

Appendix 6

Plant Communities Of The Newaukum River Basin

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PLANT COMMUNITIES OF THE NEWAUKUM RIVER BASIN

INTENT

These plant community fact sheets are designed to provide local landowners, conservation districts, counties, municipalities, and tribes, as well as the broader restorative flood protection design team with a more-technical understanding of the role that vegetation plays in restorative flood protection. The dense woody structure of many Pacific Northwest trees and shrubs are particularly good at slowing flood water and reducing the negative effects of fast moving floods. This aquatic-interference is often called 'roughness' or 'hydraulic roughness' by hydrologists and river engineers. Restoring healthy scrub-shrub and forest communities along the river and on the floodplain is critical for slowing, and storing floodwaters, reducing the risk of catastrophic flood damage.

PLANT COMMUNITIES OF THE NEWAUKUM RIVER BASIN

Restoring Floodplains for Flood Protection

FIVE RIPARIAN AND FLOODPLAIN PLANT COMMUNITY TYPES

The plant communities of the riparian corridor and the adjacent floodplain may be classified into five (5) main types:

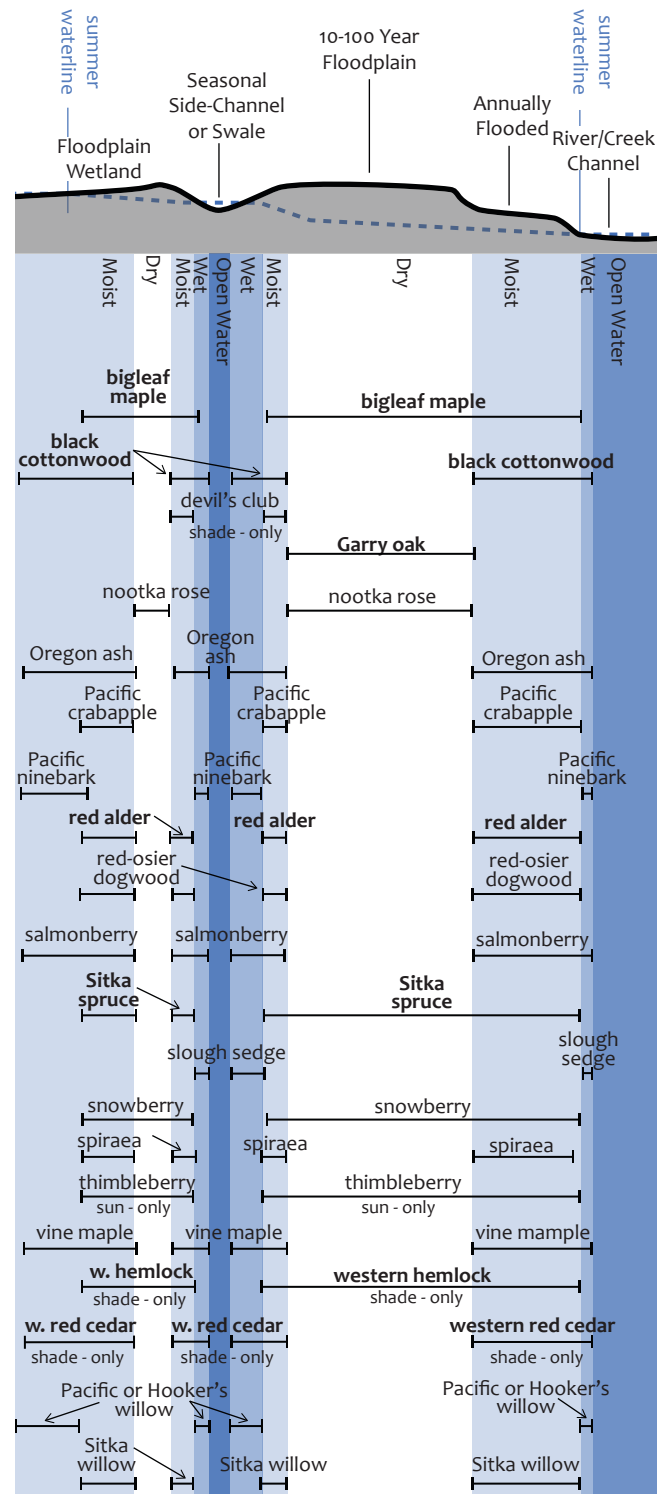
1. **Scrub-shrub** ≥ 30% woody vegetation < 18 ft. (6 m)
2. **Deciduous Forest** ≥ 30% deciduous woody vegetation > 18 ft. (6 m) high
3. **Mixed Forest** ≥ 30% deciduous and ≥ 30% coniferous woody vegetation > 18 ft. (6 m) high
4. **Coniferous Forest** ≥ 30% woody vegetation > 18 ft. (6 m) high
5. **Emergent** ≥ 30% herbaceous vegetation

As defined by the US Fish and Wildlife Service (USFWS), classifications are applied to the tallest plants that comprise 30% or more of the canopy cover. Because woody shrubs provide a significant amount of hydraulic roughness to slow and store floodwaters on floodplains these fact sheets focus on scrub-shrub, deciduous forest, and coniferous forest plant communities with shrubby understories.

SPECIES COMPOSITION (PLANT ASSOCIATIONS)

The species composition of these five plant community types vary from place to place depending on local geology, hydrology, and climate. Plants self-assemble into groups that adapt to particular landscape conditions, ranging from dry and rocky, to wet and mucky, and with different levels of flood tolerance. Decades of research has gone into the United States National Vegetation Classification system (2016), which provides detailed regional information on groundcover, shrub, and tree species typically found together under various ranges of landscape and climatic conditions. Plant species and their associations were selected from the USNVCs database for their current or likely presence on the Newaukum River floodplain and river banks under existing and proposed restored conditions. A list of likely dominant species and their relationship to soil moisture conditions is provided to the right. A detailed list of plant communities existing in the Newaukum River Basin, including those with an herbaceous understory, are provided on the back of this page.

PREFERRED SOIL-MOISTURE CONDITIONS FOR DOMINANT PLANT SPECIES OF THE NEWAUKUM RIVER BASIN



PLANT COMMUNITITES OF THE NEWAUKUM RIVER BASIN

Restoring Floodplains for Flood Protection

PLANT COMMUNITIES OF THE NEWAUKUM

1. Communities with Rough Woody Understory

SCRUB-SHRUB

pg. 3-5

Nootka Rose Thicket
Pacific Crab Apple Thicket
Pacific Crab Apple Thicket w/ Slough Sedge
Pacific Ninebark Thicket
Red Osier Dogwood - Willow - Spirea Thicket
Spirea Thicket
Stink Currant - Salmonberry Thicket
Hooker's Willow - Spirea Thicket
Willow - Spirea Thicket
Hooker's Willow - Crab Apple Thicket
Multi-species Willow Thicket
Hooker's Willow Thicket w/ Sitka Willow
Pacific Willow / River Willow Thicket
Sitka Willow Thicket
Sitka Willow Thicket w/ Horsetails
Pacific Willow Thicket w/ Nettles

DECIDUOUS FOREST

pg. 6-8

Bigleaf Maple Forest w/ Salmonberry
Black Cottonwood - Bigleaf Maple Forest w/ Snowberry
Black Cottonwood - Red Alder Forest w/ Snowberry
Black Cottonwood - Red Alder Forest w/ Salmonberry
Black Cottonwood Forest w/ Red-osier Dogwood & Slough Sedge
Oak Forest w/ Snowberry
Oregon Ash - Cottonwood Forest w/ Red-osier Dogwood & Nettles
Oregon Ash - Cottonwood Forest w/ Vine Maple
Oregon Ash - Cottonwood Forest w/ Hazelut & Pacific Ninebark
Oregon Ash - Cottonwood Forest w/ Salmonberry
Oregon Ash - Cottonwood Forest w/ Snowberery
Oregon Ash Forest
Oregon Ash Forest w/ Snowberry
Oregon Ash Forest w/ Red-osier Dogwood
Oregon Ash Forest w/ Spirea
Red Alder Forest w/ Vine Maple
Red Alder Forest w/ Thimbleberry
Red Alder Forest w/ Salmonberry

MIXED FOREST - N/A

CONIFEROUS FOREST

pg. 9-11

Sitka Spruce - Western Hemlock Forest w/ Devil's Club & Sword Fern
Sitka Spruce Forest w/ Salmonberry
Western Hemlock Forest w/ Devil's Club and Sword Fern
Western Redcedar Forest w/ Salmonberry and Oxalis

EMERGENT - N/A

2. Communities with Smooth Herbaceous Understory

Communities in grey have been omitted from RFP plant community fact sheets, but are ecologically relevant.

SCRUB-SHRUB - N/A

DECIDUOUS FOREST

Bigleaf Maple Forest w/ Oxalis
Bigleaf Maple Forest w/ Trailing Blackberry
Bigleaf Maple Forest w/ Swordfern and Youth-on-age
Black Cottonwood - Bigleaf Maple Forest w/ Horsetails
Black Cottonwood - Red Alder Forest
Oregon Ash Forest w/ Slough Sedge

Oregon Ash Forest w/ Nettles
Red Alder Forest w/ Lady Fern and Skunk Cabbage
Red Alder Forest w/ Wild Rye
Red Alder Forest w/ Mannagrass
Red Alder Forest w/ Cooley Hedgenettle and Youth-on-age
Red Alder Forest w/ Skunk-cabbage

MIXED FOREST

Cottonwood - Sitka Spruce Forest w/ Oxalis
Sitka Spruce - Red Alder Forest w/ Skunk-cabbage

CONIFEROUS FOREST

Sitka Spruce Forest w/ Slough Sedge and Skunk-cabbage
Sitka Spruce Forest w/ Small-fruited Bulrush
Western Hemlock - Douglas Fir Forest w/ Sword Fern and Lady Fern
Western Redcedar - Western Hemlock Forest w/ Skunk-cabbage

EMERGENT

Hard-stemmed Bulrush Marsh
Cattail Marsh
Slough Sedge Marsh
Beaked Sedge and Sitka Sedge Marsh
Sitka Sedge Marsh
Sitka Sedge and Marsh Cinquefoil Marsh
Reed Canarygrass Marsh

SCRUB-SHRUB COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL SCRUB-SHRUB PLANT COMMUNITIES

A plant list comprised of the individual species introduced here, along with additional non-dominant species typically present in these communities with less percent cover, can be found on page 5.

A. Nootka Rose Thicket

Rosa nutkana / *Deschampsia caespitosa*

B. Pacific Crab Apple Thicket

Malus fusca or *Malus fusca* / *Boykinia major* / *Carex obnupta*

C. Pacific Ninebark Thicket

Physocarpus capitatus

D. Red Osier Dogwood - Willow - Spirea Thicket

Cornus sericea - *Salix* spp. - *Spiraea douglasii*

E. Spirea Thicket

Spiraea douglasii

F. Stink Currant - Salmonberry Thicket

Ribes bracteosum - *Rubus spectabilis*

G. Willow Thicket

Salix (*hookeriana*, *lucida* ssp. *Lasiandra*, *sitchensis*)

Salix spp. - *Spiraea douglasii* / *Carex* (*aquatilis* var. *Dives*, *obnupta*, *utriculata*)

Salix hookeriana - (*Malus fusca*) / *Carex obnupta* - *Lysichiton americanus*

Salix hookeriana - (*Salix sitchensis*)

Salix lucida ssp. *Lasiandra* / *Salix fluviatilis*

Salix sitchensis / *Equisetum arvense* - *Petasites frigidus*

Salix lucida ssp. *Lasiandra* / *Urtica dioica* ssp. *Gracilis*

HYDRAULIC ROUGHNESS

On floodplains...

... fallen logs, swales, and shrubs provide the most surface-roughness³:

Shrubs (n=0.14-0.30)

- western skunk cabbage - avg. ht. 1-5 ft
- water parsley - avg. ht. 12-18"
- Nootka rose - avg. ht. 2-10 ft
- tufted hairgrass - avg. ht. 2-3 ft
- large boykinia - avg. ht. 3 ft
- slough sedge - up to 4 ft
- Pacific ninebark - up to 13 ft
- red-osier dogwood - avg. ht. 4 ft
- dune willow - up to 27 ft
- Pacific willow - shrub or tree up to 50 ft tall

- Sitka willow - up to 40 ft tall
- northwest sandbar willow - up to 16 ft
- Douglas' spirea - up to 6 ft
- devil's club - up to 5 ft
- stink currant - up to 10 ft
- salmonberry - avg. ht. 6 ft
- common horsetail - up to 3 ft
- American stinging nettle - avg. ht. 3-7 ft

Trees (n=0.07)

* Tree species listed to the right.

Aggregated Landscape Roughness
n = 0.14 - 0.30

In channels...

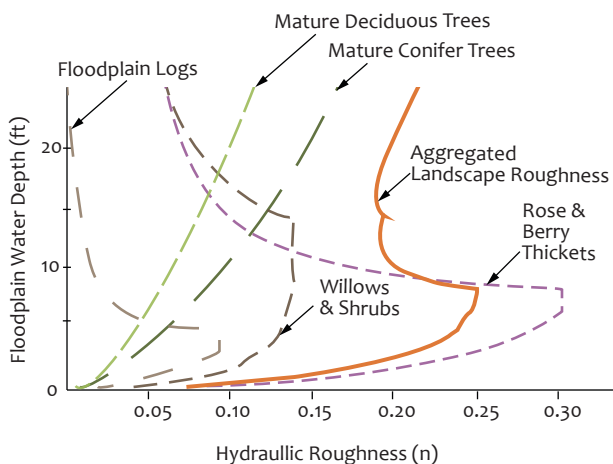
... small logs contribute to hydraulic roughness when combined with larger logs to form log jams. The dominant log types found in channels near scrub-shrub communities include:

- Gray alder - avg. ht 50-65 ft
- Sitka alder - usually shrub-like, up to 30 ft tall
- Pacific crab apple - 20-30 ft tall, 8-10" dia.

See deciduous and coniferous forest pages for max log jam n value.

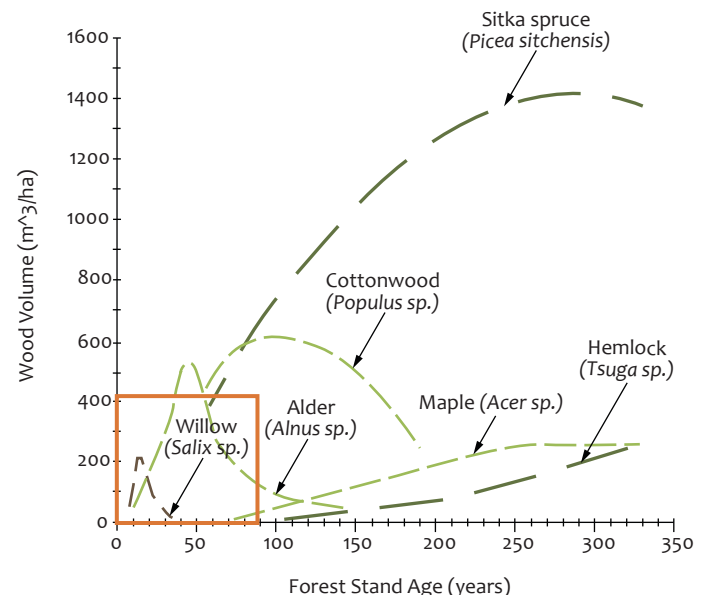
Modeled Hydraulic Roughness (n)

... of Mature Deciduous Forested Floodplain. Results from Roughness of Vegetation in Rivers (ROVER) model of mature riparian and floodplain forest. (modified from graph in Abbe et al., 2016)



Wood Volume (m³/ha) over Time (years)

* Natural time scale is accelerated by decades with adaptive management. (modified from Van Pelt et al. 2006)

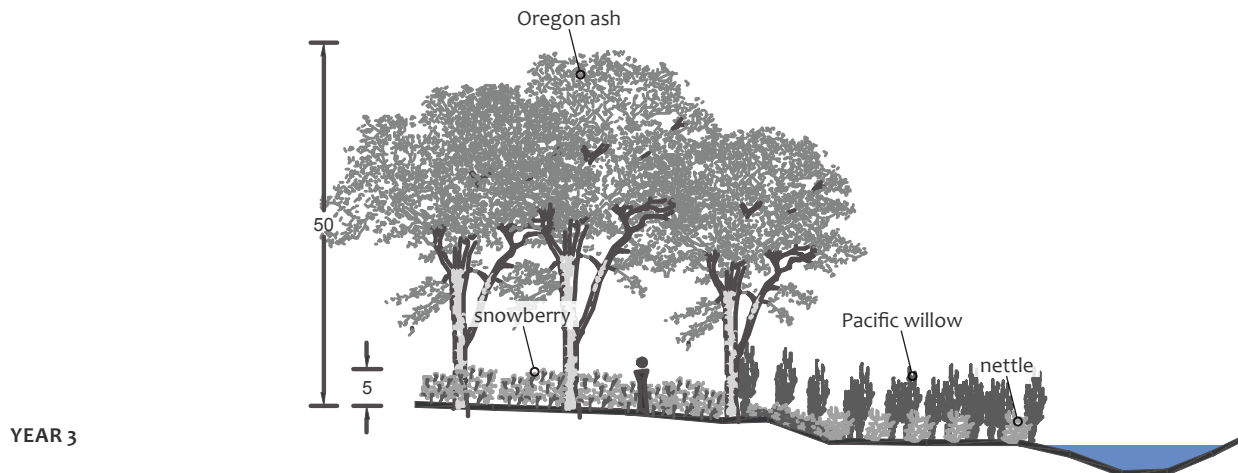


SCRUB-SHRUB COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL CROSS-SECTIONS

(Pacific willow - stinging nettle example)



YEAR 3

A young scrub-shrub plant community grows on the marshy banks of a stream near a deciduous forest (typically Oregon ash forest for this community) - see pg. 7 for deciduous forest typical cross-sections.



YEAR 50

Willows and nettles have grown to form a dense thicket. *Salix lucida* ssp. *Lasiandra* is considered a tree in this association, but in some stands may not exceed shrub height. Other shrub species may include *Cornus sericea*, *Sambucus racemosa*, and *Salix sitchensis* in patches. Native herbs such as

Impatiens capensis, *Urtica dioica* ssp. *gracilis*, *Bidens frondosa*, and *Leersia oryzooides* are typical groundcover. Stands with seasonal inundation may have a higher component of native herb species. Stands are adapted to flooding in winter, and are often flooded in the growing season as well, but need late-season draw-down to survive.

SCRUB-SHRUB COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

GEOMORPHIC CONTEXT

Scrub-shrub plant communities are most prevalent along the edges of the river channel or in seasonally flooded areas. In addition to channel margins, scrub-shrub plant communities occupy abandoned channels, old oxbow lakes, wetland edges, beaver ponds, and depressions. Soils vary from glacial till or outwash to sand and cobble, to saturated muck with woody debris. As long as

these plants have leaves above-water, many of them can withstand flooding for long periods of time, including year-round. In some cases, scrub-shrub dominated plant communities may eventually switch to coniferous forest or deciduous forest, or a mix of both. See below and page 1 for the preferred soil moisture conditions of these plants.

SPECIES LIST

Genus species	Common Name	Structural Type	Designation	Soils & Light	Hydrology
<i>Alnus rubra</i>	red alder	tree	FAC	clay soils, nutrient poor soils / mostly sunny	moist
<i>Pyrus fusca</i>	Pacific crabapple	tree	FACW	wetlands soils / mostly sunny to full sun	moist to wet
<i>Cornus sericea</i>	red-osier dogwood	shrub	FACW	nutrient rich soils	moist to wet
<i>Deschampsia cespitosa</i>	tufted hairgrass	shrub	FACW	gravelly, nutrient rich soils / full sun	moist
<i>Equisetum arvense</i>	common horsetail	shrub	FAC	all soils including poor soil / full shade to partial sun	dry to moist
<i>Loisera involucrata</i>	black twinberry	shrub	FAC	sand to clay soils / shady to full sun	moist to wet
<i>Lysichiton americanus</i>	western skunk cabbage	shrub	OBL	muddy, clay soils, wetland soils	year-round moist to wet
<i>Physocarpus capitatus</i>	Pacific ninebark	shrub	FACW	nutrient rich soils, mineral soils / partial to full sun	moist to wet
<i>Rhamnus purshiana</i>	casacara	shrub	FAC	muddy soils / mostly shady to mostly sunny	dry to wet
<i>Ribes bracteosum</i>	stink currant	shrub	FAC	sandy to clay soils / shade	moist to wet
<i>Rosa nutkana</i>	Nootka rose	shrub	FAC	nutrient rich soils / mostly sunny	dry to moist
<i>Rubus spectabilis</i>	salmonberry	shrub	FAC+	rich loam, loamy clays, pure peat, drained gravel or infertile soils / partial sun to full sun	moist to wet
<i>Salix fluviatilis</i>	northwest sandbar willow	shrub	OBL	sand or gravel overladen with silt to clay soils / sun	moist to wet
<i>Salix hookeriana</i>	Hooker's willow	shrub	FACW	well-drained to moist / part shade to full sun	moist
<i>Salix lucida ssp. lasiandra</i>	Pacific willow	shrub	FACW	mostly to full sun	moist to wet
<i>Salix sitchensis</i>	Sitka willow	shrub	FACW	mostly to full sun	moist to wet
<i>Spiraea douglasii</i>	Douglas' spirea/hardhack	shrub	FACW	mostly sunny to full sun	moist to wet
<i>Vaccinium parvifolium</i>	red huckleberry	shrub	FACU	acidic, humic, organic soils / mostly shady to mostly sunny	moist
<i>Athyrium filix-femina</i>	lady fern	groundcover	FAC	deep soils, basic soils, humic soils, nutrient rich soils / full shade to partial sun	wet
<i>Boykinia major</i>	large boykinia	groundcover	FACW	moist soil / mostly shady	moist
<i>Carex aquatilis var. Dives</i>	Sitka slough	groundcover	OBL	muddy wet soils	moist
<i>Carex obnupta</i>	slough sedge	groundcover	OBL	wet soil / part sun to full sun	wet
<i>Carex utriculata</i>	northwest territory sedge	groundcover	OBL	sandy to clay soils / semi shade to full sun	wet to semi-aquatic
<i>Carex vesicaria</i>	inflated sedge	groundcover	OBL	moist to wet soil / part shade	wet
<i>Cicuta douglasii</i>	western water-hemlock	groundcover	OBL	wet soil / part sun to full sun	moist to wet
<i>Glyceria occidentalis</i>	western mannagrass	groundcover	OBL	sandy to clay soils / semi to full shade	wet
<i>Lycopus uniflorus</i>	northern bugleweed	groundcover	OBL	sandy, loamy or marshy soils / partial to full sun	moist to wet
<i>Maianthemum dilatatum</i>	false lily of the valley	groundcover	FAC	sandy to clay soils / semi to full shade	moist
<i>Myosotis laxa</i>	small-flowered forget-me-not	groundcover	OBL	moist soil / part shade to full sun	moist to semi-aquatic
<i>Nuphar polysepalata</i>	pond lilly	groundcover	OBL	rich soil / full sun	wet to semi-aquatic
<i>Oenanthe sarmentosa</i>	water parsley	ground cover	OBL	muddy, wetland soil / partial to full sun	wet to semi-aquatic
<i>Petasites frigidus</i>	Arctic sweet coltsfoot	groundcover	NA	sandy to clay soils / full shade to no shade	moist to wet
<i>Puccinellia pauciflora</i>	weak alkali grass	groundcover	NA	wet, nitrogen rich soils / full sun	wet
<i>Ranunculus flammula</i>	lesser spearwort	groundcover	NA	sandy or muddy soils / part shade to full sun	moist to wet
<i>Scirpus microcarpus</i>	smallfruit bulrush	groundcover	OBL	sandy, loamy, clay soils / partial to full sun	moist to wet
<i>Sparganium emersum</i>	simplestem bur-reed	groundcover	OBL	shallow water or flooded soils / partial to full sun	wet
<i>Typha latifolia</i>	common cattail	groundcover	OBL	sandy to clay soils / sun, no shade	wet to semi-aquatic
<i>Urtica dioica ssp. Gracilis</i>	American stinging nettle	groundcover	FAC+	rich moist soil / partial-shade to full sun	moist
<i>Veronica americana</i>	American brooklime	groundcover	OBL	light to clay soils / part-shade to sun	wet to semi-aquatic
<i>Veronica scutellata</i>	marsh speedwell	groundcover	OBL	light to clay soils / part-shade to sun	wet
<i>Viola palustris</i>	marsh violet	groundcover	OBL	well-drained soils / part-shade to sun	moist

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DECIDUOUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL DECIDUOUS FOREST COMMUNITIES

A plant list comprised of the individual species introduced here, along with additional non-dominant species typically present in these communities with less percent cover, can be found on page 5.

A. Bigleaf Maple Forest w/ Salmonberry

Acer macrophyllum / *Rubus spectabilis*

B. Black Cottonwood - Bigleaf Maple Forest w/ Snowberry

Populus balsamifera ssp. *trichocarpa* - *Acer macrophyllum* / *Symphoricarpos albus*

C. Black Cottonwood - Red Alder Forest w/ Snowberry or Salmonberry

Populus balsamifera ssp. *trichocarpa* - *Alnus rubra* / *Symphoricarpos albus* or *Rubus spectabilis*

D. Black Cottonwood Forest w/ Red-osier Dogwood & Slough Sedge

Populus balsamifera ssp. *trichocarpa* / *Cornus sericea* / *Carex obnupta*

E. Garry Oak Forest w/ Snowberry

Quercus garryana / *Symphoricarpos albus*

F. Oregon Ash - Cottonwood Forest w/ Red-osier Dogwood & Nettles

Fraxinus latifolia - *Populus balsamifera* ssp. *trichocarpa* / *Cornus sericea* / *Urtica dioica*

G. Oregon Ash - Cottonwood Forest w/ Vine Maple or Hazelut & Pacific Ninebark or Salmonberry or Snowberry

Fraxinus latifolia - *Populus balsamifera* ssp. *trichocarpa* / *Acer circinatum* or *Corylus cornuta* and *Physocarpus capitatus* or *Rubus spectabilis* or *Symphoricarpos albus*

H. Oregon Ash Forest w/ Snowberry or Red-Osier Dogwood or Spirea

Fraxinus latifolia / *Symphoricarpos albus* or *Cornus sericea* or *Spiraea douglasii*

I. Red Alder Forest w/ Vine Maple or Thimbleberry or Salmonberry

Alnus rubra / *Acer circinatum* / *Claytonia sibirica*

Alnus rubra / *Rubus parviflorus*

Alnus rubra / *Rubus Spectabilis* / *Athyrium filix-femina* - *Lysichiton americanus*

HYDRAULIC ROUGHNESS

On floodplains...

... fallen logs, swales, and shrubs provide the most surface-roughness²:

Shrubs (n=0.14-0.30)

- salmonberry - avg. ht. 6 ft
- snowberry - avg. ht. 5 ft
- slough sedge - avg. ht. 2-5 ft
- nettles - avg. ht. 2-4 ft
- vine maple - up to 25 ft
- hazelnut - up to 15 ft
- pacific ninebark - up to 14 ft

- red-osier dogwood - up to 4 ft
- Douglas' spirea - avg. ht. 6 ft
- thimbleberry - avg. ht. 2-9 ft

Trees (n=0.07)

* Tree species listed to the right.

Aggregated Landscape Roughness n = 0.07 - 0.30

In Channels...

... large log jams provide the most hydraulic roughness. The dominant log types found in channels near these deciduous forest communities include:

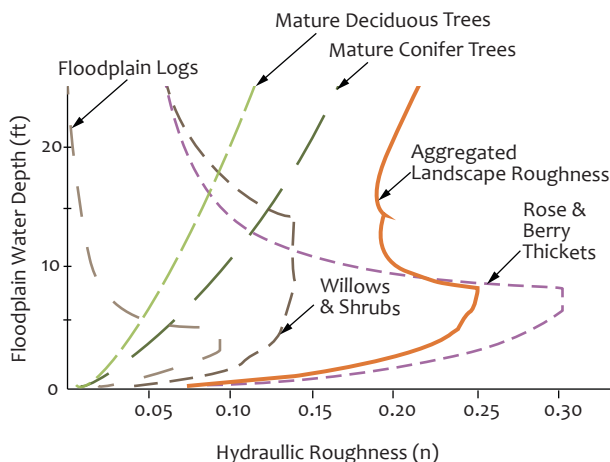
- bigleaf maple - up to 125 ft tall, 72" dia.
- black cottonwood - 160-200 ft tall when growing on rich

bottomland soil, 48-72" dia. red alder - 100-110 ft tall, 10-20" dia. in 60 years
- Garry oak - 80 ft tall, 36" dia. on fertile valley soils
- Oregon ash - 60-80 ft tall, 16-30" dia. in 100-150 years

Est. log jam n = 0.09 - 0.30

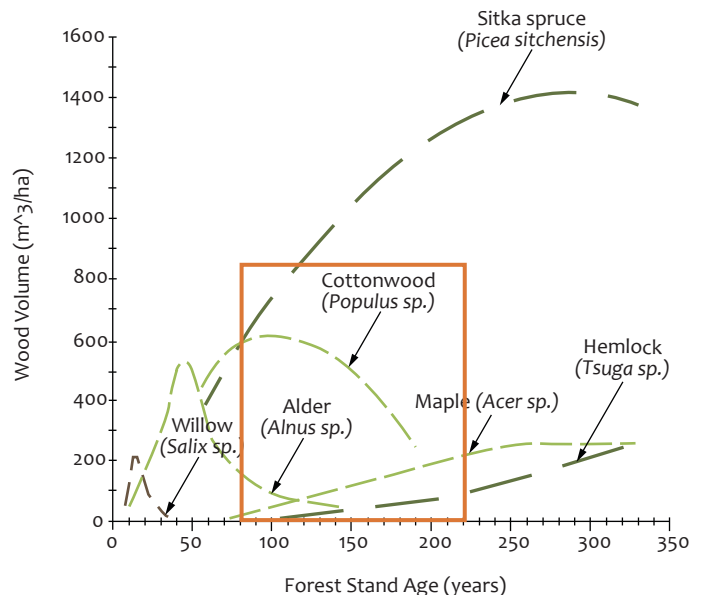
Modeled Hydraulic Roughness (n)

... of Mature Deciduous Forested Floodplain. Results from Roughness of Vegetation in Rivers (ROVER) model of mature riparian and floodplain forest. (modified from graph in Abbe et al., 2016)



Wood Volume (m³/ha) over Time (years)

* Natural time scale is accelerated by decades with adaptive management. (modified from Van Pelt et al. 2006)



DECIDUOUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL CROSS-SECTIONS

(Black Cottonwood-Red Alder Example)

Disturbance event: flood, fire or blow-down.



YEAR 0

A large flood creates some gaps in the adjacent floodplain, depositing sand and silt and clearing away some of the shrubby understory. Cottonwood

seeds take root in this silty sand, along with some red alder and begin to fill in these small gaps in the riparian and floodplain area.



YEAR 50

After about 40 years, the alders begin to reach the end of their natural life cycle but, the cottonwoods will continue to grow for another 150 years, or so. These large trees will help to regenerate the next generation of gap-filling floodplain forest and provide refuge and food for many species, ranging from

wood peckers to beavers and bears. Around this time, some shade-tolerant conifers, such as western red cedar, or western hemlock will begin to grow as part of the understory, acting as thick shrubs in their younger years and significantly increasing floodplain roughness.



MATURE DECIDUOUS FOREST (~200 YEARS)

Eventually, deciduous forests contain a mix of both conifers and mature shrubs, forming a broad spectrum of adjacent plant communities, in transition from one to another. Some select places have also been 'reset'

by the river, as described at Time 0, above. Even under these diverse conditions, cottonwoods continue to dominate many of the wetter sheltered depressions, adjacent to the river, forming the classic 'cottonwood bottomland'.

DECIDUOUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

GEOMORPHIC CONTEXT

Deciduous forest plant communities are commonly found in the same areas as the coniferous forest plant communities, including the active floodplain, mid and high-terraces, the edges of oxbow lakes, and the edges of the active channel and secondary channels. Soils can vary from well-drained soil to alluvium, to peatland and deep muck. Similar to scrub-shrub plant communities, many of these species may withstand long-periods of

inundation, others are more-drought tolerant. These plant communities are often an early-seral forest stage, preceding coniferous forest development. However, in flooded areas, water-tolerant species such as cottonwood remain dominant, creating 'cottonwood bottomland', a unique and increasingly threatened type of riparian forest. See below and page 1 for the preferred soil moisture conditions of these plants.

SPECIES LIST

Genus species	Common Name	Type	Designation	Soils & Light	Hydrology
<i>Abies grandis</i>	grand fir	tree	FACU	well drained soils / partial sun and shade 40%-60%	dry to moist
<i>Acer macrophyllum</i>	bigleaf maple	tree	FACU	sandy, clay, muddy soils	dry to moist
<i>Alnus rubra</i>	red alder	tree	FAC	nutrient poor, clay soils / mostly sunny	moist
<i>Cornus sericea</i>	red twig dogwood	tree	FACW	rich soils / part shade to full sun	moist to wet
<i>Crataegus douglasii</i>	black hawthorn	tree	FAC	sandy to clay soils / semi-shade to full sun	moist to wet
<i>Frangula purshiana</i>	Cascara buckthorn	tree	FAC-	rich soils / part shade to full sun	dry to wet
<i>Fraxinus latifolia</i>	Oregon ash	tree	FACW	part to full sun	moist to wet
<i>Oemleria cerasiformis</i>	Indian plum	tree	FACU	nutrient rich soils / partial sun and shade	dry to moist
<i>Picea sitchensis</i>	Sitka spruce	tree	FAC	well drained soil / partial to full sun	moist
<i>Populus balsamifera ssp. trichocarpa</i>	black cottonwood	tree	FAC	mostly sunny to full sun	moist to wet
<i>Pseudotsuga menziesii</i>	Douglas fir	tree	FACU	gravelly, well drained soils / partial sun to full sun	dry to moist
<i>Pyrus fusca</i>	Pacific crabapple	tree	FACW	clay soils / part to full sun	moist to wet
<i>Quercus garryana</i>	Garry oak	tree	FACW	nutrient poor soils / full sun	dry
<i>Sambucus racemosa</i>	red elderberry	tree	FACU	partial sun to full sun	moist
<i>Thuja plicata</i>	western redcedar	tree	FAC	clay, muddy, nutrient rich soils / mostly shady to part sun	moist to wet
<i>Tsuga heterophylla</i>	western hemlock	tree	FACU	full shade to full sun	dry to moist
<i>Acer circinatum</i>	vine maple	shrub	FAC-	well-drained sandy to clay soils / shade to full sun	dry
<i>Amelanchier alnifolia</i>	Pacific serviceberry	shrub	FACU	well drained soils / partial shade to full sun	dry to moist
<i>Cornus stolonifera</i>	red-osier dogwood	shrub	FACW	nutrient rich soils / mostly sunny	moist to wet
<i>Corylus cornuta</i>	beaked hazelnut	shrub	FACU	rich, well-drained soils / part shade to full sun	dry to moist
<i>Lysichiton americanus</i>	western skunk cabbage	shrub	OBL	muddy, clay, wetland soils	moist to wet
<i>Mahonia aquifolium</i>	Oregon-grape	shrub	NA	partial sun to mostly sunny	dry to moist
<i>Physocarpus capitatus</i>	Pacific ninebark	shrub	FACW-	nutrient rich mineral soils / partial sun and shade to full sun	moist to wet
<i>Rubus parviflorus</i>	thimbleberry	shrub	FAC-	rich, slightly acidic, well-drained soil / part shade to full sun	moist
<i>Rubus spectabilis</i>	salmonberry	shrub	FAC+	partial sun and shade to full sun	moist to wet
<i>Rubus ursinus</i>	California blackberry	shrub	FACU	shade to sun	moist
<i>Spiraea douglasii</i>	Douglas' spirea/hardhack	shrub	FACW	well-drained, acidic soils / part shade to full sun	moist to wet
<i>Symphoricarpos albus</i>	snowberry	shrub	FACU	partial sun and shade to mostly sunny	moist to wet
<i>Athyrium filix-femina</i>	lady fern	groundcover	FAC	basic, humic, nutrient rich soils / full shade to partial sun	wet
<i>Carex deweyana</i>	Dewey's sedge	groundcover	FAC	part shade to shade	dry to moist
<i>Carex obnupta</i>	slough sedge	groundcover	OBL	part sun to full sun	wet
<i>Circaea alpina</i>	enchanter's nightshade	groundcover	FAC	rich soils / part shade to shade	moist to wet
<i>Claytonia sibirica</i>	Siberian spring-beauty	groundcover	FAC	nutrient rich soils / mostly shady	moist
<i>Equisetum hyemale</i>	rough horsetail	groundcover	FACW	sandy to clay soils / full sun to part shade	moist to wet
<i>Eurhynchium praelongum</i>	feather moss	groundcover	NA	NA	moist to wet
<i>Galium aparine</i>	Goosegrass	groundcover	FACU	sandy to clay soils / full shade to sun	dry to moist
<i>Maianthemum dilatatum</i>	False Lily of the Valley	groundcover	FAC	shade	moist to wet
<i>Maianthemum stellatum</i>	Star Solomon's Seal	groundcover	FAC	humic soils / part shade to full shade	moist
<i>Melica subulata</i>	Alaska oniongrass	groundcover	NA	nitrogen rich soils / partial shade	moist
<i>Nemophila parviflora</i>	smallflower nemophila	groundcover	NA	NA	NA
<i>Polystichum munitum</i>	western swordfern	groundcover	FACU	mostly shady to full shade	dry to moist
<i>Stachys chamissonis var. cooleyae</i>	hedgenettle	groundcover	FACW	muddy, peaty, nutrient rich soils / partial sun and shade	moist
<i>Tolmiea menziesii</i>	piggyback plant	groundcover	FAC	humic, nutrient rich, organic soils / mostly to full shade	moist
<i>Trillium parviflorum</i>	small-flowered trillium	groundcover	NA	alluvial soil covered with humus / shady	moist
<i>Urtica dioica ssp. Gracilis</i>	American stinging nettle	groundcover	FAC+	rich soil / partial-shade to full sun	moist
<i>Viola glabella</i>	pioneer violet	groundcover	FACW	shade	moist

CONIFEROUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL CONIFEROUS FOREST COMMUNITIES

A plant list comprised of the individual species introduced here, along with additional non-dominant species typically present in these communities with less percent cover, can be found on page 5.

A. Sitka Spruce - Western Hemlock Forest^{1, 4}

Picea sitchensis - *Tsuga heterophylla* - (*Alnus rubra*) / *Oplopanax horridus* / *Polystichum munitum*²

B. Sitka Spruce Forest^{1, 4}

Picea sitchensis / *Rubus spectabilis*²

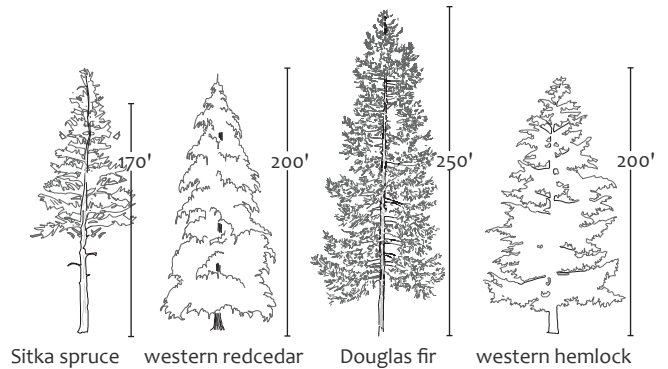
C. Western Hemlock Forest¹

Tsuga heterophylla - (*Pseudotsuga menziesii* - *Thuja plicata*) / *Oplopanax horridus* / *Polystichum munitum*²

D. Western Redcedar Forest¹

Thuja plicata / *Rubus spectabilis* / *Oxalis oregana*²

Mature Tree Height



HYDRAULIC ROUGHNESS

On floodplains...

... fallen logs, swales, and shrubs provide the most surface roughness³:

Shrubs (n=0.14-0.30)

- devil's club - avg. ht. 3.5 ft
- sword fern - avg. ht. 3 ft
- salmonberry - avg. ht. 5-13 ft

Trees (n=0.10)

* Tree species listed to the right.

Aggregated Landscape Roughness
max n = 0.20 - 0.30

In Channels...

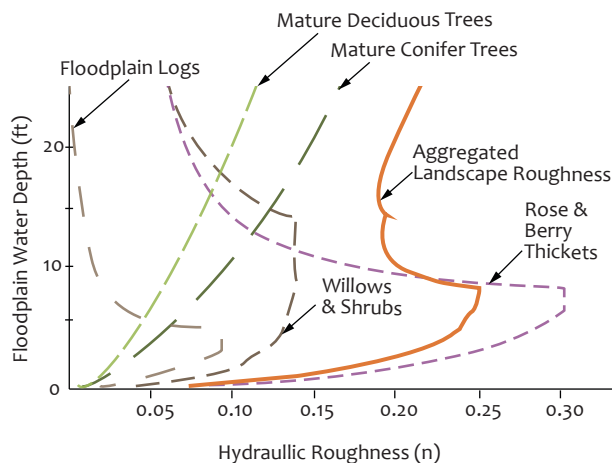
... large logs provide the most hydraulic roughness.

- Sitka spruce - up to 170 ft tall, 48" dia. in 100 years with old growth reaching 84" dia.
- western hemlock - up to 200 ft tall, 48-96" dia.
- western redcedar - 200 ft tall, 86-120" dia., thrives in wet valleys
- Douglas fir - up to 250 ft tall, 96" dia.

Est. log jam max n = 0.14

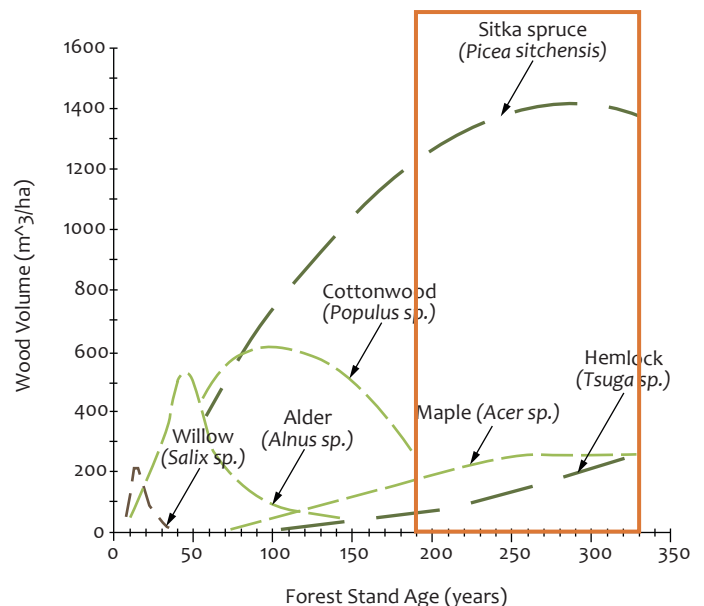
Modeled Hydraulic Roughness (n)

... of Mature Deciduous Forested Floodplain. Results from Roughness of Vegetation in Rivers (ROVER) model of mature riparian and floodplain forest. (modified from graph in Abbe et al., 2016)



Wood Volume (m³/ha) over Time (years)

* Natural time scale is accelerated by decades with adaptive management. (modified from Van Pelt et al. 2006)

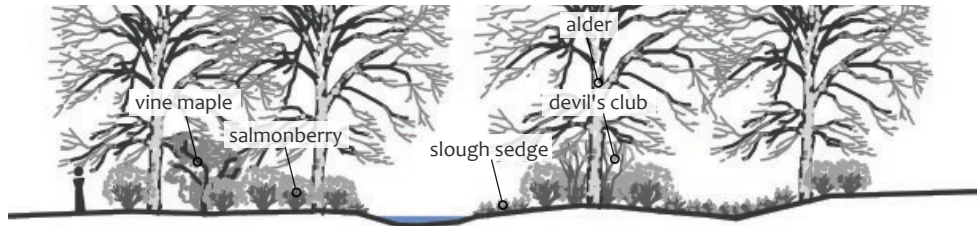


CONIFEROUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

TYPICAL CROSS-SECTIONS

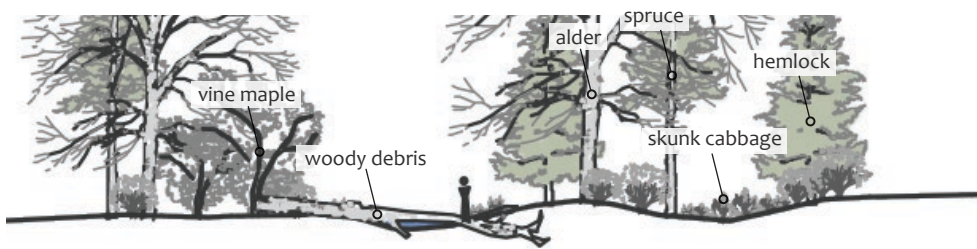
(Sitka spruce - western hemlock Forest Example)



YEAR 0

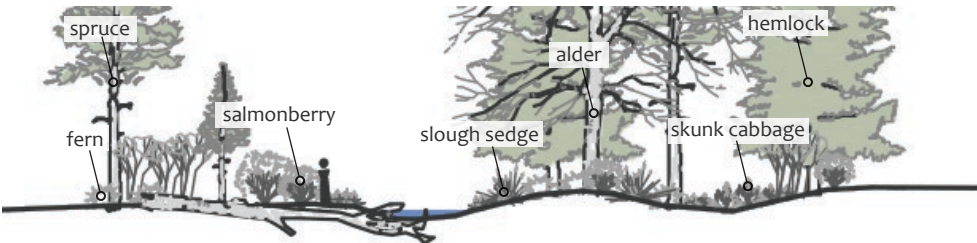
Mature deciduous forest or scrub-shrub plant community (e.g. alder, big leaf maple, willow, snowberry, salmonberry, sword fern, devil's club). See page 9 for deciduous forest typical cross sections.

Disturbance event: flood, fire or blow-down.



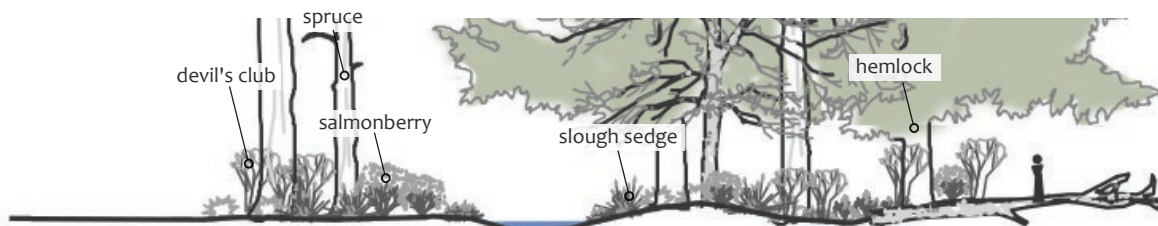
YEAR 20

Old alders fall into the creek, small Sitka spruce and western hemlock, which is more shade tolerant than most conifers, begin to colonize. Saplings often get established on fallen logs.



YEAR 150

Sitka spruce and western hemlock grow bigger. Hemlock increases in dominance in scenarios where no major disturbance event takes place.



MATURE CONIFEROUS FOREST (~ 200 YEARS)

Sitka spruce and western hemlock mature, forming coniferous riparian and floodplain forest.

CONIFEROUS FOREST COMMUNITIES

Utilizing a Rough Shrub Understory for Slowing Floodwaters

GEOMORPHIC CONTEXT

All of these plant communities are found in areas with deep, poorly drained soils that are seasonally to perennially wet, including parts of the active floodplain, oxbow lakes or ponds, abandoned channels, secondary channels,

and upper riparian terraces near smaller streams. Ability to withstand inundation varies by species. See below and page 1 for the preferred soil moisture conditions of these plants.

SPECIES LIST

Genus species	Common Name	Structural Type	Wetland Designation	Soils & Light	Hydrology
<i>Alnus rubra</i>	red alder	tree	FAC	nutrient poor soils, clay soils, mostly sunny	moist
<i>Picea sitchensis</i>	Sitka spruce	tree	FAC	well drained soil / partial to full sun	moist
<i>Pseudotsuga menziesii</i>	Douglas fir	tree	FACU	gravelly, well drained soils / partial sun to full sun	dry to moist
<i>Thuja plicata</i>	western redcedar	tree	FAC	clay, muddy, nutrient rich soils / mostly shady to part sun	moist to wet
<i>Tsuga heterophylla</i>	western hemlock	tree	FACU	full shade to full sun	dry to moist
<i>Acer circinatum</i>	vine maple	shrub	FAC-	well-drained sandy to clay soils /shade to full sun	dry
<i>Oplopanax horridus</i>	devil's club	shrub	FAC+	well drained, nutrient rich soils / mostly shady	moist
<i>Ribes bracteosum</i>	stink currant	shrub	FAC	sandy to clay soils / sun	moist to wet
<i>Rubus spectabilis</i>	salmonberry	shrub	FAC+	partial sun and shade to full sun	moist to wet
<i>Vaccinium ovatum</i>	oval-leaf huckleberry	shrub	FACU	well drained soil / mostly shady to mostly sunny	dry to moist
<i>Athyrium filix-femina</i>	lady fern	groundcover	FAC	deep, basic, humic, nutrient rich soils / full shade to partial sun	wet
<i>Blechnum spicant</i>	deer fern	groundcover	FAC	humic, mineral, organic soils / mostly shady to full shade	moist
<i>Maianthemum dilatatum</i>	false lily of the valley	groundcover	FAC	sandy to clay soils / semi to full shade	moist
<i>Oxalis oregana</i>	Oregon sorrel	ground cover	FACU	organic / mostly shady to full shade	dry to moist
<i>Polystichum munitum</i>	western swordfern	groundcover	FACU	full shade to mostly shady	dry to moist
<i>Tiarella trifoliata</i>	threeleaf foamflower	groundcover	FAC	organic soils / full shade to mostly shady	moist

ENDNOTES

1. Forest Types From United States National Vegetation Classification (USNVC). Dozens of other plant species comprise these plant communities and affect roughness values. More-detailed plant community descriptions can be found on the USNVC website.
2. Dominant Trees / Dominant Shrubs / Dominant Ground Cover. Co-dominant species are separated with a dash “-”, with common but less-dominant species in parenthesis “()”
3. Manning's roughness values (n) are from Abbe et al. 2016, and are based on Roughness of Vegetation in Rivers (ROVER) model. Values reported on these sheets represent a max n below 10' water depth.
4. Sitka spruce forests represent a later stage in floodplain forest succession, being preceded by red alder deciduous forest with a salmonberry understory, or Hooker's willow/slough sedge scrub-shrub plant community, see Deciduous Forest and Scrub-Shrub Plant Community sheets.

ABBREVIATIONS

avg = average
dia. = diameter
est. = estimate or estimated
FAC = facultative wetland species, 34-66% wetland probability
FACU = facultative upland species, 1 - 33% wetland probability
FACW = facultative wet wetland species, 67- 99% wetland probability
ft = feet
m=meter
max = maximum
n = Manning's hydraulic roughness value, unitless
OBL = obligate wetland species, > 99% wetland probability
RFP = Restorative Flood Protection
UPL = Obligate upland species, <1% wetland probability
USFWS = United States Fish and Wildlife Service

CITATIONS

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