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.

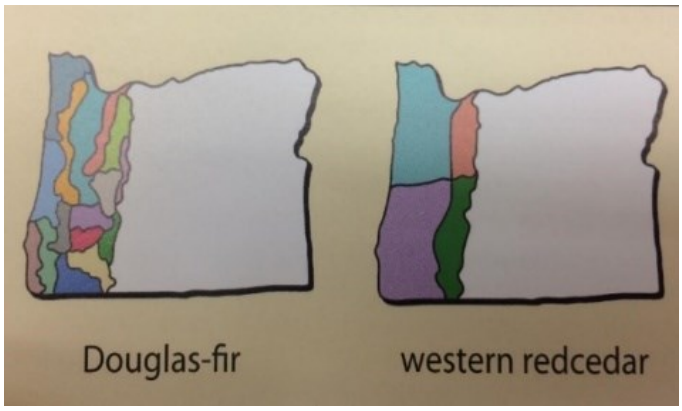

Figure 1. Seed transfer zones for Douglas fir and western red cedar in Oregon [19].

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].

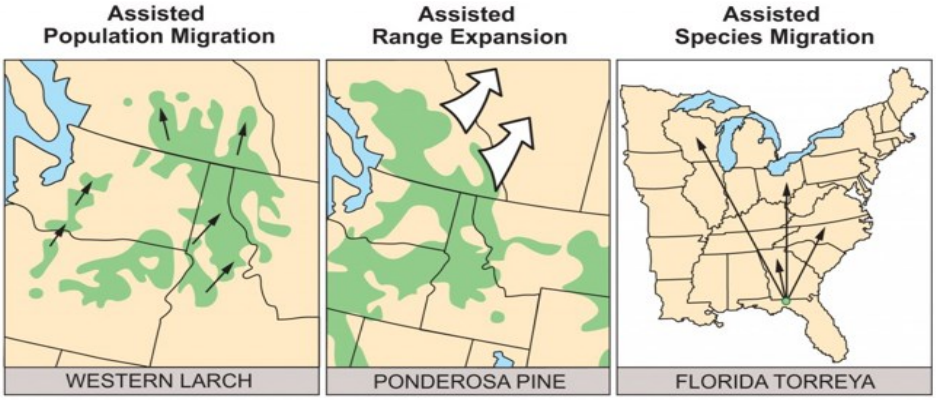

Figure 2. Three forms of assisted migration: assisted population migration, assisted range expansion, and assisted species migration [48].

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].

References

1. Omernik JM and GE Griffith. 2014. Ecoregions of the conterminous United States: evolution of a hierarchical spatial framework. *Environmental Management,* 54: 1249-1266. Available online: https://data-wadnr.opendata.arcgis.com/datasets/3b9362e8f29e465a985aa8ddc8de2d86_0?geometry=-130.278%2C46.891%2C-117.006%2C49.454
2. Falk DA and KE Holsinger. 1991. Appendix. Genetic sampling guidelines for conservation collections of endangered plants. In: DA Falk and KE Holsinger, (eds.). *Genetics and conservation of rare plants*.
3. Kaye TN. 2001. Common ground and controversy in native plant restoration. In: Haase DL and R Rose, (eds.). Proceedings of the Conference: Native Plant Propagation and Restoration Strategies. Nursery Technology Cooperative and Western Forestry and Conservation Association. Eugene, OR.
4. U. S. Forest Service. 2012 Native Plant Materials Policy, https://www.fs.fed.us/wildflowers/Native_Plant_Materials/documents/NativePlantMaterialsPolicy_Sept2012.pdf
5. Withrow-Robinson B and R Johnson. 2006. Selecting native plant materials for restoration projects. Corvallis, OR. Oregon State University Extension Service.
6. Joshi J, B Schmid, MC Caldeira, PG Dimitrakopoulos, et al. 2001. Local adaptation enhances performance of common plant species. *Ecology Letters*, 4: 536-544.
7. Roybal CM and BJ Butterfield. Functional trait heritability and local climatic adaptation among grasses: a meta-analysis. 2018. *Plant Ecology*, 219:369-379.
8. Kawecki TJ and D Ebert. 2004. Conceptual issues in local adaptation. *Ecology Letters,* 7:1225–1241.
9. Bucharova A, S Michalski, JM Hermann, K Heveling, et al. 2017. Genetic differentiation and regional adaptation among seed origins used for grassland restoration: Lessons from a multi-species transplant experiment. *Journal of Applied Ecology*, 54: 127–136.
10. Rua MA, A Antonika, PM Antunes, VB Chaudhary, et al. 2016. Home-field advantage? Evidence of local adaptation among plant, soil, and arbuscular mycorrhizal fungi through meta-anaylsis. *BMC Evolutionary Biology*, https://doi.org/10.1186/s12862-016-0698-9.
11. Montalvo AM and NC Ellstrand. 2000. Transplantation of the subshrub *Lotus scoparius*: testing the home-site advantage hypothesis*. Conservation Biology*, 14: 1034-1045.
12. Bennington CC, N Fetcher, MC Vavrek, GS Shaver, et al. 2012. Home site advantage in two long-lived artic plant species: results from two 30-year reciprocal transplant studies. *Journal of Ecology*, 100: 841-851.
13. Miller SA, A Bartow, M Gisler, K Ward, et al. 2011. Can an ecoregion serve as a seed transfer zone? Evidence from a common garden study with five native species. *Restoration Ecology*, 2: 1-9.
14. St. Clair JB. The development of forest tree seed zones in the Pacific Northwest of the United States. 2014. In: Bozza M, R Jalonen, E Thomas, D Boshier, L Gallo, S Cavers, S Bordiics, P Smith, (eds.). 2014. *Genetic considerations in ecosystem restoration using*

native tree species. State of the World's Forest Genetic Resources-Thematic Study. Rome, FAO and Bioversity International.
15. Want IJ and GS Bradburd. 2014. Isolation by environment. *Molecular Ecology*, 23: 5469-5662.
16. Slatkin M. 1993. Isolation by distance in equilibrium and non-equilibrium populations. *Evolution*, 47: 264–279.
17. Bower AD, JB St. Clair and V Reickson. 2014. Generalized provisional seed zones for native plants. *Ecological Applications*, 24: 913-919.
18. Johnson GR, FC Sorensen, JB St. Clair and RC Cronn. 2004. Pacific northwest forest tree seed zones: a template for native plants? *Native Plants*, 52: 131-140.
19. Steinfeld DE, S Riley, KM Wilkinson, et al. Roadside revegetation: An Integrated Approach to Establishing Native Plants. Federal Highway Administration, FHWA-WFL/TD-07-005.
20. Rogers DL and AM Montalvo. 2004. Genetically appropriate choices for plant materials to maintain biological diversity. University of California. Report to the USDA Forest Service, Rocky Mountain region, Lakewood, CO.
21. Jørgensen D. 2015. Ecological restoration as objective, target, and tool in international biodiversity policy. *Ecology and Society* 20, 4:43.
22. Ruiz-Jaen MC and TM Aide. 2005. Restoration success: how is it being measured? *Restoration Ecology,* 13: 569–577.
23. Brudvig LA. 2011. The restoration of biodiversity: where has research been and where does it need to go? *American Journal of Botany*, 98: 549–558.
24. Wortley L, JM Hero and M Howes. 2013. Evaluating ecological restoration success: a review of the literature. *Restoration Ecology,* 21: 537–543.
25. Mijangos JL, C Pacioni, PBS Spencer and MD Craig. 2015. Contribution of genetics to ecological restoration. *Molecular Ecology*, 24: 22–37.
26. Prober SM, VAJ Doerr, LM Broadhurst, KJ Williams, et al. 2019. Shifting the conservation paradigm: a synthesis of options for renovating nature under climate change. *Ecological Monographs*, 89: 1-23.
27. Sgro CM, AJ Lowev and AA Hoffman. 2011. Building evolutionary resilience for conserving biodiversity under climate change. *Evolutionary Applications*, 4: 326-337.
28. Prober SM, KJ Williams, LM Broadhurst and VAJ Doerr. 2017. Nature conservation and ecological restoration in a changing climate: what are we aiming for? *Rangeland Journal*, 39: 477-486.
29. Reynolds LK, KJ McGlathery and M Waycott. 2012. Genetic diversity enhances restoration success by augmenting ecosystem services. *PLoS ONE*, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0038397.
30. Thomas E, R Jalonen, J Loo, D Boshier, et al. 2014. Genetic considerations in ecosystem restoration using native tree species. *Forest Ecology and Management*, 333: 66-75.
31. Mijnsbrugge KV, A Bischoff and B Smith. A question of origin: where and how to collect seed for ecological restoration. 2009. *Basic and Applied Ecology*, 11: 300-311.
32. Espeland EK, NC Emery, KL Mercer, SA Woolbright, et al. 2017. Evolution of plant materials for ecological restoration: insights from the applied and basic literature. *Journal of Applied Ecology,* 54: 102–115.

33. Aavik T and A Helm. 2017. Restoration of plant species and genetic diversity depends on landscape–scale dispersal. *Restoration Ecology*. 26: 92–102.
34. Landis T, D Dreesen and KR Dumroese. 2003. Sex and the single S*alix*: considerations for riparian restoration. *Native Plants Journal,* 4: 110-117.
35. McLachlan JS, JJ Hellmann and MW Schwartz. 2007. A framework for debate of assisted migration in an era of climate change. *Conservation Biology*, 21: 297-302.
36. Davis MB and RG Shaw. 2001. Range shifts and adaptive responses to Quaternary climate change. *Science*, 291: 673-679.
37. Petit RJ, F Sheng Hu, and CW Dick. 2008. Forests of the past: a window to future changes. *Science*, 320: 1450-1452.
38. Malcolm JR, A Markham, RP Neilson and M Garaci. 2002. Estimated migration rates under scenarios of global climate change. *Journal of Biogeography,* 29: 835–849.
39. Jump AS and J Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. *Ecology Letters*, 8: 1010–1020.
40. Aitken SN, S Yeaman, JA Holliday, W TongLi, et al. 2008. Adaptation, migration or extirpation: climate change outcomes for tree populations. *Evolutionary Applications*, 1: 95–111.
41. Corlett RT and DA Westcott. 2013. Will plant movements keep up with climate change? *Trends in Ecology and Evolution*, 28: 482-488.
42. Hoffmann AA and CM Sgro. 2011. Climate change and evolutionary adaptation. *Nature*, 470: 479-485.
43. McKay JK, CE Christian, S Harrison and KJ Rice. 2005. "How local is local?"— a review of practical and conceptual issues in the genetics of restoration. *Restoration Ecology,* 13: 432-440.
44. Lawing MA and PD Polly. 2011. Pleistocene climate, phylogeny, and climate envelope models: an integrative approach to better understand species' response to climate change, *PloS ONE,* https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0028554
45. Aitken SN, S Yeaman, JA Holliday, T Wang, et al. 2008. Adaptation, migration, or extirpation: climate change outcomes for tree populations. Evolutionary Applications, 1: 95-111.
46. Zhu K, CW Woodall and JS Clark. 2012. Failure to migrate: lack of tree range expansion in response to climate change. Global Change Biology, 18: 1042–1052.
47. Vitt P, PN Belmaric, R Book and M Curran. 2016. Assisted migration as a climate change adaptation strategy: lessons from restoration and plant reintroductions. *Israel Journal of Plant Sciences*, 63: 250-261.
48. Williams MI and RK Dumroese. 2014. Planning the future's forests with assisted migration [Chapter 8]. In: Sample, V. Alaric; Bixler, R. Patrick, (eds.). Forest conservation and management in the Anthropocene: Conference proceedings. Proceedings. RMRS-P-71. Fort Collins: CO: US Department of Agriculture, Forest Service. Rocky Mountain Research Station. p. 133-144.
49. Ste-Marie C, E Nelson, A Dabros and ME Bonneau. *2011*. Assisted migration: introduction to a multifaceted concept. *The Forestry Chronicle*, 87: 724-730.

50. Gray LK, T Gylander, MS Mbogga, Pei-Yu Chen and A Hamann. 2011. Assisted migration to address climate change: recommendations for aspen reforestation in western Canada. *Ecological Applications*, 21: 1591-1603.
51. Wang Y, JLM Pederson, SE Macdonald, SE Nielsen, et al. 2019. Experimental test of assisted migration for conservation of locally range-restricted plants in Alberta, Canada. Global Ecology and Conservation. sciencedirect.com/science/article/pii/s2351989418303342.
52. Templeton AR. 1991. Off-site breeding of animals and implications for plant conservation strategies. In Genetics and conservation of rare plants, edited by DA Falk and KE Holsinger. New York: Oxford University Press.
53. Handler S, C Pike and JB St. Clair. 2018. Assisted Migration. USDA Forest Service Climate Change Resource Center, https://www.fs.usda.gov/ccrc/topics/assisted-migration.
54. Kranabetter JM, M Stoehr and GA O'Neil. 2015. Ectomycorrhizal fungal maladaptation and growth reduction associated with assisted migration of Douglas fir. *New Phytologist*, 206: 1135-1144.
55. Aitken S and JB Bemmels. 2015. Time to get moving: assisted gene flow of forest trees. Evolutionary applications, 9: 271-290.
56. Consortium of Pacific Northwest Herbaria Specimen Database (CPNWH). 2022. Website https://www.pnwherbaria.org (accessed February 7, 2022).
57. Knoke D. 2004. Vascular Plant List: Whatcom County. Washington Native Plant Society. https://www.wnps.org/plant-lists/list?Whatcom_County#specieslist

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

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

Shrubs, Vines, and Trailing Plants (42)

Common Name	Scientific Name	Family
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 horridus (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)

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

Northern starwort	Stellaria calycantha	Caryophyllaceae
Oregon stonecrop	Sedum oreganum	Crassulaceae
Oregon sunshine	Eriophyllum lanatum	Asteraceae
Pacifc 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-starwart	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 heterohylla	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)	
Common Name	**Scientific Name**	**Family**
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 candensis	Poaceae
Blunt spikerush	Eleocharis obtusa	Cyperaceae
Bolander's bluegrass	Poa bolanderi	Poaceae
Bolander's rush	Juncus bolanderi	Juncaceae
California oatgrass	Danthonia califonica	Poaceae
Canadian wildrye	Elymus candensis	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	Carexs 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 austiniae (Eburophyton austiniae)	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

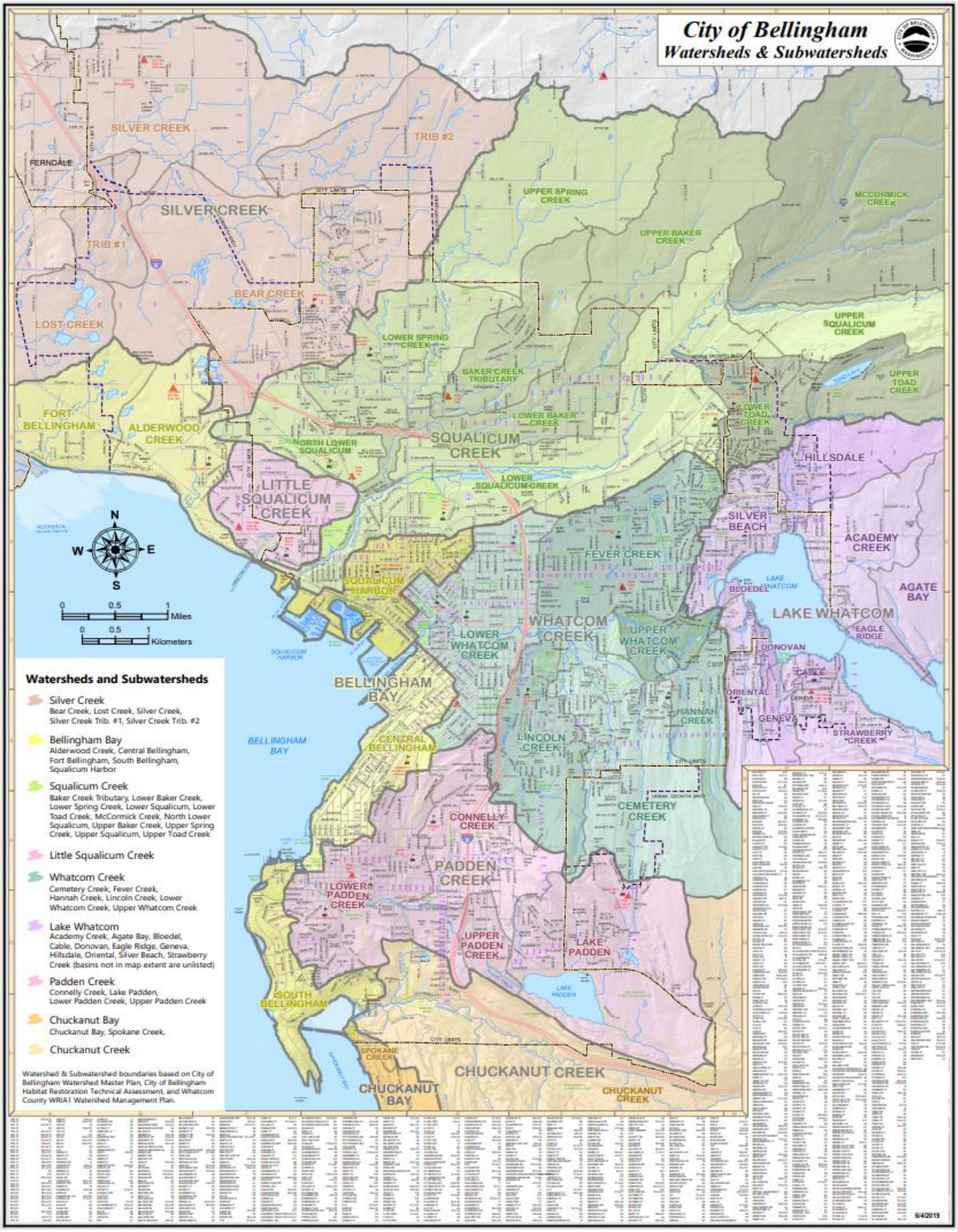

Figure 3. Level III Ecoregions of Washington. The Puget Trough Ecoregion is highlighted in dark green.