USDA Natural Resources Conservation Service

Ecological site R009XY502OR
Low Slope Alluvial Mountain 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.

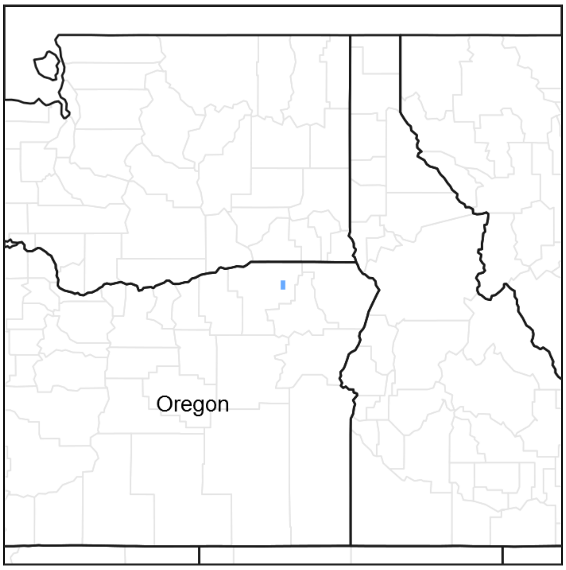


Figure 1. Mapped extent

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 air 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 fifth order or greater streams in gently sloping alluvial fill valleys that are partially confined by steep, colluvial slopes. Drainage area is greater than 90,000 acres, and the watershed is composed of steep, heavily-dissected mountains and lava plateaus. Valley slope is typically less than 2 percent, and stream channel gradient is typically less than 1 percent. Stream channel potential is a Rosgen C type channel, with a braided Rosgen D type channel phase (Rosgen 1994). Aggradation is caused by an overwhelming amount of channel substrate conveyed to the lower low energy, depositional channel reaches. Bedrock control is present in some sections, which causes deep troughs and scour along the valley margins. Plant communities are dominated by white alder (*Alnus rhombifolia*), black cottonwood (*Populus balsamifera* ssp. trichocarpa), black hawthorn (*Crataegus douglasii*), and ponderosa pine (*Pinus ponderosa*). Soils have developed in recent alluvium from basalt.

Associated sites

R009XY031OR	**Shallow South 14+ PZ** This ecological site occurs on the adjacent south- facing hillslopes on the Gwin soils. Native vegetation is dominated by bluebunch wheatgrass (Pseudoengnena spicata) and Idaho fescue (Festuca idahoensis).

Similar sites

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.
R009XY501OR	**Low Slope Alluvial Valley Riparian Complex** This ecological site occurs at lower elevations, on the edge of the Colombia Plateau. Ponderosa pine (Pinus ponderosa) is absent and basin wildrye (Leymus cinereus) may be present on the terraces.
R009XY504OR	**Moderately Sloping Plateau Riparian Complex** This ecological site occurs on gentle terraces on the edge of the Colombia Plateau. Channel gradients are between 2 and 5 percent, and flow may be 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.

Table 1. Dominant plant species

Tree	(1) *Populus balsamifera subsp. trichocarpa* (2) *Alnus rhombifolia*
Shrub	(1) *Symphoricarpos albus* (2) *Rosa woodsii*
Herbaceous	(1) *Elymus glaucus*

Physiographic features

This ecological site occurs on floodplains and stream terraces. Valley slope is typically less than 2 percent, but terrace slopes may range to 4 percent. Elevations range from 1,772 to 2,034 feet (540 to 620 m).

There are four fluvial surfaces associated with this ecological site.

CC1- Floodplain- Gravel Bar- Active channel
Water table depth 0 to 36 inches, with frequent, brief flooding.

CC2- Floodplain
Water table depth 0 to 36 inches, with frequent, brief flooding.

CC3- Floodplain step
Water table depth 24 to 44 inches, with rare flooding.

CC4, Terrace
Water table greater than 60 inches, with rare flooding.

Table 2. Representative physiographic features

Landforms	(1) Flood plain (2) Stream terrace
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Rare to frequent
Ponding frequency	None
Elevation	540–620 m
Slope	0–2%
Aspect	Aspect is not a significant factor

Climatic features

This ecological site 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 29 to 31 inches (737 to 787 millimeters). Mean annual air temperature (MAAT) ranges from 45 to 50 degrees F (7.2 to 10 degrees C). The frost-free period ranges from 115 to 139 days, and the freeze-free period ranges from 148 to 173 days.

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

Meacham climate station MAAT is 43.5 degrees F and MAP is 32.4 inches.

Table 3. Representative climatic features

Frost-free period (average)	122 days
Freeze-free period (average)	154 days
Precipitation total (average)	432 mm

Climate stations used

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

Influencing water features

This site occurs on floodplains and terraces, with frequent to rare flooding depending upon fluvial surface.

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

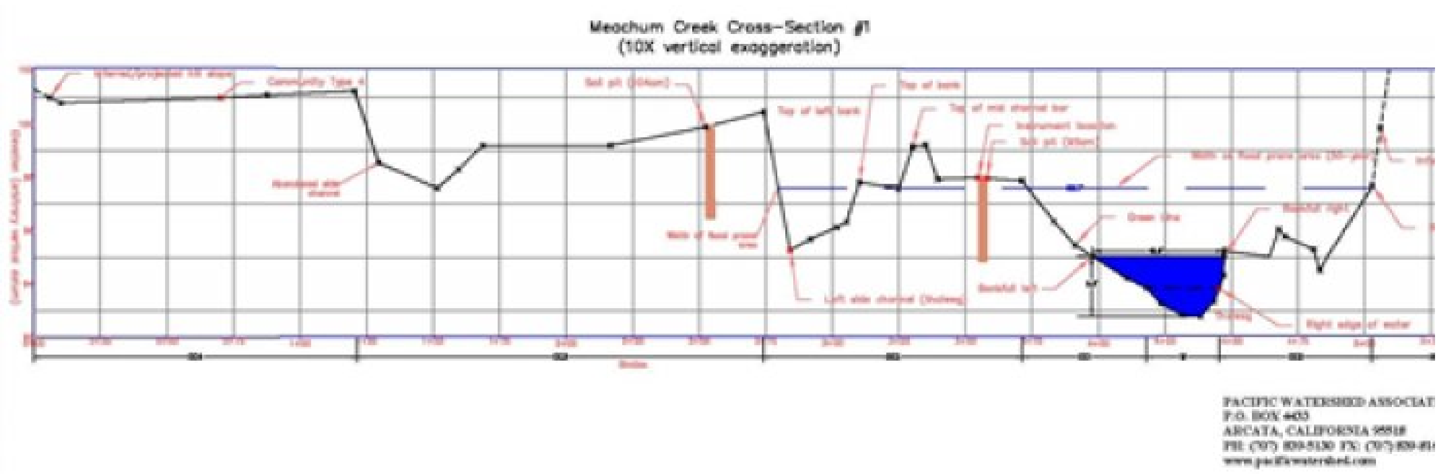


Figure 6. Meacham Cross Section 1, C channel

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 basalt parent material. The soil moisture regime is xeric and the soil temperature regime is mesic.

CC1- Floodplain, gravel bar

The Joseph soils are on active channels and 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.

CC2, Floodplain

The Joseph soils associated with this landform are on active floodplains, which are subject to frequent flooding. They are somewhat poorly drained. This component has a loam surface phase, and has dense vegetative cover.

The Joseph soils are classified as Sandy-skeletal, mixed, mesic, Oxyaquic Xerofluvents. Surface rock cover < 3 inches (gravels) ranges from 10 to 15 percent, and rock fragments > 3 inches (cobbles) ranges from 0 to 30 percent. Subsurface rock fragments < 3 inches range from 15 to 70 percent, and > 3 inch fragments range from 10 to 41 percent.

CC3, Floodplain step

The Psuni soils are on floodplains or abandoned floodplains (terraces), which have rare flooding due to channel incision. They are somewhat poorly to moderately well drained.

The Psuni soils are classified as Sandy-skeletal, mixed, mesic Oxyaquic Haploxerolls. Surface rock fragments < 3 inches range from 20 to 30 percent and > 3 inches range from 0 to 30 percent. Subsurface rock fragments < 3 inches range from 30 to 70 percent, and > 3 inch fragments range from 10 to 15 percent by volume.

CC4 Terrace

The Bridgewater soils when associated with this ecological site are well drained, and occur on rarely flooded stream terraces.

These soils are classified as Loamy-skeletal, mixed, superactive, mesic, Cumulic Haploxerolls. Surface rock cover < 3 inches ranges from 0 to 35 percent, and rock fragments > 3 inches range from 0 to 25 percent. Subsurface rock fragments < 3 inches range from 15 to 50 percent, and > 3 inch fragments range from 5 to 35 percent.

Table 4. Representative soil features

Parent material	(1) Alluvium–basalt
Surface texture	(1) Extremely gravelly loamy sand (2) Extremely cobbly sandy loam (3) Loam
Family particle size	(1) Loamy
Drainage class	Somewhat poorly drained to well drained
Soil depth	152 cm
Surface fragment cover <=3"	0–55%
Surface fragment cover >3"	0–30%
Subsurface fragment volume <=3" (Depth not specified)	15–70%
Subsurface fragment volume >3" (Depth not specified)	5–41%

Ecological dynamics

Scale and stream classification system:
Lotic ecological sites describe portions of valley section with similar reaches, defined by slope, valley width, Strahler stream order, and similar associated fluvial landforms and associated 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 mapunit size ranging from 1.6 to 16 hectare (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 mapunits for a valley section based on slope classes and changes in composition of soil components, which often correspond 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 alluvial valleys in mountains and dissected lava plateaus. Stream gradients are typically 0.5 to 1 percent, but may be up to 2 percent. Valley bottom width ranges from 300 to 1000 feet, with floodplain widths typically between 300 and 800 feet. Bank full channel widths range from 50 to 150 feet, with mean depths between 1 and 3.5 feet. Channel morphology alternates between reaches of moderately entrenched single-thread Rosgen C type channel 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, Floodplain-frequently flooded, Floodplain-rarely flooded, and Stream Terrace. The gravel bar component occurs in the active channel and is associated with poorly developed soils, which are subject to frequent flooding and reworking. The gravel bar component is vegetated by pioneer forbs, of which the majority are invasive, non-native species. The floodplain components occur within the flood zone, and depending upon duration of stability, may have young soils or more developed soils with a thick A horizon from organic matter accumulation. White alder (*Alnus rhombifolia*) and black cottonwood (*Populus balsamifera* ssp. trichocarpa) are the dominant trees, 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. Species dependent on a shallow water table or flooding, such as white alder and black cottonwood, 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. Black hawthorn (*Crataegus douglasii*), ponderosa pine (*Pinus ponderosa*), and common snowberry (*Symphoricarpos albus*) are common. Soils are typically loamy-skeletal

with thick A horizon development, indicating stability for organic matter accumulation.

Disturbance Factors:
This ecological site is developed based on lower Meacham Creek within the boundaries of the Confederated Tribes of the Umatilla Indian Reservation. It may be used in the future for similar areas outside of the CTUIR boundary, so disturbances are discussed in generality, rather than specific locations. After the1855 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 for land allotments drew more Indian and non-Indian settlers. Land use intensified, and cattle and sheep grazing increased (Confederated Tribes of the Umatilla Indian Reservation 2014). Highest stocking rates occurred during 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 heads of cattle (BIA and CTUIR 2007). Today, grazing by cattle and feral horses still occurs in these riparian corridors. In the upper watershed the United States Forest Service logged conifer forests in the early 1900s, but logging has declined in recent years. Past logging practices and unplanned road building has decreased soil stability and caused increased susceptibility to erosion when affected by flooding or fire (Colombaroli and Gavin 2010). In the lower watershed, historic, intensive grazing 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 (U.S. Geological Survey 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, it appears that channel aggradation has increased, and braided channels are in the process of transferring excessive sediment. These sediments can be rapidly incised, because the channel tries to regain equilibrium between sediment supply, stream volume, and velocity. 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 uncommon in these streams today. Beaver dams create ponds, which slow water flow and raise surface flow, which raises water tables and allows 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.

Invasive weeds are a concern for this ecological site. Himalayan blackberry (*Rubus armeniacus*) is common, and can create dense impenetrable thickets, crowding out native species. Invasive forbs such as diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea stoebe*), gypsyflower (*Cynoglossum officinale*), common viper's bugloss (*Echium vulgare*), common St Johnswort (*Hypericum perforatum*), Dalmatian toadflax (*Linaria dalmatica*), sweetclover (*Melilotus officinalis*), catnip (*Nepeta cataria*), curly dock (*Rumex crispus*), moth mullein (Vebascum blatteria), and common mullein (*Verbascum thapsus*) were recorded on this ecological site. Most forbs occur on the gravel bar, but some are on the floodplains and terraces.

Fire was historically an important natural disturbance in these riparian areas and adjacent ponderosa pine forests. Ponderosa pine forests typically have fire regimes dominated by frequent, low-intensity understory burns. Ponderosa pine forests and shrublands are typical on north-facing slopes, and grasslands are typical on the south-facing slopes above the valley floor. Fires initiated on the hillslopes may burn down into the riparian areas due to wind or fuel conditions. A study in the Blue Mountains, south of this ecological site, indicate that historic fire regimes in riparian areas are closely associated with the fire regime of the surrounding upslope vegetation. The mean fire return interval (MFRI) for the riparian plots near Dugout, OR was between 13-14 years, one year longer than the upslope forest. The riparian plots near Baker, OR had a MRFI of 13-36 years, while paired upland plots have 10 to 20 year MFRI (Olson 2000). With fire suppression since the 1900s, the structure, density, and extent of the riparian forest and upland ponderosa pine forest has changed. Documentation is limited on historic riparian forest structure, but with frequent understory burns, a more open herbaceous and grass-dominated understory would be favored. 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 (*Prunus virginiana*), Woods' rose (*Rosa woodsii*), and common snowberry, oceanspray (*Holodiscus discolor*), Saskatoon serviceberry (*Amelanchier alnifolia*), white spirea (Spirea betulifolia), mallow ninebark (*Physocarpus malvaceus*), Lewis' mock orange (*Philadelphus lewisii*), and the non-native Himalayan blackberry (*Rubus armeniacus*). Repeated fire may reduce 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. The present structure of 95% of the riparian forest in the Dugout area is prone to severe crown fires under 90th percentile fire conditions, so fuel reduction is necessary prior to implementing prescribed burns (Olson 2000). The combination of altered hydrologic conditions (lower water tables and less flood activity on floodplains) and fire suppression has allowed succession to continue with ponderosa pine forests becoming dominant on abandoned floodplains and terraces. When the floodplain and terraces become dry and disconnected from flooding events, these areas are more influenced by upland disturbance processes such as fire, lack of fire, and forest pathogens. 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 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 thread 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 erosion potential. The channels on this site support gravel (C4) reaches, which have very high erosion potentials 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 bank full 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, forming 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.

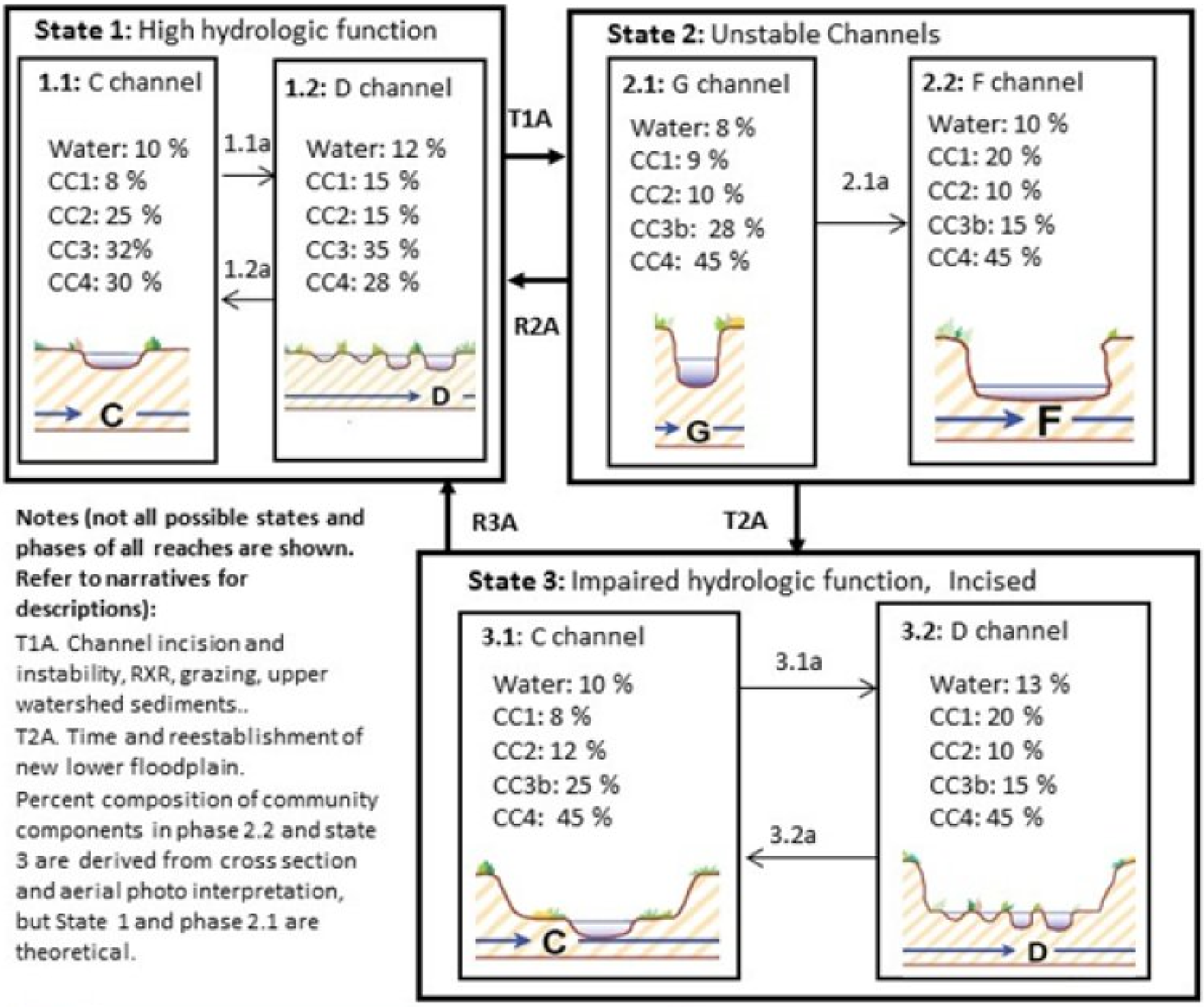
Climate change
Climate records for the Northwest United States show that average annual temperature has increased 1.5 degree F in the last 100 years, and it is predicted to increase by 3 to 10 degrees F in the next century (EPA 2013). Precipitation predictions are less clear, but warmer temperatures 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; for example, 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

Low slope, Alluvial Mountain Valley Riparian Complex

(*Populus balsamifera ssp. trichocarpa*) - (*Alnus rhombifolia*) / (*Symphoricarpos albus*) – (Rosa *woodsii*) / *Elymus glaucus*

Black cottonwood –white alder/ common snowberry – Woods rose/ blue wildrye



I.D.	Plant Association	Fluvial Surface/Landform
1	Pioneer forbs, willows	Gravel bar, frequently flooded
2	White alder, black cottonwood	Floodplain, frequently flooded
3	Black cottonwood, white alder, Woods' rose	Floodplain, occasionally flooded
3b	Black cottonwood, black hawthorn, ponderosa pine	Floodplain, abandoned, rarely flooded
4	Ponderosa pine, common snowberry	Terrace, rare to no flooding

Figure 7. R009XY502OR 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, logging, 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-entrenched C type channel, which can access the floodplain every 2 to 3 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 reduce the cover of ponderosa pine (CC4), and favor more cottonwood development. Community component 1 (CC1), gravel bar, 8% composition: 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 white sagebrush (*Artemisia ludoviciana*), willowherb (Epilobium sp.), knotweed (Polygonum sp.), seep monkeyflower (*Mimulus guttatus*), willow (Salix spp.), white alder, Canadian horseweed (*Conyza canadensis*), and clover (Trifolium sp.). Willow and white alder 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. This community is within the active channel at high flows, becoming exposed gravels and cobbles during low flow. This community is subject to frequent scouring and depositional events, making it difficult for longer lived species to establish. It is dominated by annual and short-lived perennial species, whose seeds are deposited by floods, wind or animals. Willows and white alder may establish in areas with relative stability and absence of grazing. Community component 2 (CC2), floodplains, 25% composition This community occurs on frequently flooded floodplains, typically adjacent to the gravel bar community. In some areas it occurs at the bank full 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. 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 bank full 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 out in the 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 3 meters in order to survive, and can withstand seasonal inundation. After flood events and stem breakage, white alder can resprout or reproduce by layering. White alder develops best on these soils that are coarse textured and have well-aerated subsurface water flow. White alder has nitrogen fixing nodules, which help develop soil nutrients. Their roots develop dense matrixes 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, finer textured, surface horizons. Black cottonwood may be more widely dispersed across the floodplain, as 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 couple of weeks.

Once the seeds become wet they begin to germinate, and need a good substrate in order to survive. Seedling survival is best 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 resprout from buried stems or develop root succors after stem damage. Twigs broken by flood events can resprout if buried in moist sediments with leaves still attached (Steinberg 2001). This is more common in areas with moist summers. Mature cottonwood need to have roots in a perennial water table, but since roots may penetrate to depths of 7 meters they can persist on higher floodplains and terraces (CC3 and CC4). Willow species also produce seeds yearly 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 flex with water flows. If stems are damaged they can resprout from the roots or lower stem. Some species of willow, for example narrowleaf willow (*Salix exigua*), can form dense clonal colonies from sprouting of root shoots. Broken branches and root pieces can resprout if lightly buried in fresh flood deposits (Anderson 2006, Uchytil 1989). This floodplain community has a successional trend as it recovers 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, dominated by pioneer and short-lived forbs. At this time willow, white alder and black cottonwood seedlings also establish. With time, the white alder and 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. Community component 3 (CC3), Floodplain step, 32% composition This community component was historically the active floodplain, but is rare to find in its natural conditions due to stream incision. Today this community is typically situated above the 50 year flood influence, and the water table may drop below 100 centimeters in the summer and fall. Historically, it may have resembled or had low points and side channels with vegetation similar to CC2. Community component 4 (CC4), Stream terrace, 30% composition. This community component occurs on terraces above the active floodplain. Flooding frequency is rare. The water table drops to below 6 feet in the dry season. The vegetation is dominated by a ponderosa pine forest with common snowberry often dominant in the understory. Changes in sediment deposits, log jams or other features that obstruct flow can cause flow to divert across terraces, creating a new channel or temporary side channels. This is less likely to occur in States 2 and 3, where flow is typically contained within the incised channel, requiring a large (50 to 100 year) flood event and ideal topography to allow over flow onto the terrace level. No data was collected for this phase. Refer to State 3 for community component data.

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-Landform, Composition (%) W, Water, Water, Active channel, 12% CC1, Pioneer forbs, white alder, willows, Gravel Bar, 15 % CC2, White alder- black cottonwood, Floodplain- Frequently Flooded, 15 CC3, Black cottonwood-black hawthorn-ponderosa pine, Floodplain- Occasionally flooded, 35% CC4, Ponderosa pine- common snowberry, Terrace- Rare to no flooding, 28 %

Pathway 1.1a
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 1.2a
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 more 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, Active channel, 8 % CC1, Pioneer forbs, white alder, willows, Gravel Bar, 9 % CC2, White alder- black 10 % CC3b, Black hawthorn- ponderosa pine, Floodplain- Occasionally to rarely flooded, 28 % CC4, Ponderosa Pine- common snowberry, Terrace- Rare to no flooding, 35 %

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, Active channel, 10 % CC1, Pioneer forbs, white alder, willows, Gravel Bar, 20 % CC2, White alder- black cottonwood, Floodplain, 10 % CC3b, Black hawthorn- ponderosa pine, Floodplain- occasional to rarely flooded, 15 % CC4, Ponderosa pine- common snowberry, Terrace, 45 %

Pathway 2.1a
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 disconnect from the floodplains. Stream banks are unstable, stream canopy cover is low, and floodplains are endosaturated. This state may have C or D type channel morphology, because the stream transitions from transport to aggradation reaches. Bedrock control is present in some sections, which may cause localized scouring and create deeper pools.

Community 3.1
C Channel

Figure 8. CC1

Figure 9. CC2

Figure 10. CC3

Figure 11. CC4

Figure 12. CC1_soil

Figure 13. CC2_soil

Figure 14. CC3_soil

Figure 15. CC4 soil

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) becomes dominated by upland species, but some relict floodplain species such as black cottonwood may be present. Black cottonwood will decline over time in the absence of flooding, since it needs flooding for dispersal and regeneration of seeds. The terrace community (CC4) remains stable. The species composition and production by community components are described below. Typically, these components have similar species in a C or D channel phase (phases 3.1 or 3.2), but the percent composition of the components changes across the valley bottom. 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 white sagebrush (*Artemisia ludoviciana*), willowherb (Epilobium sp.), knotweed (Polygonum sp.), seep monkeyflower (*Mimulus guttatus*), willow (Salix spp.), white alder, Canadian horseweed (*Conyza canadensis*), and clover (Trifolium sp.). Willow and white alder 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 that dominate this community include: common viper's bugloss (*Echium vulgare*), common mullein (Verbascum thapus), moth mullein (Vebascum blatteria), common St Johnswort (*Hypericum perforatum*), spotted knapweed (*Centaurea stoebe*), diffuse knapweed (*Centaurea diffusa*), Dalmatian toadflax (*Linaria dalmatica*), prickly lettuce (*Lactuca serriola*), and sweetclover (*Melilotus officinalis*). This community is within the active channel at high flows, becoming exposed gravels and cobbles during low flow. It is subject to frequent scouring and depositional events, making it difficult for longer-lived species to establish. It is dominated by annual and short-lived perennial species, whose seeds are deposited by floods, wind, or animals. Willows and white alder may establish in areas with relative stability and absence of grazing. Annual Production (air-dry lbs/ac) Plant Type Low RV High Grass/Grasslike 0 12 24 Forbs 0 75 150 Shrubs/Vines 0 42 60 Trees 0 1 5 Totals 0 130 239 This community occurs on frequently-flooded floodplains, typically adjacent to the gravel bar community. In some areas it occurs at the bank full 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. 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 bank full 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 matrixes 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, 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 good substrate in order to survive. Seedling survival is best 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 cottonwood need to have roots in a perennial water table, but since 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 flex with water flows. If stems are damaged, they can re-sprout from the roots or 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 it recovers 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 and short-lived forbs. At this time, willow, white alder, and black cottonwood seedlings also establish. With time, white alder and 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. Non-native species (listed in CC1) are more prominent in the early seral stages, with open canopies and poorly developed soils. With increased canopy shading, many invasive species decline. However, Himalayan blackberry can form impenetrable thickets in the understory, which outcompete native species. Grasses are typically scattered, with blue wildrye (*Elymus glaucus*) dominating. Geyer's sedge (*Carex geyeri*) and bentgrass (Agrostis sp.) may be present. Reed canarygrass (*Phalaris arundinacea*) was abundant at one location. Native forbs include stinging nettle (*Urtica dioica*), field horsetail (*Equisetum arvense*), common ladyfern (*Athyrium filix-femina*), western white clematis (*Clematis ligusticifolia*), and woodland strawberry (*Fragaria vesca*). Annual Production (air-dry lbs/ac) Plant Type Low RV High Grass/Grasslike 1 20 28 Forbs 5 45 75 Shrubs/Vines 20 75 111 Trees 300 500 1200 Totals 326 640 1414 This community component (CC3) was historically the active floodplain. Today it (CC3b) is typically situated 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 overmature and decadent, and seedling regeneration is absent, due to 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. Ponderosa pine establishes in the absence of disturbance, such as large floods or canopy fire, and this community begins to resemble the upper terrace community (CC4). Ponderosa pine cover ranges from 3 to 25 percent, and black cottonwood cover ranges from 15 to 30 percent. These species tend to co-dominant the canopy, but over time ponderosa pine will shade out cottonwood. The understory varies, depending upon land use and management history. Common snowberry and black hawthorn are typically dominant, with other shrubs such as oceanspray, Saskatoon serviceberry, white spirea, western chokecherry, mallow ninebark, Lewis' mock orange, whitebark raspberry (*Rubus leucodermis*), cascara buckthorn (*Frangula purshiana*), and the non-native Himalayan blackberry. There were few grasses in our plot for this community component, but grasses become more dominant in cleared areas or under ponderosa pine canopy. Blue wildrye is the dominant grass in similar areas. Forbs include stinging nettle, violet (Viola sp.), bedstraw (Galium sp.), hollyfern (Polystichum sp.), common ladyfern (Athyrium felix-femina), Virginia strawberry (Frageria virginiana), and the non-native gypsyflower and catnip. Annual Production (air-dry lbs/ac) Plant Type Low RV High Grass/Grasslike 0 1 1 Forbs 25 75 116 Shrubs/Vines 235 525 990 Trees 5 15 30 Totals 265 616 1137 This community component occurs on terraces above the active floodplain. Flooding frequency is rare to none. The water table is typically below six feet. The vegetation is dominated by ponderosa pine in the forest overstory with common snowberry in the understory. This component may border the active channel where stream bank erosion has cut back into the terrace. Vertical cut banks of four to six feet are common on outer meander bends. Changes in sediment deposits, log jams, or other features that obstruct flow can cause flow to divert across terraces, creating a new channel or temporary side channels. This is less likely to occur in States 2 and 3, where flow is typically contained within the incised channel. A large (50 to 100 year) flood event and ideal topography would be required to allow over flow onto the terrace level. Ponderosa pine is one to two tiered, with 30 to 60 percent cover in the upper canopy. There may be one to ten percent cover in the mid story, and one to two percent cover of younger regeneration. Black cottonwood is occasionally present. At higher elevations or on shaded north-facing canyons, Douglas-fir (Pseudotsuga menzesii) and grand fir (*Abies grandis*) are present with low cover. Common snowberry is the dominant shrub, with oceanspray and black hawthorn common. Rocky Mountain maple (*Acer glabrum*), chokecherry, and Woods' rose may be present with low cover. Grasses may be abundant, with blue wildrye dominant. Other native grasses and grass-likes include: needlegrass (Achnatherum sp.), brome (Bromus sp.), bentgrass (Agrostis sp.), bluegrass (Poa sp.), and largespike sedge (Carex marcostachys). Non-native grasses include: poverty brome (*Bromus sterilis*), Kentucky bluegrass (*Poa pratensis*), tall oatgrass (*Arrhenatherum elatius*), cheatgrass (*Bromus tectorum*), and orchardgrass (*Dactylis glomerata*). Annual Production by Plant Type Table Annual Production (air-dry lbs/ac) 1/ Plant Type Low RV High

Grass/Grasslike 3 35 87 Forbs 10 45 57 Shrubs/Vines 135 190 234 Trees 5 25 50 Totals 153 295 428

Community 3.2
D 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 as it is spread across the wide channel. The flow is insufficient to transport the larger gravels and cobbles. 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, Active channel, 13 % CC1, Pioneer forbs, white alder, willows, Gravel Bar, 20 % CC2, White alder- black cottonwood, Floodplain-Frequently flooded, 10 % CC3b, Black hawthorn- ponderosa pine, Floodplain- Occasional to rarely flooded, 15 % CC4, Ponderosa pine- common snowberry, Terrace, 45

Pathway 3.1a
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 3.2a
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, unstable state develops. Stream gradient and velocity increases, and G or F type channel phases develop.

Restoration pathway R2A
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 raise the channel bed, increase meander, or remove floodplain restrictions. 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. Reintroduction of beavers 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 (Confederated Tribes of the Umatilla Indian Reservation 2014, Lambert 2014).

Transition T2A
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 pool- riffle 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.

Additional community tables

Table 5. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Gravel bar**			0–67	
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	0–56	0–1
	narrowleaf willow	SAEX	*Salix exigua*	0–6	0–1
	willow	SALIX	*Salix*	0–6	0–1
2	**Floodplain**			22–124	
	Woods' rose	ROWO	*Rosa woodsii*	1–45	1–4
	black hawthorn	CRDO2	*Crataegus douglasii*	0–26	0–1
	mallow ninebark	PHMA5	*Physocarpus malvaceus*	0–11	0–2
	Lewis' mock orange	PHLE4	*Philadelphus lewisii*	0–9	0–1
	redosier dogwood	COSE16	*Cornus sericea*	0–9	0–1
	common snowberry	SYAL	*Symphoricarpos albus*	0–6	0–3
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	0–6	0–1
	cutleaf blackberry	RULA	*Rubus laciniatus*	0–6	0–1
	Rocky Mountain maple	ACGL	*Acer glabrum*	0–6	0–1
3	**Floodplain step**			39–367	
	common snowberry	SYAL	*Symphoricarpos albus*	17–168	3–80
	black hawthorn	CRDO2	*Crataegus douglasii*	17–73	1–3
	Woods' rose	ROWO	*Rosa woodsii*	6–50	1–5
	oceanspray	HODI	*Holodiscus discolor*	0–11	0–2
	Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	0–11	0–2
	Lewis' mock orange	PHLE4	*Philadelphus lewisii*	0–9	0–1
	Cascara buckthorn	FRPU7	*Frangula purshiana*	0–9	0–1
	mallow ninebark	PHMA5	*Physocarpus malvaceus*	0–9	0–1
	chokecherry	PRVI	*Prunus virginiana*	0–9	0–1
	white spirea	SPBE2	*Spiraea betulifolia*	0–6	0–2
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	0–6	0–1
	whitebark raspberry	RULE	*Rubus leucodermis*	0–6	0–1
4	**Terrace**			39–262	
	common snowberry	SYAL	*Symphoricarpos albus*	17–106	5–30
	black hawthorn	CRDO2	*Crataegus douglasii*	17–73	1–3
	oceanspray	HODI	*Holodiscus discolor*	6–39	1–5

	Lewis' mock orange	PHLE4	*Philadelphus lewisii*	0–9	0–1
	chokecherry	PRVI	*Prunus virginiana*	0–9	0–1
	blue elderberry	SANIC5	*Sambucus nigra ssp. cerulea*	0–9	0–1
	Rocky Mountain maple	ACGL	*Acer glabrum*	0–6	0–1
	Woods' rose	ROWO	*Rosa woodsii*	0–6	0–1
	Himalayan blackberry	RUAR9	*Rubus armeniacus*	0–6	0–1
Grass/Grasslike					
1	**Gravel bar**			0–27	
	Grass, perennial	2GP	*Grass, perennial*	0–13	0–1
	blue wildrye	ELGL	*Elymus glaucus*	0–6	0–2
	quackgrass	ELRE4	*Elymus repens*	0–1	0–1
	fescue	FESTU	*Festuca*	0–1	0–1
	bulbous bluegrass	POBU	*Poa bulbosa*	0–1	0–1
	Sandberg bluegrass	POSE	*Poa secunda*	0–1	0–1
	bentgrass	AGROS2	*Agrostis*	0–1	0–1
	poverty brome	BRST2	*Bromus sterilis*	0–1	0–1
	sedge	CAREX	*Carex*	0–1	0–1
2	**Floodplain**			1–31	
	reed canarygrass	PHAR3	*Phalaris arundinacea*	0–135	0–30
	bentgrass	AGROS2	*Agrostis*	0–11	0–5
	blue wildrye	ELGL	*Elymus glaucus*	0–2	0–1
	Geyer's sedge	CAGE2	*Carex geyeri*	0–1	0–1
3	**Floodplain step**			0–1	
	bentgrass	AGROS2	*Agrostis*	0–1	0–1
4	**Terrace**			3–98	
	poverty brome	BRST2	*Bromus sterilis*	0–28	0–8
	blue wildrye	ELGL	*Elymus glaucus*	3–26	1–8
	needlegrass	ACHNA	*Achnatherum*	0–11	0–5
	bentgrass	AGROS2	*Agrostis*	0–9	0–3
	Kentucky bluegrass	POPR	*Poa pratensis*	0–9	0–3
	tall oatgrass	AREL3	*Arrhenatherum elatius*	0–9	0–2
	brome	BROMU	*Bromus*	0–1	0–1
	bluegrass	POA	*Poa*	0–1	0–1
	cheatgrass	BRTE	*Bromus tectorum*	0–1	0–1
	largespike sedge	CAMA51	*Carex macrostachys*	0–1	0–1
	orchardgrass	DAGL	*Dactylis glomerata*	0–1	0–1
Forb					
1	**Gravel bar**			0–168	
	Forb, perennial	2FP	*Forb, perennial*	0–84	0–1
	common viper's bugloss	ECVU	*Echium vulgare*	0–22	0–15
	common St. Johnswort	HYPE	*Hypericum perforatum*	0–17	0–5
	common mullein	VETH	*Verbascum thapsus*	0–11	0–8
	moth mullein	VEBL	*Verbascum blattaria*	0–9	0–8

	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–6	0–2
	sweetclover	MEOF	*Melilotus officinalis*	0–6	0–2
	diffuse knapweed	CEDI3	*Centaurea diffusa*	0–2	0–2
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–2	0–1
	spotted knapweed	CEST8	*Centaurea stoebe*	0–1	0–1
	sandmat	CHAMA15	*Chamaesyce*	0–1	0–1
	Canadian horseweed	COCA5	*Conyza canadensis*	0–1	0–1
	seep monkeyflower	MIGU	*Mimulus guttatus*	0–1	0–1
	catnip	NECA2	*Nepeta cataria*	0–1	0–1
	plantain	PLANT	*Plantago*	0–1	0–1
	knotweed	POLYG4	*Polygonum*	0–1	0–1
	sulphur cinquefoil	PORE5	*Potentilla recta*	0–1	0–1
	curly dock	RUCR	*Rumex crispus*	0–1	0–1
	clover	TRIFO	*Trifolium*	0–1	0–1
	willowherb	EPILO	*Epilobium*	0–1	0–1
	prickly lettuce	LASE	*Lactuca serriola*	0–1	0–1
	Dalmatian toadflax	LIDA	*Linaria dalmatica*	0–1	0–1
2	**Floodplain**			6–84	
	sweetclover	MEOF	*Melilotus officinalis*	0–28	0–10
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–22	0–8
	stinging nettle	URDI	*Urtica dioica*	0–11	0–5
	gypsyflower	CYOF	*Cynoglossum officinale*	0–6	0–3
	field horsetail	EQAR	*Equisetum arvense*	0–6	0–2
	woodland strawberry	FRVE	*Fragaria vesca*	0–1	0–1
	common St. Johnswort	HYPE	*Hypericum perforatum*	0–1	0–1
	common viper's bugloss	ECVU	*Echium vulgare*	0–1	0–1
	common ladyfern	ATFI	*Athyrium filix-femina*	0–1	0–1
	chicory	CIIN	*Cichorium intybus*	0–1	0–1
	leather flower	CLEMA	*Clematis*	0–1	0–1
	vetch	VICIA	*Vicia*	0–1	0–1
	catnip	NECA2	*Nepeta cataria*	0–1	0–1
	curly dock	RUCR	*Rumex crispus*	0–1	0–1
3	**Floodplain step**			28–130	
	violet	VIOLA	*Viola*	0–90	0–3
	stinging nettle	URDI	*Urtica dioica*	0–34	0–2
	common ladyfern	ATFI	*Athyrium filix-femina*	0–1	0–1
	gypsyflower	CYOF	*Cynoglossum officinale*	0–1	0–1
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–1	0–1
	bedstraw	GALIU	*Galium*	0–1	0–1
	catnip	NECA2	*Nepeta cataria*	0–1	0–1
	hollyfern	POLYS	*Polystichum*	0–1	0–1
4	**Terrace**			0–64	
	Queen Anne's lace	DACA6	*Daucus carota*	0–28	0–10
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	Forb, annual	2FA	*Forb, annual*	0–22	0–20
	gypsyflower	CYOF	*Cynoglossum officinale*	0–1	0–1
	Fuller's teasel	DIFU2	*Dipsacus fullonum*	0–1	0–1
	common viper's bugloss	ECVU	*Echium vulgare*	0–1	0–1
	desertparsley	LOMAT	*Lomatium*	0–1	0–1
	trefoil	LOTUS	*Lotus*	0–1	0–1
	sweetclover	MEOF	*Melilotus officinalis*	0–1	0–1
	sulphur cinquefoil	PORE5	*Potentilla recta*	0–1	0–1
	curly dock	RUCR	*Rumex crispus*	0–1	0–1
	longstalk starwort	STLO2	*Stellaria longipes*	0–1	0–1
	yellow salsify	TRDU	*Tragopogon dubius*	0–1	0–1
	stinging nettle	URDI	*Urtica dioica*	0–1	0–1
	vetch	VICIA	*Vicia*	0–1	0–1
Tree					
2	**Floodplain**			336–1345	
	white alder	ALRH2	*Alnus rhombifolia*	336–1121	20–80
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–224	0–10
3	**Floodplain step**			6–39	
	ponderosa pine	PIPO	*Pinus ponderosa*	6–34	5–25
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–6	0–1
4	**Terrace**			6–56	
	ponderosa pine	PIPO	*Pinus ponderosa*	6–50	30–60
	black cottonwood	POBAT	*Populus balsamifera ssp. trichocarpa*	0–6	0–1
	Douglas-fir	PSME	*Pseudotsuga menziesii*	0–6	0–1
	grand fir	ABGR	*Abies grandis*	0–6	0–1

Animal community

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

Birds and mammals eat the needles, cones, twigs, pollen, and seeds of ponderosa pine. Insects and fungi associated with ponderosa pine also provide food (Habeck 1992). Young ponderosa pines provide ground cover for mammals and birds. Mid-sized trees create shelter in thickets for larger mammals. Large ponderosa pines create habitat for arboreal species, and down logs and snags provide habitat for cavity dwellers (Habeck 1992).

Fish community:
Anadromous species such as Coho salmon (Oncorhynchus kisutch), steelhead (Oncorhynchus mykiss), and Pacific lamprey (Entosphenus tridentatus) access this ecological site (CTUIR 2014). The Coho salmon and steelhead are listed as federally threatened species in this region. The Pacific lamprey is a species of concern. These species spawn and live in the stream during their juvenile stages, migrate to the ocean, return to spawn, and die after spawning. These species prefer cool streams with gravel substrate for spawning. They need high water quality and high levels of dissolved oxygen for spawning. Fine sand, silt, clay, and organic matter can clog pores in the gravel, reducing dissolved oxygen content. Water temperatures greater than 16 degrees C can cause high mortality.

Steelhead prefer to spawn at the head or tail of riffles, with stream velocities between 0.6 to 1.5 m/s (Fulton 2004).

Resident fish include the long-nose dace (Rhinichthys cataractae), speckled dace (Rhinichthys osculus), and skulpin (Personal communication CTUIR 2015). Dace are freshwater minnows, which feed on aquatic insects. They are bottom feeders, and prefer riffles with fast moving water, and with overhead canopy cover.

Macroinvertebrates are diverse and abundant, with 87 species identified in Meacham Creek (Wooster and DeBano 2011). Stoneflies (Plecotera sp.), caddisflies (Trichoptera sp.), mayflies (Ephemerella sp.), water penny (Psephenidae sp.) and riffle beetle (Stenelmis sp.), indicators of good water quality (Natural Resources Conservation Service 2011, Draft 4), were abundant. Species moderately-tolerant of poor water quality and pollution such as crane flies, crayfish, scuds, and sowbugs were also abundant.

Recreational uses

This area is used for hiking, swimming, and hunting.

Wood products

Ponderosa pine produces valuable lumber that can be used for molding, mill work, cabinets, doors, and windows. Lower grade wood is used for dimensional lumber (Habeck 1992).

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 (Steinberg 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 and 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 4 (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:
ME_1_N
ME_2_N
ME_3_N
ME_CC1_018_N (2015OR059018)
ME_XS1_CC1
ME_XS1_CC2_500 (2014OR059500)
ME_XS1_CC3_503 (2014OR059503)
ME_XS1b_N
ME_XS3_CC1
ME_XS3_CC2
ME_XS3_CC2b_013 (2015OR059013)
ME_XS3_CC4_012 (2015OR059012)
ME_XS4_CC4_019 (2015OR059019)
ME_XS4_CC4b_020N (2015059020)

Stream cross-sections
ME_XS1
ME_XS1b
ME_XS2
ME_XS3

Type locality

Location 1: Umatilla County, OR	
UTM zone	N
UTM northing	5061043
UTM easting	394735
General legal description	The type location is on Meacham Creek, OR approx. 0.75 miles upstream from confluence with the Umatilla River.

Other references

Anderson, K. (2006). Tending the Wild. Berkeley, CA, University of California Press.

Anderson, M. (2006). "*Salix exigua* In: Fire Effects Information System." 2015, from http://www.fs.fed.us/database/feis/plants/shrub/salexi/all.html.

BIA and CTUIR (2007). Environmental Assessment Draft. A program to manage rangeland and pasture resouce on the Umatilla Indian Reservation, Umatilla County, Oregon. Pendleton, OR, US. Department of the Interior.

Chang, H. and J. Jones (2010). Climate change and freshwater resources in Oregon. Chapter 3, Oregon Climate Assessment Report. K. D. Dello and P. W. Mot. , Corvallis, OR, Oregon Climate Change Research Institute.

Chatfield, K. (1997). Medicine from the Mountains, Medicinal Plants of the Sierra Nevada
South Lake Tahoe, CA, Range of Light Publications.

Colombaroli, D. and D. G. Gavin (2010). "Highly episodic fire and erosion regime over the past 2,000 y in the Siskiyou Mountains, Oregon." Proceedings of the National Academy of Sciences(DOI: 10.1073/pnas.1007692107).

Confederated Tribes of the Umatilla Indian Reservation (2014). Meacham Creek river mile 6.0 to 8.5 floodplain restoration and in-stream enhancement project and completion report. Bothell, Washington, Tetra Tech, Inc.

Fryer, J. L. (2014). "*Alnus rhombifolia*. In: Fire Effects Information System." from http://www.fs.fed.us/database/feis/plants/tree/alnrho/all.html.

Fulton, A. (2004). A review of the characteristics, habitat requirements, and ecology of the anadromous steelhead trout (Oncorhynchus mykiss) in the Skeena Basin. , UC Davis.

Habeck, R. J. (1992). "*Pinus ponderosa* var. ponderosa In: Fire Effects Information System." 2015, from http://www.fs.fed.us/database/feis/plants/tree/pinponp/all.html.

Harrison, J. (2009). "Beavers." Retrieved March 18th, 2015, from nwcouncil.org/history/Beavers.

Jeffrey P. Repp, et al. (2011). Lotic riparian complex ecological site descriptions guidelines for development. P. West National Technology Support Center, Oregon: 123.

Lambert, M. B. (2014). The Umatilla Anadromous Fish Habitat Project: 2012 Annual Report, Confederated Tribes of the Umatilla Indian Reservation.

Leopold, L. and G. Wolman (1957). River channel patterns: Braided, meandering and straight. Physiographic and hydraulic studies of rivers., US. Geological Survey, US Department of the Interior.

Montgomery, D. R. and J. M. Buffington (1993). Channel classification, prediction of channel response, and assessment of channel condition. Seattle, WA 98195, University of Washington: 110.

Moore, M. (1993). Medicinal Plants of the Pacific West. Santa Fe, New Mexico Red Crane Books.

Natural Resources Conservation Service (2011, Draft 4). Lotic riparian complex ecological site descriptions. Guidelines for Development. Portland, OR, West National Technology Support Center, US Department of Agriculture.

Olson, D. (2000). Fire in riparian zones: a comparison of historical fire occurrence in riparian and upslope forests in the Blue Mountains and southern Cascades of Oregon. Seattle, WA, College of Forest Resources, University of Washington. Master of Science: 274.

Pollock, M., et al. "Working with beaver to restore salmon habitat." Retrieved March 18th, 2015, from http://www.nwfsc.noaa.gov/research/divisions/fe/wpg/beaver-assist-stld.cfm.

Pollock, M. M., et al. (2007). "Geomorphic changes upstream of beaver dams in Bridge Creek, an incised stream channel in the interior Columbia River basin, eastern Oregon." Earth Surface Processes and Landforms, Wiley Interscience 32: 1174-1185.

Rosgen, D. L. (1994). "A classification of natural rivers." 22.

Rosgen, D. L. (1996). Applied river morphology. Pagosa Springs, Colo., Wildland Hydrology.

Rosgen, D. L. (2006). Watershed assessment of river stability and sediment supply (WARSSS). Fort Collins, Colo., Wildland Hydrology.

Soil Survey Division Staff (1993). Soil survey manual, Soil Conservation Service, USDA.

Steinberg, P. D. (2001). "*Populus balsamifera* subsp. trichocarpa. In: Fire Effects Information System." 2015, from http://www.fs.fed.us/database/feis/plants/tree/alnrho/all.html.

U.S. Environmental Protection Agency (2013). "Climate impacts in the Pacific Northwest." from http://www.epa.gov/climatechange/impacts-adaptation/northwest.html.

U.S. Geological Survey (2015). Water data for USA: USGS Surface-Water Annual Statistics . Meacham.

Uchytil, R. J. (1989). "Salix lasiolepis. In: Fire Effects Information System." 2015, from http://www.fs.fed.us/database/feis/plants/tree/sallas/all.html.

Wooster, D. and S. DeBano (2011). Assessment of aquatic invertebrates in Meacham Creek. Bio-assessment of restoration project river mile 6-7. Technical memorandum, Hermiston Agricultural Research & Extension Center, Oregon State University.

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:**

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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:**