



Public Works Department City of Bellingham

Native Plant Materials Selection Guidelines March 2022

Purpose

This document outlines the native plant materials selection guidelines for the City of Bellingham (City) Public Works Department. Public Works uses native plants in restoration and mitigation projects to restore ecosystem function and increase habitat diversity. However, until this time, Public Works has not established specific guidelines for native plant materials selection. Thus, in 2020 staff conducted a literature review on best practices in plant materials selection, including information related to climate change and assisted migration. This document synthesizes current research and provides guidelines for plant materials selection with the purpose of increasing plant survivorship and long-term project success.

Approach for Native Plant Materials Selection

Bellingham watersheds have unique ecological characteristics. Sourcing genetically diverse, locally adapted plant materials ensures functional and self-sustaining restoration and mitigation projects. Therefore, Public Works restoration and mitigation projects should consist of plants that are native to Bellingham watersheds (Figure 2), have a source of origin from the Puget Trough Ecoregion, and are genetically diverse. To ensure plants adhere to these standards, project staff should follow the Guidelines for Selecting Native Plant Materials, below. For additional background information, please see Background, below.

Guidelines for Selecting Native Plant Materials

Step 1. Native to Bellingham watersheds

Choose native plant species from the Bellingham Plant List (Figure 1). This list was developed using the Consortium of Pacific Northwest Herbaria database and

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Bellingham plant checklists curated by Don Knoke, a volunteer at the University of Washington Burke Herbarium.

Step 2. Grown from materials sourced from the Puget Trough Ecoregion

Obtain verification from the supplier that the individual plants were grown from seeds or cuttings collected in the Puget Trough Ecoregion [1] (Figure 3). Due to a lack of availability on some occasions, it may not always be possible to purchase native plant materials sourced from the Puget Trough Ecoregion. In this case, select native plant materials sourced from Washington, west of the Cascades.

Step 3. Genetically diverse

If using willows:

- a. Ask the supplier if the live stakes are wild collected or nursery grown. If the supplier indicates that the live stakes are nursery grown, consider choosing a different supplier (nursery beds are frequently started from one mother plant and therefore would produce live stakes that are genetically identical and of a single sex). If the supplier indicates that the live stakes are wild collected, ask the supplier how many different stands and how many different trees they utilize in their collections. As a baseline, aim for finding a live stake vendor that collects from at least three stands and three individuals within each stand [2].
- b. Identify a supplier that determines the sex of the mother plant prior to collecting and request that the order be filled with an equal proportion of male and female live stakes.

Background

Definition of Native

The term “native plant” has become ubiquitous in our day-to-day vocabulary. Even though the term is commonly used, there is little consensus on its definition or how it should be applied when selecting plants for restoration projects. In order to achieve successful restoration outcomes, a narrow definition—one that considers local adaptations—would be beneficial when evaluating which native plant species and populations are appropriate for a project site. The following definition of “native” speaks to some of the questions and concerns discussed in this document: ***A species occurring in an area of the U.S. prior to European colonization that is adapted to the local ecosystem and is genetically similar to adjacent populations [3].***

This definition is in line with the Native Plant Materials Policy for the U.S. Forest Service, which states that “land management prescriptions will include the selection and use of native plant

species that are genetically appropriate and adapted to on-the-ground ecological conditions” [4].

Source of Origin

Selecting plant species that are native to Bellingham watersheds is a good starting place for Public Works restoration and mitigation projects, but it is also important to evaluate the “source of origin” of the native plant materials; that is, the original collection location of the seeds or cuttings [5]. Individual plant species grow in a wide range of conditions which can span across ecoregions and different floristic provenances. This is possible because different populations have adapted to their local environment through natural selection [6, 7, 8]. For example, oceanspray grows from the northwestern coast of Washington to the Blue Mountains of southwest Washington. Adaptations that have allowed oceanspray to persist in the Blue Mountains would not be advantageous for growing along the coast in Bellingham.

Plants used in restoration and mitigation are often widespread species, with different populations exhibiting significant genetic variation across their geographic range [3]. Part of the genetic variation between populations is driven by local adaptation which leads to local plants having a “home-site advantage” over non-local plants in restoration and mitigation [9, 10, 11, 12]. Selecting locally sourced native plant materials will ensure the installed plants are adapted to the project site, thereby increasing plant survivorship and project success.

Seed Transfer Zones

In recognizing the need to use plant species of local origin, a critical question emerges: How far can plant materials move and still be considered appropriate for a site? Decades of observations by foresters have revealed that failures in reforestation projects have often been the result of using seed that was sourced from a location too far from the planting site [14]. Subsequent scientific research has validated this observation and demonstrated that genetic differentiation between populations increases with geographic distance and environmental difference [15, 16].

Researchers used these observations to develop the concept of and specifications for “seed transfer zones” [14]. A seed transfer zone is the geographic area within a given species’ range in which plant material can be moved freely with insignificant differences in growth and development [17, 18]. Seed transfer zones are validated by field inventories and common garden studies illustrating differences in phenology and plant performance based on the geographic origin of the seed [14, 18]. Figure 1 displays the seed transfer zones for Douglas fir and western red cedar in Oregon. Each colored area represents a unique seed transfer zone. In this example, Douglas fir would be considered a site specialist (with relatively smaller seed transfer zones), while western red cedar would be considered a site generalist (with relatively

larger seed transfer zones) [5]. In practice, this means that seed from western red cedar can travel farther than Douglas fir and still be considered “appropriate” for a planting site.

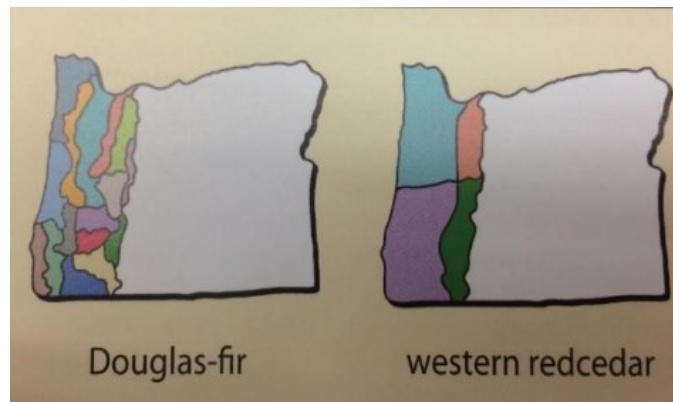


Figure 1. Seed transfer zones for Douglas fir and western red cedar in Oregon [19].

The difference between Douglas fir and western red cedar seed transfer zones demonstrates that there are no simple distance rules that can be equally applied across all species. For some species, unique local populations may be present within a small geographic area; while for other species, distant populations may be genetically similar [20]. Unfortunately, due to the extensive amount of time and resources required for validation, seed transfer zones have not yet been published for most herbaceous and shrub species used in restoration in the Pacific Northwest. Nonetheless, Public Works can harness the principles and best practices of seed transfer zones by selecting native plant materials that have a source of origin from the Puget Trough Ecoregion [1]. Bellingham lies within the Puget Trough Ecoregion and shares overlapping abiotic and biotic conditions with the rest of the ecoregion. Sourcing native plant materials from the Puget Trough Ecoregion will increase the likelihood that the installed plants will have the necessary adaptations and traits to establish and thrive in our local environment [13].

Genetic Diversity

One of the primary goals of ecological restoration is to generate self-sustaining systems that provide diverse ecosystem services [21]. Genetic diversity is a prerequisite for establishing self-sustaining populations [22, 23, 24, 25] and has been shown to increase a population’s resilience to environmental change [26, 27]. The genetic diversity of a restored population has been positively correlated with both plant density and ecosystem services, including habitat provision, productivity, and nitrogen retention [27, 28, 29, 30]. Therefore, successful revegetation outcomes will depend on a) using local materials that have high genetic diversity [30, 31] and b) using restoration techniques that promote genetic diversity [29, 32, 33].

Unfortunately, many widespread nursery practices used to produce restoration materials risk decreasing the genetic diversity of restored populations. Consider the case of willow live stakes. Riparian restoration projects often use live stakes for stabilizing and revegetating streambanks, with willows being the predominate species used in these applications. Growing mature willows from live stakes is a form of vegetative propagation, and, as a result, the mature plants are genetic clones of the source plant (i.e., mother plant). For efficiency, live stake vendors often manage and collect from the same stand on a yearly basis. This management and harvesting strategy results in low genetic diversity, as the live stakes are collected from a small number of mother plants.

The low genetic diversity associated with the collection of willow live stakes is compounded by two features of willow natural history. First, willow stands are often sustained by vegetative reproduction from root sprouts or buried branches and, as a result, adjacent plants are often genetically identical [34]. Second, willows carry male and female reproductive organs on separate plants. As a consequence, an entire stand of willows may be male clones. If live stakes are collected from only one stand, the collection may be biased towards one sex and thus have limited reproductive capacity. In order to maximize the genetic diversity and reproductive capacity of the restored population, live stake and seed collection protocols should be specifically informed by a species' natural history.

Climate Change and Assisted Migration

Global climate change has sparked a far-reaching debate about whether nonlocal species and materials should be used by natural resource managers and restoration practitioners [35]. On the one hand, climate is universally accepted as the main driver of selection [36, 37] and the current rate of warming may outpace the ability of many plant species to adapt or migrate to suitable locations [38, 39, 40, 41, 42]. On the other hand, long standing ecological principles advocate for the use of locally sourced materials to maintain genetic variation and local adaptations between populations [20, 43]. Leaving aside (for the purposes of this paper) the debate on whether nonlocal sources should be used in restoration projects, the following section provides a basic overview of assisted migration as a climate change adaptation strategy.

The climate range in which a species currently exists is described as its "climate envelope." If climatic conditions change, a species' climate envelope can uncouple from its current range [44]. Although many species have endured climatic changes in the past, contemporary climate change presents additional challenges for plant species survival when compared to historical periods, due to the rate of warming coupled with highly fragmented landscapes, isolated populations, and invasive species [36, 45]. Indeed, an analysis of the 1998-2008 USDA Forest Inventory and Analysis data from the eastern United States revealed range contractions at both the northern and southern boundaries of 59% of the 92 tree species included in the analysis

[46]. This study also reported that only 21% of the tree species exhibited a northward shift and that range expansion was not observed in areas where the climate had changed most significantly.

The dissonance between the rate of environmental change and the rate of species' adaptations threatens to disrupt many fundamental ecosystem processes [40, 41, 42]. This has led to the development of a suite of assisted migration strategies to offset the deleterious effects of climate change on plant populations and ecosystem services [47, 48, 49]. Assisted migration can take three different forms: 1) assisted population migration (assisted gene flow), 2) assisted range expansion, and 3) assisted species migration [48] (Fig 2). Assisted population migration is the movement of seed sources from one location to another location along a climatic gradient (i.e., temperature or precipitation) within a species' current range [48, 49]. The aim of assisted population migration is to enhance the spread of climate-adaptive genotypes within a species' current range. Assisted range expansion is the movement of a species to a location just beyond that species' current range [50]. Assisted species migration is the movement of a species that is threatened with climate-related extinction to a location far outside its current range where a viable population can be established [48, 49]. Assisted population migration and assisted range expansion apply to common and widespread species with the aim of maintaining ecosystem function, whereas assisted species migration applies to threatened and endangered species for the purpose of preserving biological diversity [50].

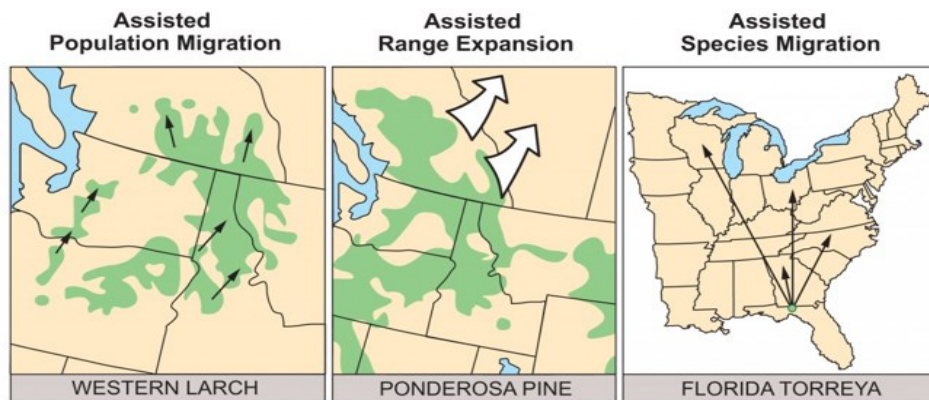


Figure 2. Three forms of assisted migration: assisted population migration, assisted range expansion, and assisted species migration [48].

A central concern for assisted migration is whether the transplanted materials will have the ability to survive under the current environmental conditions of the transplant site [47, 48, 49, 51]. This issue along with inappropriate matching of the seed source with the transplant site could increase establishment failure and lead to maladaptation of the local population through the transfer of genetic traits that are not adapted to the local environment (i.e., outbreeding depression) [47, 49, 52]. Relatedly, without precise knowledge of the future climate in any

given location, it is particularly difficult to match a seed source with a transplant site [48, 50, 53]. In 2014, Canadian researchers evaluated Douglas firs that were transplanted within their current range forty years earlier and found that transferred seed did not grow as well as seed sourced from local trees. Researchers linked this outcome to the inability of transplanted trees to form adequate symbiotic relationships with the local mycorrhizal fungi [54]. The above example brings into sharp relief the complexities of moving populations to distant locations and illustrates that using a single axis, such as temperature, may result in maladaptation. Even with cautionary tales like the Douglas fir study, researchers are actively pursuing strategies to improve assisted migration outcomes.

Worldwide, researchers are using reciprocal transplant studies, space-for-time substitutions, phenotyping, and genomic methods to identify suitable source material for assisted migration [55]. Notably, early results from this research discourage basing assisted migration decisions on long-term climate projections [51, 53, 55]. Instead, researchers recommend using a 20-year climate projection as the foundation for setting suitable transfer distances [53]. This guideline aims to reduce the risk of maladaptation and transplant failure from source material moved to warmer climates.

City of Bellingham's Approach to Assisted Migration

To ensure that assisted migration is ecologically beneficial and that risks are minimized, assisted migration decisions should be informed and supported by the best available science. Before including assisted migration in restoration and mitigation projects, Public Works would benefit from the development of an adaptation plan. Among other things, the adaptation plan would outline the City's goals for including assisted migration in species selection protocols and provide guidelines for implementing the different forms of assisted migration. The adaptation plan would specify a projected climate range to guide the sourcing of plant materials and outline how the City intends to monitor and evaluate the assisted migration plantings.

Prior to the development of City-wide guidelines for assisted migration, Public Works staff should focus on using native plant materials that, to the best of our ability, contain the adaptations and traits necessary to grow and thrive within our local environment. At this time, the most established way to achieve this is through sourcing native plant materials that were originally collected from local populations [9, 10, 11, 12].

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Appendix A: City of Bellingham Native Plant List March 2022

The City of Bellingham Native Plant List (Figure 1) includes plant species that are native to Bellingham watersheds (Figure 2). The native plant list applies to all habitat types, including riparian, upland, and wetland areas. The list was developed using specimen records from the Consortium of Pacific Northwest Herbaria [56] and Whatcom County plant checklists curated by Don Knoke [57], a volunteer at the University of Washington Herbarium. The native plant list will continue to be updated as we become aware of additional species that have been documented in our region.

To improve plant establishment and protect the genetic resources of our local plant populations, the City recommends using native plants that were grown from seeds or cuttings collected from the Puget Trough Ecoregion (Figure 3). Obtaining native plants grown from material collected from the Puget Trough Ecoregion will help ensure the plants are adapted to the unique environmental conditions of our region and are genetically similar to our local plant populations. A more thorough discussion of the rational and selection process is provided in the City of Bellingham Public Works Department Native Plant Materials Selection Guidelines, December 2020.

Figure 1. City of Bellingham Native Plant List (322)

Ferns (20)		
<u>Common Name</u>	<u>Scientific Name</u>	<u>Family</u>
Bracken fern	<i>Pteridium aquilinum</i> var. <i>pubescens</i>	Dennstaedtiaceae
Bristle-like quillwort	<i>Isoetes tenella</i>	Isoetaceae
Common horsetail	<i>Equisetum arvense</i>	Equisetaceae
Deer fern	<i>Struthiopteris spicant</i> (<i>Blechnum spicant</i>)	Blechnaceae
Dream fern	<i>Aspidotis densa</i>	Pteridaceae
Giant horsetail	<i>Equisetum telmateia</i> ssp. <i>braunii</i>	Equisetaceae
Gold fern	<i>Pentagramma triangularis</i>	Pteridaceae
Lady fern	<i>Athyrium filix-femina</i> ssp. <i>cyclosorum</i>	Athyriaceae
Licorice fern	<i>Polypodium glycyrrhiza</i>	Polypodiaceae
Maidenhair fern	<i>Adiantum aleuticum</i> var. <i>aleuticum</i> (<i>Adiantum pedatum</i>)	Pteridaceae
Marsh horsetail	<i>Equisetum palustre</i>	Equisetaceae
Mexican waterfern	<i>Azolla microphylla</i>	Salviniaceae
Oak fern	<i>Gymnocarpium dryopteris</i>	Cystopteridaceae
River horeetail	<i>Equisetum fluviatile</i>	Equisetaceae
Scouring rush horsetail	<i>Equisetum hyemale</i>	Equisetaceae
Spreading wood-fern	<i>Dryopteris expansa</i> (<i>Dryopteris austriaca</i>)	Dryopteridaceae
Variegated horesetail	<i>Equisetum variegatum</i>	Equisetaceae
Wallace's spikemoss	<i>Selaginella wallacei</i>	Selaginellaceae
Western quillwort	<i>Isoetes occidentalis</i>	Isoetaceae
Western sword fern	<i>Polystichum munitum</i>	Dryopteridaceae
Trees (23)		
<u>Common Name</u>	<u>Scientific Name</u>	<u>Family</u>
Alaska yellow cedar	<i>Callitropsis nootkatensis</i>	Cupressaceae
Bigleaf maple	<i>Acer macrophyllum</i>	Sapindaceae
Black cottonwood	<i>Populus trichocarpa</i>	Salicaceae
Douglas fir	<i>Pseudotsuga menziesii</i>	Pinaceae
Grand fir	<i>Abies grandis</i>	Pinaceae
Green alder	<i>Alnus alnobetula</i> (<i>Alnus viridis</i>)	Betulaceae
Hooker's willow	<i>Salix hookeriana</i>	Salicaceae
Lodgepole pine	<i>Pinus contorta</i>	Pinaceae
Oregon white oak	<i>Quercus garryana</i> var. <i>garryana</i>	Fagaceae
Pacific dogwood	<i>Cornus nuttallii</i>	Cornaceae
Pacific madrone	<i>Arbutus menziesii</i>	Ericaceae
Pacific willow	<i>Salix lasiandra</i>	Salicaceae
Paper birch	<i>Betula papyrifera</i>	Betulaceae
Ponderosa pine	<i>Pinus ponderosa</i>	Pinaceae
Quaking aspen	<i>Populus tremuloides</i>	Salicaceae
Red alder	<i>Alnus rubra</i>	Betulaceae
Scouler's willow	<i>Salix scouleriana</i>	Salicaceae
Sitka spruce	<i>Picea sitchensis</i>	Pinaceae
Sitka willow	<i>Salix sitchensis</i> var. <i>sitchensis</i>	Salicaceae

Western hemlock	Tsuga heterophylla	Pinaceae
Western red cedar	Thuja plicata	Cupressaceae
Western white pine	Pinus monticola	Pinaceae
Western yew	Taxus brevifolia	Taxaceae

Shrubs, Vines, and Trailing Plants (42)

<u>Common Name</u>	<u>Scientific Name</u>	<u>Family</u>
Baldhip rose	Rosa gymnocarpa	Rosaceae
Beaked hazelnut	Corylus cornuta	Betulaceae
Bitter cherry	Prunus emarginata	Rosaceae
Black twinberry	Lonicera involucrata var. involucrata	Caprifoliaceae
Blackcap	Rubus leucodermis	Rosaceae
Bog labrador tea	Rhododendron groenlandicum	Ericaceae
Cascade Oregon grape	Mahonia nervosa (Berberis nervosa)	Berberidaceae
Cascara	Frangula purshiana (Rhamnus purshiana)	Rhamnaceae
Clustered wild rose	Rosa pisocarpa var. pisocarpa	Rosaceae
Coast black gooseberry	Ribes divaricatum var. divaricatum	Grossulariaceae
Common snowberry	Symphoricarpos albus	Caprifoliaceae
Creeping snowberry	Symphoricarpos mollis	Caprifoliaceae
Devil's club	Oplopanax horridum (Oplopanax horridum)	Araliaceae
Douglas hawthorn	Crataegus douglasii	Rosaceae
Douglas maple	Acer glabrum var. douglasii	Sapindaceae
Douglas spirea	Spiraea douglasii	Rosaceae
Evergreen huckleberry	Vaccinium ovatum	Ericaceae
False azalea	Rhododendron menziesii (Menziesia ferruginea)	Ericaceae
Indian plum	Oemleria cerasiformis	Rosaceae
Kinnikinnick	Arctostaphylos uva-ursi	Ericaceae
Mock orange	Philadelphus lewisii	Hydrangeaceae
Nootka rose	Rosa nutkana	Rosaceae
Oceanspray	Holodiscus discolor	Rosaceae
Orange honeysuckle	Lonicera ciliosa	Caprifoliaceae
Pacific crabapple	Malus fusca (Pyrus fusca)	Rosaceae
Pacific ninebark	Physocarpus capitatus	Rosaceae
Prickly currant	Ribes lacustre	Grossulariaceae
Red elderberry	Sambucus racemosa	Adoxaceae
Red flowering currant	Ribes sanguineum var. sanguineum	Grossulariaceae
Red huckleberry	Vaccinium parvifolium	Ericaceae
Red-osier dogwood	Cornus sericea	Cornaceae
Redstem Ceanothus	Ceanothus sanguineus	Rhamnaceae
Salal	Gaultheria shallon	Ericaceae
Salmonberry	Rubus spectabilis	Rosaceae
Serviceberry	Amelanchier alnifolia	Rosaceae
Soapberry	Shepherdia canadensis	Elaeagnaceae
Stink currant	Ribes bracteosum	Grossulariaceae
Tall Oregon grape	Mahonia aquifolium (Berberis aquifolium)	Berberidaceae
Thimbleberry	Rubus nutkanus (Rubus parviflorus)	Rosaceae
Thinleaf huckleberry	Vaccinium membranaceum	Ericaceae
Trailing blackberry	Rubus ursinus	Rosaceae
Vine maple	Acer circinatum	Sapindaceae

Herbaceous Plants (125)

<u>Common Name</u>	<u>Scientific Name</u>	<u>Family</u>
Amerian vetch	Vicia americana	Fabaceae
American brookline	Veronica americana	Plantaginaceae
American bumbleweed	Lycopus americanus	Lamiaceae
Attenuate paintbrush	Castilleja attenuata	Orbanchaceae
Baneberry	Actaea rubra	Ranunculaceae
Barestem biscuitroot	Lomatium nudicaule	Apiaceae
Bigleaf lupine	Lupinus polyphyllus var. polyphyllus	Fabaceae
Bigleaf sandwort	Moehringia macrophylla (Arenaria macrophylla)	Caryophyllaceae

Bleeding heart	<i>Dicentra formosa</i> ssp. <i>formosa</i>	Papaveraceae
Blister buttercup	<i>Ranunculus sceleratus</i>	Ranunculaceae
Bluntleaf sandwort	<i>Moehringia lateriflora</i> (<i>Arenaria lateriflora</i>)	Caryophyllaceae
Broadleaved starflower	<i>Lysimachia latifolia</i> (<i>Trientalis latifolia</i>)	Primulaceae
Broadleaved stonecrop	<i>Sedum spathulifolium</i>	Crassulaceae
Canada goldenrod	<i>Solidago lepida</i> (<i>Solidago canadensis</i> var. <i>subserrata</i>)	Asteraceae
Candyflower	<i>Claytonia sibirica</i> (<i>Montia sibirica</i>)	Montiaceae
Cascade goldenrod	<i>Solidago elongata</i>	Asteraceae
Cascade penstemon	<i>Penstemon serrulatus</i>	Plantaginaceae
Chickweed monkeyflower	<i>Erythranthe alsinoides</i> (<i>Mimulus alsinoides</i>)	Phrymaceae
Ciliate willowherb	<i>Epilobium glandulosum</i>	Onagraceae
Cleavers	<i>Galium aparine</i>	Rubiaceae
Coastal gumweed	<i>Grindelia hirsutula</i>	Asteraceae
Coastal strawberry	<i>Fragaria chiloensis</i>	Rosaceae
Coltsfoot	<i>Petasites frigidus</i>	Asteraceae
Common biscuitroot	<i>Lomatium utriculatum</i>	Apiaceae
Common mare's-tail	<i>Hippuris vulgaris</i>	Plantaginaceae
Common monkeyflower	<i>Erythranthe guttata</i> (<i>Mimulus guttatus</i>)	Phrymaceae
Common pink wintergreen	<i>Pyrola asarifolia</i>	Ericaceae
Common silverweed	<i>Potentilla anserina</i>	Rosaceae
Cooley's hedge-nettle	<i>Stachys cooleyae</i>	Lamiaceae
Cow clover	<i>Trifolium wormskioldii</i>	Fabaceae
Cow parsnip	<i>Heracleum maximum</i> (<i>Heracleum lanatum</i>)	Apiaceae
Creeping buttercup	<i>Ranunculus flammula</i>	Ranunculaceae
Crisped starwort	<i>Stellaria crispa</i>	Caryophyllaceae
Dark throat shooting star	<i>Dodecatheon pulchellum</i>	Primulaceae
Dotted saxifrage	<i>Micranthes nelsoniana</i>	Saxifragaceae
Douglas aster	<i>Symphyotrichum subspicatum</i> (<i>Aster subspicatus</i>)	Asteraceae
Enchanter's nightshade	<i>Circaea alpina</i> ssp. <i>pacifica</i>	Onagraceae
Evening primrose	<i>Oenothera biennis</i>	Onagraceae
Evergreen violet	<i>Viola sempervirnes</i>	Violaceae
Few-flowered clover	<i>Trifolium oliganthum</i>	Lamiaceae
Fireweed	<i>Chamaenerion angustifolium</i> (<i>Epilobium angustifolium</i>)	Onagraceae
Fragrant bedstraw	<i>Galium triflorum</i>	Rubiaceae
Fringecup	<i>Tellima grandiflora</i>	Saxifragaceae
Giant vetch	<i>Vicia nigricans</i> var. <i>gigantea</i> (<i>Vicia gigantea</i>)	Fabaceae
Goatsbeard	<i>Aruncus dioicus</i> var. <i>acuminatus</i> (<i>Aruncus sylvestris</i>)	Rosaceae
Grassland saxifrage	<i>Micranthes integrifolia</i>	Saxifragaceae
Green wintergreen	<i>Pyrola chlorantha</i>	Ericaceae
Hairy rockcress	<i>Arabis eschscholtziana</i> (<i>Arabis hirsuta</i>)	Brassicaceae
Harsh paintbrush	<i>Castilleja hispida</i>	Orobanchaceae
Henderson's checker-mallow	<i>Sidalcea hendersonii</i>	Malvaceae
Kneeling angelica	<i>Angelica genuflexa</i>	Apiaceae
Large-leaved avens	<i>Geum macrophyllum</i>	Rosaceae
Little buttercup	<i>Ranunculus uncinatus</i>	Ranunculaceae
Little western bittercress	<i>Cardamine oligosperma</i>	Brassicaceae
Low saltwort	<i>Salicornia depressa</i>	Amaranthaceae
Madweed	<i>Scutellaria lateriflora</i>	Lamiaceae
Maritime peavine	<i>Lathyrus japonicus</i>	Fabaceae
Marsh peavine	<i>Lathyrus palustris</i>	Fabaceae
Marsh violet	<i>Viola palustris</i>	Violaceae
Marsh yellowcress	<i>Rorippa palustris</i>	Brassicaceae
Meadow alumroot	<i>Heuchera chlorantha</i>	Saxifragaceae
Miner's lettuce	<i>Claytonia perfoliata</i>	Montiaceae
Mountain larkspur	<i>Delphinium menziesii</i>	Ranunculaceae
Mountain sweet-cicely	<i>Osmorhiza berteroi</i> (<i>Osmorhiza chilensis</i>)	Apiaceae
Nodding beggar-ticks	<i>Bidens cernua</i>	Asteraceae
Northern bugleweed	<i>Lycopus uniflorus</i>	Lamiaceae

Northern starwort	Stellaria calycantha	Caryophyllaceae
Oregon stonecrop	Sedum oreganum	Crassulaceae
Oregon sunshine	Eriophyllum lanatum	Asteraceae
Pacific hemlock-parsley	Conioselinum pacificum	Apiaceae
Pacific sanicle	Sanicula crassicaulis	Apiaceae
Pacific silverweed	Potentilla anserina ssp. pacifica (Potentilla pacifica)	Rosaceae
Pacific waterleaf	Hydrophyllum tenuipes	Hydrophyllaceae
Pathfinder	Adenocaulon bicolor	Asteraceae
Pennsylvania bittercress	Cardamine pensylvanica	Brassicaceae
Philadelphia fleabane	Erigeron philadelphicus	Asteraceae
Pickleweed	Salicornia pacifica	Amaranthaceae
Piggyback plant	Tolmiea menziesii	Saxifragaceae
Pipsissewa	Chimaphila umbellata	Ericaceae
Pond lily	Nuphar polysepala	Nymphaeaceae
Poverty clover	Trifolium deparperatum	Lamiaceae
Puget Sound gumweed	Grindelia integrifolia	Asteraceae
Purple sweet-cicely	Osmorhiza purpurea	Apiaceae
Red columbine	Aquilegia formosa var. formosa	Ranunculaceae
Rough cinquefoil	Potentilla norvegica	Rosaceae
Round-leaved violet	Viola orbiculata	Violaceae
Scouler's harebell	Campanula scouleri	Campanulaceae
Scouler's valerian	Valeriana scouleri	Valerianaceae
Sea milkwort	Lysimachia maritima	Primulaceae
Seaside plantain	Plantago maritima	Plantaginaceae
Sea-watch	Angelica lucida	Apiaceae
Selfheal	Prunella vulgaris	Lamiaceae
Sharp-tooth angelica	Angelica arguta	Apiaceae
Silver bursage	Ambrosia chamissonis	Asteraceae
Single-flowered pipe	Monotropa uniflora	Ericaceae
Small-flowered alumroot	Heuchera micrantha	Saxifragaceae
Small-flowered nemophila	Nemophila parviflora	Hydrophyllaceae
Small-flowered willowherb	Epilobium minutum	Onagraceae
Small-head clover	Trifolium microcephalum	Lamiaceae
Souler's St. John's wort	Hypericum scouleri	Hypericaceae
Spreading dogbane	Apocynum adrosaemifolium	Apocynaceae
Spring water-starwort	Callitriche palustris	Plantaginaceae
Stinging nettle	Urtica dioica	Urticaceae
Straightbeak buttercup	Ranunculus orthorhynchus	Ranunculaceae
Streambank spring beauty	Montia parvifolia	Montiaceae
Suksdorf's sagewort	Artemisia suksdorfii	Asteraceae
Tall annual willowherb	Epilobium brachycarpum	Onagraceae
Tall pussy-toes	Antennaria anaphaloides	Asteraceae
Three-leaf foamflower	Tiarella trifoliata var. trifoliata	Saxifragaceae
Twinflower	Linnaea borealis ssp. longiflora	Linnaeaceae
Vanilla leaf	Achlys triphylla	Berberidaceae
Water crowfoot	Ranunculus aquatilis	Ranunculaceae
Water parsley	Oenanthe sarmentosa	Apiaceae
Water parsnip	Sium suave	Apiaceae
Water smartweed	Persicaria amphibia (Polygonum amphibium)	Polygonaceae
Water starwort	Callitriche heterophylla	Plantaginaceae
Watson's willowherb	Epilobium ciliatum	Onagraceae
Western dock	Rumex occidentalis var. occidentalis	Polygonaceae
Western parsley-piert	Aphanes occidentalis	Rosaceae
Western water hemlock	Cicuta douglasii	Apiaceae
White-vein wintergreen	Pyrola picta	Ericaceae
Wild ginger	Asarum caudatum	Aristolochiaceae
Woodland strawberry	Fragaria vesca	Rosaceae
Woolly pussy-toes	Antennaria lanata	Asteraceae

Yarrow	Achillea millefolium	Asteraceae
Grasses, Grass-Like Plants, and Related Species (112)		
<u>Common Name</u>	<u>Scientific Name</u>	<u>Family</u>
Alaska brome	Bromus sitchensis	Poaceae
American dunegrass	Leymus mollis ssp. mollis (Elymus mollis)	Poaceae
American mannagrass	Glyceria grandis	Poaceae
Artic wheatgrass	Elymus violaceus	Poaceae
Baltic rush	Juncus balticus ssp. ater	Juncaceae
Beaked ditch-grass	Ruppia maritima	Ruppiaceae
Beaked sedge	Carex utriculata	Cyperaceae
Bearded fescue	Festuca subulata	Poaceae
Black rush	Juncus gerardii	Juncaceae
Blue wildrye	Elymus glaucus	Poaceae
Bluebunch fescue	Festuca idahoensis	Poaceae
Blue-eyed grass	Sisyrinchium idahoensis	Iridaceae
Bluejoint reedgrass	Calamagrostis canadensis	Poaceae
Blunt spikerush	Eleocharis obtusa	Cyperaceae
Bolander's bluegrass	Poa bolanderi	Poaceae
Bolander's rush	Juncus bolanderi	Juncaceae
California oatgrass	Danthonia californica	Poaceae
Canadian wildrye	Elymus canadensis	Poaceae
Chocolate lily	Fritillaria affinis (Fritillaria lanceolata)	Liliaceae
Columbia brome	Bromus vulgaris	Poaceae
Common camas	Camassia leichtlinii	Liliaceae
Common cattail	Typha latifolia	Typhaceae
Common eelgrass	Zostera marina	Zosteraceae
Common spikerush	Eleocharis palustris	Cyperaceae
Common three square	Schoenoplectus pungens	Cyperaceae
Common woodrush	Luzula multiflora ssp. Multiflora	Juncaceae
Coville's rush	Juncus covillei	Juncaceae
Creeping spikerush	Eleocharis marcostachya	Cyperaceae
Crinkle-awn fescue	Festuca subulifolora	Poaceae
Cusick's sedge	Carex cusickii	Cyperaceae
Dagger rush	Juncus ensifolius	Juncaceae
Delicate sedge	Carex leptalea	Cyperaceae
Dewey's sedge	Carex deweyana	Cyperaceae
Duckweed	Lemna turionifera	Araceae
Dwarf alkali grass	Puccinellia pumila	Poaceae
Fairy slipper	Calypso bulbosa	Orchidaceae
False lily-of-the-valley	Maianthemum dilatatum	Asparagaceae
False Solomon's seal	Maianthemum racemosum ssp. amplexicaule	Asparagaceae
Fern pondweed	Potamogeton robbinsii	Potamogetonaceae
Floating-leaf pondweed	Potamogeton natans	Potamogetonaceae
Fowl mannagrass	Glyceria striata	Poaceae
Fox sedge	Carex vulpinoidea	Cyperaceae
Golden-eyed grass	Sisyrinchium californicum	Iridaceae
Great bulrush	Schoenoplectus tabernaemontani (Scirpus validus)	Cyperaceae
Great camas	Camassia quamash	Liliaceae
Green sedge	Carex viridula	Cyperaceae
Green-sheath sedge	Carex feta	Cyperaceae
Hardstem bulrush	Schoenoplectus acutus	Cyperaceae
Henderson's sedge	Carex hendersonii	Cyperaceae
Hooded ladies'-tresses	Spiranthes romanzoffiana	Orchidaceae
Hyacinth brodiaea	Triteleia hyacinthina (Brodiaea hyacinthina)	Asparagaceae
Inland sedge	Carex interior	Cyperaceae
Joint-leaved rush	Juncus articulatus	Juncaceae
Knotty leaf rush	Juncus acuminatus	Juncaceae
Koeler's grass	Koeleria macrantha	Poaceae

Leafy pondweed	Potamogeton foliosus	Potamogetonaceae
Lingby's sedge	Carex lyngbyei (Carex lyngbyei var. robusta)	Cyperaceae
Long-leaved pondweed	Potamogeton nodosus	Potamogetonaceae
Long-stolon sedge	Carex inops	Cyperaceae
Meadow barley	Hordeum brachyantherum ssp. brachyantherum	Poaceae
Needle spikerush	Eleocharis acicularis	Cyperaceae
Nodding onion	Allium cernuum	Amaryllidaceae
Nodding trisetum	Trisetum cernuum	Poaceae
Northern clustered sedge	Carex arcta	Cyperaceae
Nuttall's alkalia grass	Puccinellia nuttalliana	Poaceae
Olney's bulrush	Schoenoplectus americanus	Cyperaceae
Oval broom sedge	Carex leporina	Cyperaceae
Ovoid spikerush	Eleocharis ovata	Cyperaceae
Pacific brome	Bromus pacificus	Poaceae
Phantom orchid	Cephalanthera austiniiae (Euburophyton austiniiae)	Orchidaceae
Poverty oatgrass	Danthonia spicata	Poaceae
Poverty rush	Juncus tenuis	Juncaceae
Purple reedgrass	Calamagrostis purpurascens	Poaceae
Rattlesnake plantain	Goodyera oblongifolia	Orchidaceae
Red fescue	Festuca rubra	Poaceae
Rice cut grass	Leersia oryzoides	Poaceae
Richardson's pondweed	Potamogeton richardsonii	Potamogetonaceae
Roemer's fescue	Festuca roemeri	Poaceae
Rusty sedge	Carex subfusca	Cyperaceae
Sawbeak sedge	Carex stipata var. stipata	Cyperaceae
Seacoast bulrush	Bolboschoenus maritimus ssp. paludosus (Scirpus maritimus)	Cyperaceae
Seashore saltgrass	Distichlis spicata	Poaceae
Seaside arrowgrass	Triglochin maritima (Triglochin maritimum)	Juncaginaceae
Showy sedge	Carex spectabilis	Cyperaceae
Silvery sedge	Carex canescens	Cyperaceae
Six-weeks fescue	Vulpia octoflora	Poaceae
Skunk cabbage	Lysichiton americanus (Lysichiton americanum)	Araceae
Slender hairgrass	Deschampia elongata	Poaceae
Slender wheatgrass	Elymus trachycaulus	Poaceae
Slender-spike mannagrass	Glyceria leptostachya	Poaceae
Slimstem reedgrass	Calamagrostis stricta ssp. Inexpansa	Poaceae
Slough sedge	Carex obnupta	Cyperaceae
Small floating mannagrass	Glyceria borealis	Poaceae
Small pondweed	Potamogeton pusillus	Potamogetonaceae
Small-flowered bulrush	Scirpus microcarpus	Cyperaceae
Small-flowered woodrush	Luzula parviflora (Luzula divaricata)	Juncaceae
Smooth-stemmed sedge	Carex laeviculmis	Cyperaceae
Soft rush	Juncus effusus	Juncaceae
Spotted coralroot	Corallorhiza maculata	Orchidaceae
Star sedge	Carex echinata	Cyperaceae
Tall false oat	Trisetum canescens	Poaceae
Tall mannagrass	Glyceria elata	Poaceae
Taperfruit shortscale Sedge	Carex leptopoda	Cyperaceae
Ticklegrass	Agrostis scabra	Poaceae
Toad rush	Juncus bufonius	Juncaceae
Tufted hairgrass	Deschampsia cespitosa	Poaceae
Twisted-stalk	Streptopus amplexifolius	Liliaceae
Wapato	Sagittaria latifolia	Alismataceae
Western fescue	Festuca occidentalis	Poaceae
White bog orchid	Platanthera dilatata var. leucostachys	Orchidaceae
White trillium	Trillium ovatum var. ovatum	Melanthiaceae
Wiregrass	Carex lasiocarpa	Cyperaceae

Figure 2. City of Bellingham Watersheds and Sub-watersheds

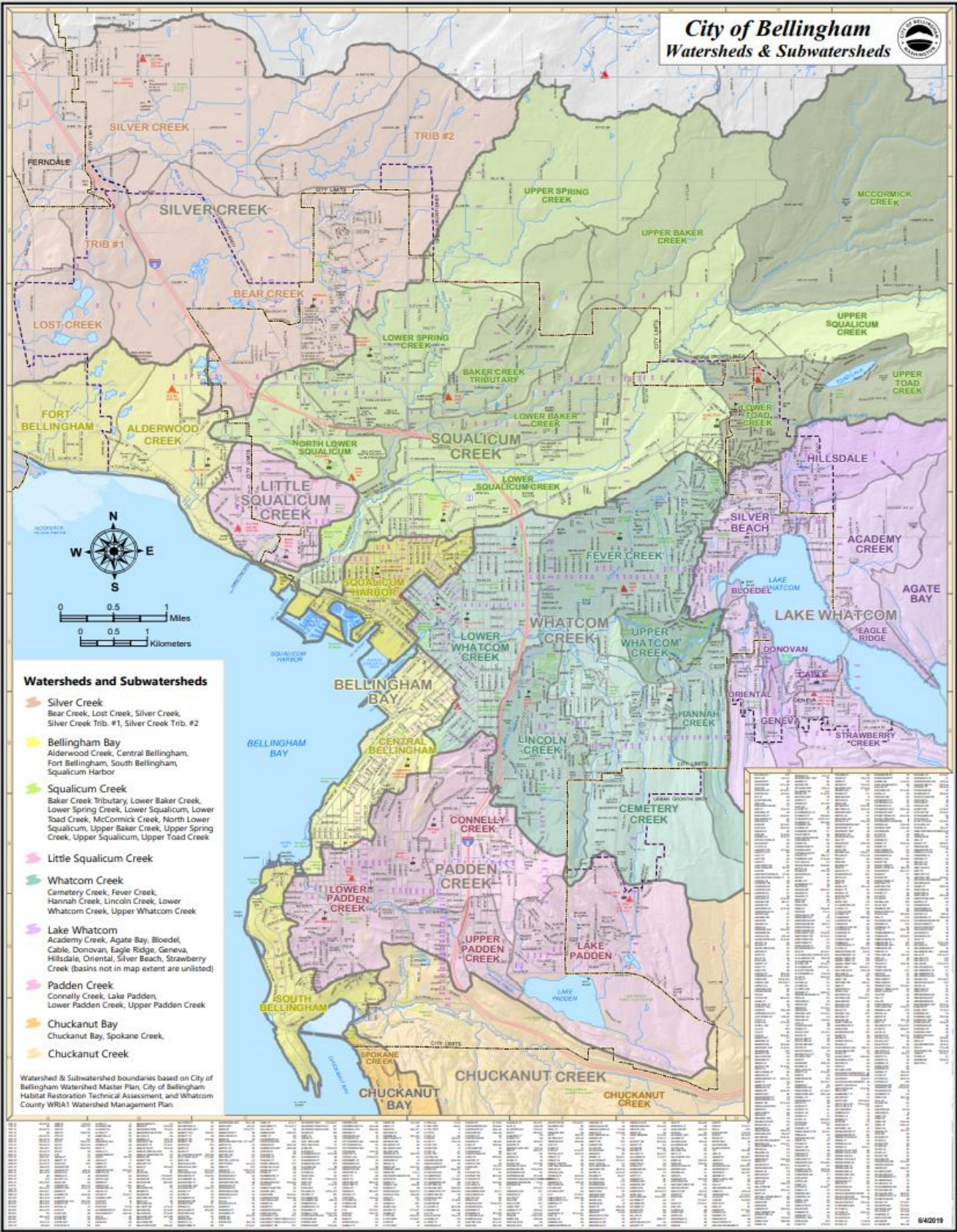


Figure 3. Level III Ecoregions of Washington. The Puget Trough Ecoregion is highlighted in dark green.

