstraw	GALIU	*Galium*	0–2	0–2
	common St. Johnswort	HYPE	*Hypericum perforatum*	0–1	0–1
	mayflower	MAIAN	*Maianthemum*	0–1	0–1
	Queen Anne's lace	DACA6	*Daucus carota*	0–1	0–1
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–1	0–1
	catnip	NECA2	*Nepeta cataria*	0–1	0–1
	Scotch cottonthistle	ONAC	*Onopordum acanthium*	0–1	0–1
	curly dock	RUCR	*Rumex crispus*	0–1	0–1
	common mullein	VETH	*Verbascum thapsus*	0–1	0–1
4	**Forbs**			325–650	
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–348	0–10
	Canada thistle	CIAR4	*Cirsium arvense*	0–189	0–3
	common plantain	PLMA2	*Plantago major*	0–50	0–8
	redstem stork's bill	ERCI6	*Erodium cicutarium*	2–45	2–18

	redstem stork's bill	ERCI6	*Erodium cicutarium*	2–45	2–18
	Scotch cottonthistle	ONAC	*Onopordum acanthium*	0–15	0–2
	knotweed	POLYG4	*Polygonum*	0–2	0–2
	sulphur cinquefoil	PORE5	*Potentilla recta*	0–1	0–1
	common mullein	VETH	*Verbascum thapsus*	0–1	0–1
	buckwheat	ERIOG	*Eriogonum*	0–1	0–1
	gumweed	GRIND	*Grindelia*	0–1	0–1
	mayflower	MAIAN	*Maianthemum*	0–1	0–1
	dove weed	CRSE11	*Croton setigerus*	0–1	0–1
	cryptantha	CRYPT	*Cryptantha*	0–1	0–1
	Queen Anne's lace	DACA6	*Daucus carota*	0–1	0–1
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–1	0–1

Animal community

This ecological site provides habitat for a variety of aquatic and upland animals.

Bear, beaver, deer, birds, and small mammals find shelter within the riparian forests along these streams. Surrounding hillslopes are often dominated by grasslands, which offer limited cover. The leaves of the shrubs and trees provide browse, and seeds are eaten by birds and small mammals.

There is limited data on the aquatic animal diversity associated with this ecological site. A dam at the McKay reservoir creates a fish barrier for summer steelhead.

Dense algal growth was observed in the stream during low summer flows.

Wood products

The wood of black cottonwood is used to make book and magazine paper, biomass production, and other wood products such as pallets and fiberboard. The wood decays easily and is not very strong, so is not used for lumber (Steinburg 2001).

Other products

Grass seeds provided a significant amount of food in some areas. The seeds can be harvested and utilized like wild rice. Some species that have been documented for this purpose include wildry (Leymus sp.), needlegrass (Achnatherum sp.), fescue (Festuca sp.), barley (Hordeum sp.), blue wildrye (*Elymus glaucus*), bromes (Bromus sp.), and wild oats (Avena sp.) (Anderson 2006).

Young green leaves were an important source of vitamins and minerals. Some plants documented as used for this purpose include, sweet cicely (Osmorhiza sp.), angelica (Angelica sp.), common cow parsnip (Heracleum maximum), wild onions (Allium sp.), clovers (Trifolium sp.), stinging nettle (Urtica Dioica), violets (Viola sp.), vetch (Vicia sp.), horsetail (Equisetum sp.), spring beauty (Claytonia sp.), and thistles (Cirsium sp.).

Many shrubs and forbs provide edible fruits, such as wild strawberry (Fragaria sp.), wild raspberry and blackberry (Rubus sp.), serviceberry (Almelanchier sp.), wild rose (Rosa sp.), western chokecherry (*Prunus virginiana*), blue elderberry (*Sambucus nigra*), gooseberries and currents (Ribes sp.) (Anderson 2006). Black hawthorn berries are also edible, and the flowering tops and berries are used to make a tincture used as a heart tonic (Moore 1993). Most of these fruits can be eaten raw, or they are used to make pies, jellies, and jams.

Historically, shrubs used for basketry were carefully managed to promote long unbranched stems. Common shrubs used for basketry include willows (Salix sp.), dogwoods (Cornus sp.), and maples (Acer sp.) (Anderson 2006).

Young shoots of cottonwood (Populus sp.) and maple were used to make cordage. Snowberry (Symphoricarpos sp.), gooseberries, willow, alder (Alnus sp.), and mock orange (*Philadelphus lewisii*), were pruned to collect material to make arrows (Anderson 2006).

There are many medicinal or ritual uses for plants that occur on this site. For example, cottonwood leave buds can be used to make tinctures or salves, and are also used as a topical anti-inflammatory and antimicrobial medicine (Moore 1993). Willow bark, shoots, and twigs can be used as a fever reducer, pain-killer, and anti-inflammatory. The chemical compound salacin was isolated from willow and eventually used to develop Aspirin (Chatfield 1997).. The inner cambial layer of ponderosa pine can be used as food, and the resin can be made into a salve for rheumatism, backaches, and dandruff (Habeck 1992).

Black cottonwood has been used to make canoes, create fire starter sets, and the ashes were used to make a soap (Parish and Thomson 1948).

Black hawthorn has dense strong wood, but is unsuitable for commercial lumber due to its growth form. The thorns are very hard and sharp and can be used like a needle or for fish hooks (Parish and Thomson 1948).

White alder can be used medicinally and to make dyes. The wood can be used to make utensils or firewood (Fryer 2014). The young twigs are used in basketry.

Inventory data references

Vegetation data includes ocular cover, production estimates, and double weight sampling methods. Herbaceous production was collected in 4.8 sq. ft. circular hoops. Shrubland production was estimated by counting weight units in four (21' X 21') plots. Soil were described at the center of selected vegetation plots, and channel cross-section measurements were taken when possible to intersect soil and vegetation plots.

Vegetation plots (soil pedon) and notes:
MK_XS1_CC1
MK_XS1_CC2
MK_XS1_CC4_023 (2015OR059023)
MK_XS1_CC4b_024 (2015OR059024)
MK_XS2_CC1
MK_XS2_CC1b_200 (2014OR059200)
MK_XS2_CC2_201 (2014OR059201)
MK_XS2_CC3_009 (2015OR059009)
MK_XS3_CC1
MK_XS3_CC2_010 (2015OR059010)
MK_XS3_CC3_011 (2015OR059011)
MK_XS4_CC3_025 (2015OR059025)

Stream cross-sections
MK_XS1
MK_XS2
MK_XS3
MK_XS4

Type locality

Location 1: Umatilla County, OR	
UTM zone	N
UTM northing	5040921
UTM easting	366251
General legal description	The type location is on McKay Creek, approximately 1.1 miles downstream from the junction of McKay Creek Road and Sumac Road.

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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):

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

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

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

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

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

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

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

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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:

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

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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):**

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:**