

Plant Propagation Protocol for *Vaccinium Ulginosum* (VAUL)
 ESRM 412 – Native Plant Production

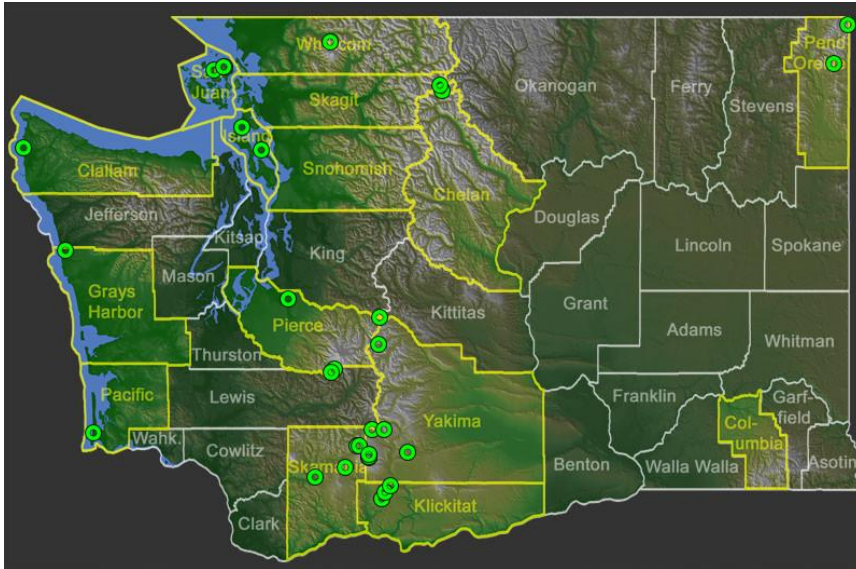


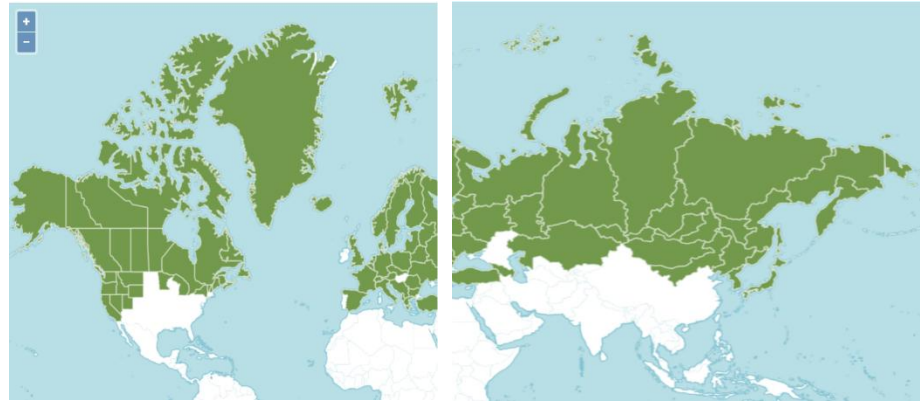
Image Source: WTU Herbarium n.d. with photo taken by Gerald D. Carr 2006

TAXONOMY	
Plant Family	
Scientific Name	Family: Ericaceae – Heath family <i>Vaccinium uliginosum</i> L. <i>Species ID – VAUL (Per USDA Website)</i> Source: Ross 2023 and USDA Plant Database 2014
Common Name	English: Bog Blueberry, Northern Bilberry, Alpine Blueberry, Lowbush Blueberry, Bilberry Welsh: Llus y Gors, Llusen y Gors, Lluswydd Mwyaf, Lluswydden Fawr Indigenioius Alaskan: asiavik [Inupiaq]; qiuq, curaq [Yup’ik]; cuawak [Alutiiq]; ugiidgin [Unangam Tunuu (Aleut)]; kanat’a [Tlingit]; nilyagh [Deg Xinag Athabaskan]; gega, gegashla [Dena’ina Athabaskan]; gege, nelyaage [Koyukon Athabaskan]; gigi gheli [Ahtna Athabaskan] Source: Atlas n.d. (English and Welsh) and Ross 2023
Species Scientific Name	

<p>Scientific Name</p>	<p>Accepted Name: <i>Vaccinium uliginosum</i> L. Publication: Sp. Pl. 1: 350. 1753.</p> <p>Source: WTU Herbarium n.d. Image Source: Atlas n.d.</p> <p>Species Authority: Matthews, Robin F. (Rocky Mountain Research Station, 2009)</p> <p>Classification</p> <ul style="list-style-type: none"> unranked Biota domain Eukaryota kingdom Plantae phylum Tracheophyta class Magnoliopsida order Ericales family Ericaceae genus <i>Vaccinium</i> species <i>Vaccinium uliginosum</i>
<p>Varieties</p>	<p>Accepted Intraspecies per KEW Database:</p> <p><i>Vaccinium uliginosum</i> var. <i>japonicum</i> T.Yamaz. <i>Vaccinium uliginosum</i> subsp. <i>nanum</i> (Boiss.) Rivas Mart., A.Asensi, Molero Mesa & F.Valle <i>Vaccinium uliginosum</i> subsp. <i>uliginosum</i> <i>Vaccinium uliginosum</i> subsp. <i>vulcanorum</i> (Kom.) Alsos & Elven</p> <p>Source: <i>Vaccinium uliginosum</i> L n.d.</p> <p>NOTE: No specific varieties were mentioned by USDA, only sub-species</p>
<p>Sub-species</p>	<p>Subspecies per USDA Database:</p> <p>VAOC – <i>Vaccinium occidentale</i> A. Gray VAULA – <i>Vaccinium uliginosum</i> L. ssp. <i>Aplinum</i> (Bigelow) Hultén VAULG - <i>Vaccinium uliginosum</i> L. ssp. <i>gaultherioides</i> (Bigelow) Young VAULM - <i>Vaccinium uliginosum</i> L. ssp. <i>microphyllum</i> Lange VAULO - <i>Vaccinium uliginosum</i> L. ssp. <i>occidentale</i> (A. Gray) Hultén VAULP - <i>Vaccinium uliginosum</i> L. ssp. <i>pedris</i> (HarshA. Berger) Young VAULP2 - <i>Vaccinium uliginosum</i> L. ssp. <i>pubescens</i> (Wormsk) S.B. Young VAULA2 - <i>Vaccinium uliginosum</i> L. var. <i>alpinum</i> Bigelow VAULO2 - <i>Vaccinium uliginosum</i> L. var. <i>occidentale</i> (A. Gray) H. Hara</p> <p>Source: USDA Plant Database 2014</p>
<p>Cultivar</p>	<p>None are listed on the USDA Database</p>
<p>Common Synonym(s)</p>	<p>Taxonomic synonyms in literature:</p> <p><i>Vaccinium uliginosum</i> L. ssp. <i>alpinum</i> (Bigelow) Hultén <i>Vaccinium uliginosum</i> L. ssp. <i>microphyllum</i> Lange <i>Vaccinium uliginosum</i> L. var. <i>salicinum</i> (Cham.) Hult.</p> <p>Synonyms & Misapplications:</p> <p><i>Vaccinium gaultherioides</i> Bigelow <i>Vaccinium occidentale</i> A. Gray [HC] <i>Vaccinium uliginosum</i> L. ssp. <i>alpinum</i> (Bigelow) Hultén</p>

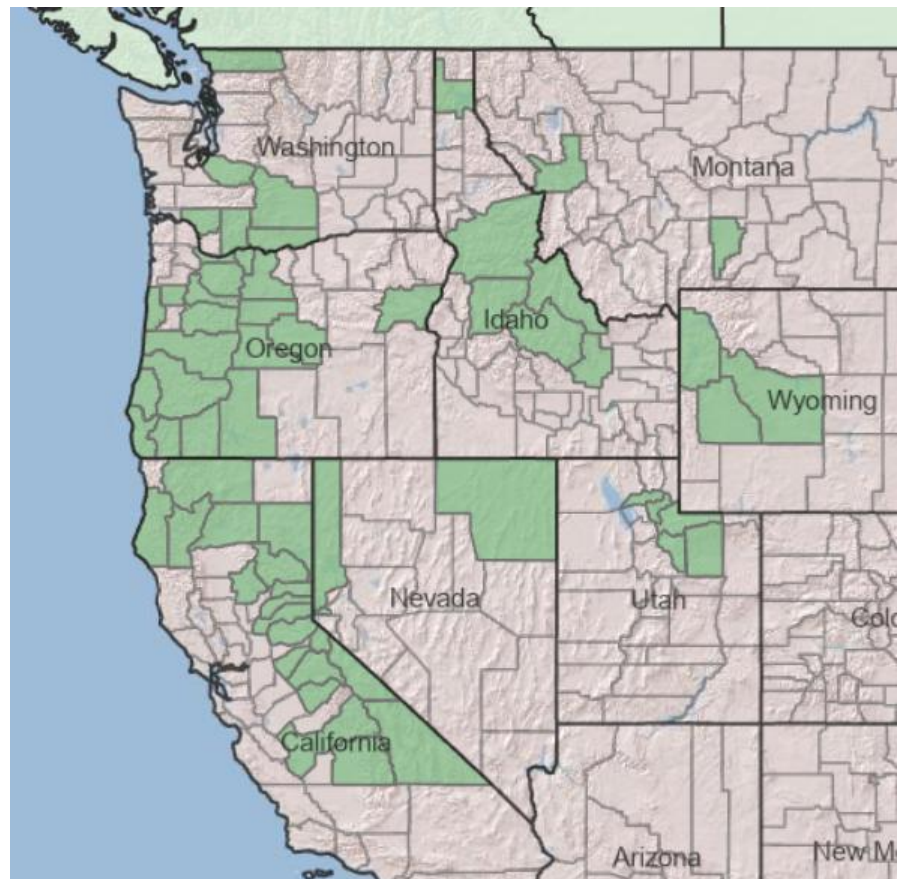
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Common Name(s)	<p>Bog blueberry, Bog bilberry, Alpine bilberry, Bog huckleberry, Bog whortleberry, Western-huckleberry Source: Ross 2023</p>																						
Species Code (as per USDA Plants database)	<p>VAUL Source: USDA Plant Database 2014</p>																						
GENERAL INFORMATION																							


Geographical range




Source: USDA Plant Database 2014 and *Vaccinium uliginosum* n.d.

As shown in each map provided, the *Vaccinium Uliginosum* appears across many continents north of the equator. Some countries that consider this plant native include North America, Canada, Greenland, United Kingdom, Russia, China, and Japan. It is important to note, however, that these findings could represent other (sub/infra)species that look extremely similar to the Bog Blueberry but were misclassified.



	<p>Specifically in the Pacific Northwest, these counties are as follows:</p> <p>Washington – Whatcom County, Pierce County, Yakima County, Cowlitz County, Skamania County, and Klickitat County</p> <p>Oregon – Baker County, Hood River County, Multnomah County, Wasco County, Clackamas County, Marion County, Polk County, Lincoln County, Linn County, Jefferson County, Crook County, Deschutes County, Lane County, Douglas County, Coos County, Curry County, Josephine County, Jackson County, Klamath County, Josephine County, and Deschutes County</p> <p>California – Siskiyou County, Trinity County, Humboldt County, Lassen County, Plumas County, Butte County, Shasta County, etc.</p> <p>Source: USDA Plant Database 2014</p>
<p>Ecological distribution</p>	<p>Bog blueberries are found across North America – stretching from the Pacific Ocean to the Atlantic. Throughout all of these regions, the main habitat can be classified as bogs and fens at low elevation. The Bog blueberry has adapted to habitats similar to subalpine heaths, slightly dry or wet alpine tundra, open woodlands, and various bogs. They are found at low elevations on both sides of the Washington Cascades.</p>  <p>Source: Ross 2023 and WTU Herbarium n.d.</p> <p>Furthermore, on the east coast – near the Great lakes – it is recorded as being found in exposed rocky shorelines and rock pools. Since the plant creates low-lying root systems, similar to <i>Pinguicula vulgaris</i> (Butterwort) and <i>Bistorta vivipara</i> (alpine bistort), it tends to not be found in areas of high movement and large debris – like a boulder field or a gravel beach.</p> <p>Text and Image Source: Smith 2024</p> <p>Other sources describe how the Bog blueberry is found in specific types of forests containing trees such as Jack Pine (<i>Pinus Banksiana</i>), Balsam fir (<i>Abies balsamea</i>), Black Spruce (<i>Picea mariana</i>), White Spruce (<i>Picea glauca</i>), and Tamarack (<i>Larix laricina</i>).</p>

	<p>Additional plant species, quoted from the USDA Rocky Mountain Research Station includes:</p> <p>”Alaska-cedar (<i>Chamaecyparis nootkatensis</i>), quaking aspen (<i>Populus tremuloides</i>), balsam poplar (<i>P. balsamifera</i>), and paper birch (<i>Betula papyrifera</i>)...</p> <p>Associated understory species include: willows (<i>Salix</i> spp.), alders (<i>Alnus</i> spp.), bog birch (<i>Betula glandulosa</i>), dwarf arctic birch (<i>B. nana</i>), Labrador tea (<i>Ledum groenlandicum</i> and <i>L. palustre</i>), lignonberry (<i>Vaccinium vitis-idaea</i>), bunchberry dogwood (<i>Cornus canadensis</i>), rustyleaf menziesia (<i>Menziesia ferruginea</i>), crowberry (<i>Empetrum nigrum</i>), red fruit bearberry (<i>Arctostaphylos rubra</i>), leatherleaf (<i>Chamaedaphne calyculata</i>), bog laurel (<i>Kalmia polifolia</i>), cloudberry (<i>Rubus chamaemorus</i>), bog rosemary (<i>Andromeda polifolia</i>), salal (<i>Gaultheria shallon</i>), fireweed (<i>Epilobium angustifolium</i>), Labrador lousewort (<i>Pedicularis labradorica</i>), entire leaf mountain avens (<i>Dryas integrifolia</i>), Mt. Washington mountain avens (<i>D. octopetala</i>), bluejoint reedgrass (<i>Calamagrostis canadensis</i>), altai fescue (<i>Festuca altaica</i>), cottonsedge (<i>Eriophorum vaginatum</i> and <i>E. angustifolium</i>), and various sedges (<i>Carex</i> spp.), feathermosses (<i>Hylocomium</i>, <i>Pleurozium</i>, and <i>Stereocaulon</i> spp.), clubmosses (<i>Lycopodium</i> spp.), sphagnum mosses (<i>Sphagnum</i> spp.), and lichens (<i>Cladonia</i> and <i>Cladina</i> spp.).”</p> <p>Source: Matthews 1992</p>
<p>Climate and elevation range</p>	<p>The Bog blueberry is typically resilient to colder temperatures, thus aiding it in its survival north of the equator (i.e. Canada, Greenland). These temperatures usually range from cool-temperate to cool-mesothermal climates (i.e. 26.6°F to 64.4°F). Furthermore, the elevation ranges from sea level (>0 meters) to alpine zones (=> 3,000 meters). For example, this image to the right was taken at 4,463 feet elevation (i.e. 1,360 meters).</p> <p>Image Source: Gerald D. Carr 2011 (WTU Herbarium n.d.)</p> 

<p>Local habitat and abundance</p>	<p>Bog blueberries provide the perfect habitat for small mammals including nesting birds, squirrels, and mice. It both serves as a dominant and codominant species and typically resides in open or closed forests alongside black and white spruce. Furthermore, songbirds and game birds such as ptarmigan and spruce grouse eat the berries, thus spreading the Bog blueberries seeds across the landscape. Its leaves are also documented as being food for snowshoe hares and making up an extreme portion of daily food intake of the red-backed vole (Less than 92% of diet).</p> <p>Furthermore, other animals that feed off of these shrubs include caribou, moose, black bears, and brown bears. These blueberries provide an excellent source of Vitamin C to herbivores, as well as mono- and disaccharides. They also serve as ideal locations for pollinators – especially bumblebees. Furthermore – in regards to the habitat’s soil type - many studies have shown how easily influential soil is to mineral content found within the plant’s concentration of “uranium, copper, and lead.”</p> <p>For their abundance, they are considered to be a “secure” species (G5) and are extremely prevalent across the world. Some countries they occur in include habitats similar to cottongrass tussock tundra, low shrub tundra, and sedge meadows.</p> <p>Source: Atlas n.d. and Matthews 1992</p>
<p>Plant strategy type / successional stage</p>	<p>Bog blueberries are resilient to fires and aid in reclamation projects. They have the ability to colonize “local seismic lines in the subarctic” because of their adaptability to colder temperature, varying soil types, and temperamental climate conditions. Furthermore, they can colonize “borrow pits in tundra regions of northwestern Canada” and can tolerate high concentrations of heavy metals in soil.</p> <p>Bog blueberry has been used in past reclamation projects and showed signs of germination after one to two growing seasons. Therefore, they are stress-tolerators that are able to adapt to unforgiving and desolate regions of the world.</p> <p>Source: Matthews 1992</p>
<p>Plant characteristics</p>	<p>The Bog blueberry is a branching shrub that is deciduous and produces stems that measure 2-6 dm. tall. Their leaves are described as “glabrous or finely puberulent” with stems that are documented as being yellowish-green to reddish-gray based upon its age.</p>

Furthermore, they produce flowers that have 1-4 leaf axils and are “5-6 mm. long [with] anthers with awns and terminal pore bearing tubes.” Their fruits are bluish-black berries that measure to be 5-7 mm. broad and are documented as having a palatability of fair to moderate in taste. Their flowers are white to pink as well.

In regards to their longevity, they are also classified as being a perennial and thus can potentially live longer than 2 years.

Source: WTU Herbarium n.d. and *Vaccinium uliginosum* L. n.d.

PROPAGATION DETAILS: FROM SEED

Ecotype
 Seeds and vegetative material will be collected from any of the natural areas listed – as long as the removal of the plant material will not cause any major consequences to the local habitat. From this, it is recommended to visit sites with high volumes of Big Blueberry to ensure the removal of material will not have a major effect on the environment. Areas that can be considered include natural zones in Whatcom County, Pierce County, Yakima County, and Cowlitz County in Washington State.

Additionally, It is important to note that when they are collected, they will be derived from multiple sites and will only consist of <10 percent of the total seeds and/or vegetative material found in that location. If extras are picked, it is best to disperse them within that region to aid in new plant growth. This is also called the 10 Percent Rule in plant conservation – which is especially followed with rare or threatened seed harvesting.

Influential Text: USDA Plant Database 2014 and Kimmerer 2013

Propagation Goal
 We will be propagating from seeds derived from native Bog Blueberries.


Image Source: WTU Herbarium n.d. (Gabriel Campbell 2023)



Propagation Method	Seed propagation method
Product Type	<p>Small deepots will be used to help germinate these seeds in a greenhouse setting to provide optimal growing conditions and to allow environmental manipulation (i.e. Temperature, humidity levels, sunlight access). Deepots are used because of their tight, rounded structure to help allow the roots to grow downwards. Furthermore, the drainage ends will allow for air pruning of the roots and keep the Bog blueberries at a smaller size before repotting/transplanting.</p> <p>Additionally, it is important to note that this plant type can be easily grown outdoors as well, especially since they are relatively resilient to acidic soils and temperate climates. Thus, if hoopouses or outside zones are considered, these can be an inexpensive alternative.</p>
Stock Type	<p>In the USDA Forest Service, they have been known to recommend using stocktypes (i.e. bareroot, container, and “plug plus”) when trying to grow plants that are accustomed to high elevation and tend to be slow growing. This can also help make bigger specimens and are usually relatively successful – especially since seedlings that are grown in containers can be easily transported to specific sites</p> <p>Thus, for this case study, we will utilize containers when trying to grow these seedlings.</p> <p>Text Source: Dumroese and Owston 2003</p>
Time to Grow	<p>Bog blueberries have been noted as being not as strong during the first growth, thus when they are first germinated, it may be advantageous to let them grow out through the spring/summer, allow them to go dormant during the winter, and then allow them to mature and then be transplanted outside to their natural location.</p> <p>Thus, it may take 2 weeks to germinate and then an additional 6-7 weeks to grow to a mature plant, which makes early to middle winter the ideal time to bring the seeds out of cold stratification, allow them to germinate in a greenhouse setting, and continue through their natural phases to reach a stronger plant within a year. This means that in order to provide resilient plant specimens, it may take two to three growing cycles – thus taking 1.5 to 3 years to accomplish.</p>
Target Specifications	<p>The target specifications includes reaching a height of approximately 7.87 to 23.6 inches, producing fruits measuring about 5-7 mm, and showcasing healthy 1-3 cm long leaves with 1-4 in flower petals (if possible).</p>

	<p>These trait specifications may change depending on what the grower is looking for. Some growers, for example, will remove the flowers as the plant grows to provide more energy into root development and stem growth. From this, it may be advantageous to remove flowers in the beginning stages of growth and then allow for cross pollination (i.e. manually or with beneficial insects) to strengthen adaptive capabilities through gene variations.</p> <p>Additionally, if the plants produce blueberries in the greenhouse, they can be collected and thus allow for more plants to be grown.</p> <p>Source: WTU Herbarium n.d.</p>
<p>Propagule Collection Instructions</p>	<p>Since Bog blueberries produce fruits in mid to late summer, it is recommended to begin harvesting the berries in June and August. This can be done by holding a tray underneath the plant’s stem and gently shaking the branch to allow the ripe blueberries to fall into the container. Additionally, it is important to note the 10 Percent rule of collection. When collecting these berries, only take less than 10% of the available blueberries.</p> <p>Furthermore, locations of collecting material should be checked to know for certain that berries can be removed from these locations (i.e. Private property, National Forests).</p> <p>Source: US Department of Agriculture 1974</p>
<p>Propagule Processing/Propagule Characteristics</p>	<p>The seed viability of Bog blueberry is considerably short, thus it is worth germinating the seeds as soon as they have been cold stratified. This would be ideally within a few months of berry harvesting.</p> <p>The seed density is also considered to be 2,000,000 seeds per pound. It’s important to note how average this number is and may vary depending on the amount of seeds collected and their mean weight.</p> <p>Source: Dirr & Heuser 1987</p>
<p>Pre-Planting Propagule Treatments</p>	<p>These berries can be first washed using a sieve and running water. After they are relatively clean, they can be placed into a blender with a quarter cup of distilled water (Measurement can be adjusted based on berry quantity). After, the blender can be put on pulse for 30 seconds and removed from the machinery. Three beakers can be prepared and a flask of tap water. A small amount of blended fruit can be poured into the first</p>

	<p>beaker, allowing the seeds to fall to the bottom. The beaker can then be slowly poured into another beaker, slowly separating the liquid pulp from the seeds. Decanting the water can be done multiple times until the seeds are clean and completely removed from blueberry debris.</p> <p>Lastly, the contents of the seeds can be poured onto a coffee filter and spread out to dry at 60-70 degrees Fahrenheit for 48 hours.</p> <p>After this, they can be placed into a refrigerator or cooler to aid in cold stratification. These seeds can reside in the cooler for all of fall and half of winter, until they are pulled out for germination in mid to late winter. The Department of Agriculture has stated that these seeds can survive up to 12 years, but in order to be certain of the seed viability, make sure to sow them and begin growing as soon as possible after cold stratification.</p> <p>Source: Ashrafi 2025 and US Department of Agriculture 1974</p> <p>Some sources state how these might not need to be cold stratified, thus choosing to use this method can be optional – but ensure to consider sources such as Dirr & Heuser 1987 (Non-supportive) and Matthews 1992 (Supportive). If cold stratification is used, if the seeds are exposed to 35 degrees Fahrenheit for 30 days, then this will suffice.</p> <p>Sources: Dirr & Heuser 1987 and Matthews 1992</p>
<p>Growing Area Preparation / Annual Practices for Perennial Crops</p>	<p>Since this propagation protocol will utilize containers for growth, there is no need for outside preparation (i.e. garden weeding, old soil tilled with new soil added). The growing media fit for these seeds would be basic peat moss or sunshine mix #4 and some vermiculite sprinkled on top towards the end of sowing.</p> <p>It also may be helpful to fluff up the soil manually by using a tarp or a sifter to increase aeration in the soil and allow for the seeds to root and easily move within the media. Later, when the seeds have germinated and needs repotting, it may be advantageous to repot them in a media consisting of higher amounts of perlite, bark, and rocks to help it acclimate before it is transplanted into rocky terrain after the hardening phase later.</p> <p>Furthermore, container sizes from 2” to 3” for beginner sizes. They can also be sowed in interconnected pots and ensure that the containers have drainage holes. Furthermore, a ½ gallon watering may be used if a hose is unavailable. Fertilizer may also help in the later stages of growth, as well as having pruners, a clear top to go over the pots to maintain moisture</p>

	<p>during germination, plant tags, and pencils to make labels (These can be made from old food containers).</p> <p>Later on, when the plants reach dormancy after maturing, it may help to refrain from watering the plant, let it slowly die back, and don't water it until late winter/early spring of next year. This can also be dependent on greenhouse conditions (i.e. May be able to grow them out of dormancy earlier).</p> <p>Source: Bañados & Stik 2002</p>
<p>Establishment Phase Details</p>	<p>Seeds will tend to germinate within 2 – 4 weeks. They will continue to grow afterwards and can be pruned and cared to encourage positive growth (i.e. breaking up roots to prevent being root bound).</p> <p>Some cultural practices include removing old shoots to aid in a greater flower yield later on. Furthermore, berry production is noted as being delayed a year or more from this method, so it is worth noting.</p> <p>Source: US Department of Agriculture 1974 and Atlas n.d.</p> <p>Image: WTU Herbarium n.d. (Gerald D. Carr 2011)</p> 
<p>Length of Establishment Phase</p>	<p>As described previously, it may take approximately a month or less for the seeds to germinate and being to grow in the deepots. This ranges from 2 – 4 weeks, thus it is important to carefully monitor the seeds to observe whether or not growth has occurred. Since this plants will be directly removed from a cooler, it may take a few days for the seeds to notice the change in environmental conditions (i.e. 25 degrees Fahrenheit to 75 degrees Fahrenheit) and begin to germinate.</p>
<p>Active Growth Phase</p>	<p>These plants are continued to be grown and will bloom around late spring to early summer. The first generation might not produce seeds from berries, thus it is important to allow these plants to go dormant around winter and fall and come back the following year. This is done because they are perennials and will increase yields of flower and berry</p>


	<p>production, as well as overall growth, if they are allowed a time of dormancy.</p> <p>Source: Bañados & Stik 2002</p>
Length of Active Growth Phase	<p>They will grow for another 6 months after germination and may begin to go dormant when temperatures are colder. This can be done in the greenhouse by manipulating the environmental control settings or by placing the plants in a specific grow chamber that allows colder temperatures to be used. They will then go dormant for roughly 4 months and begin to grow again when they experience warmer temperatures. From this, they can continue this cycle for another 3 or so years because the Bog blueberries are perennials (i.e. Can come back year after year).</p>
Hardening Phase	<p>As stated above, they can be either placed outside in colder fall temperatures or placed into a growth chamber to aid in the transition into dormancy from exposure to colder temperatures (i.e. approximately 25 degrees Fahrenheit).</p> <p>Additionally, it may be helpful to consider different soil types that may be closer to the soil the plant will be transplanted into within the wild. From this, it can be assumed that the hardening phase lasts roughly 2-3 months. This time frame will start during the Fall and end at the beginning of Winter when the plant has gone fully dormant.</p>
Length of Hardening Phase	<p>Since the Bog blueberry tends to bloom in June through August, the end of the growing season would be within late summer to early fall months. This is when the plants begin to go dormant and emerge with new growth next spring. From this, it is important to consider how a greenhouse may change this timeframe – especially since the main contributing factor towards whether or not a plant becomes dormant is change from warmer seasons to colder ones (i.e. Longer, hotter, and sunnier days change to shorter, colder, and cloudier days).</p> <p>Thus, if the active growth phase ends around mid-summer (i.e. July), then the end of growing season may occur a few months after no sign of growth is observed (i.e. October).</p> <p>Source: WTU Herbarium n.d.</p>
Harvesting, Storage and Shipping	<p>Harvesting seeds is usually done before the plants die and at peak bloom. They typically bloom around late spring to early summer (June – August) but may also last until the end of summer if temperatures are ideal. From this, it is important to collect the seeds sometime during this window and plant the seeds as soon as they are collected due to storage difficulties.</p>

	<p>Furthermore, it is recommended to clean them after harvesting and process them to remove the blueberry debris and extract the seeds only. If they are shipped, they should be kept in environments that are colder than 54 degrees Fahrenheit and stored in dry containers. They should be shipped soon after they are harvested – especially since the seeds are nondormant.</p> <p>It might also be worth conducting a viability test before sowing them to doublecheck they will yield a successful number of plants.</p> <p>Source: U.S. Dept. of Agriculture 2020</p>
<p>Length of Storage</p>	<p>Seeds can be stored for no more than a few years. Ideally, it is good practice to sow them as soon as they are harvested – or at least after wintertime. It is also worth using viability tests to check the seeds every year and ensure they are still alive.</p> <p>For seedlings, they should be grown until they fully acclimate to a 1-gallon pot. This can take a few months and if timed correctly, can be grown in a Greenhouse from the end of fall (November) to the beginning of spring (March-April). From this point, they may be prepared to be out planted after they've reach maturity.</p>
<p>Guidelines for Outplanting / Performance on Typical Sites</p>	<p>If the seeds are conditioned and slowly subjected to slightly colder temperatures in the Greenhouse, as well as wind and rocky terrain, then they should be prepared enough to survive in their outdoor habitat. Some may be sensitive to colder temperatures during spring freezing, but for the most part, the survival percentage may be relatively high (i.e. >75%).</p> <p>The end product should look thick, woody, and branched. The stems should be between 2-6 dm. tall with leaves of about 1-3 cm long. The flowers should be 1-4 in and 5-6 mm long towards the sepals deltoid. Furthermore, they should later produce berries that measure from about 5-7 mm.</p> <p>In regard to their elapsed time before flowering, they typically take a few months (i.e. 3 months) to acclimate to their environment before flowering. This could be from late March to early June before flowering. They will then proceed to bloom up until August.</p> <p>Source: WTU Herbarium n.d.</p>

Other Comments	No collection restrictions are known; however, it is important to mention how relatively dispersed and prevalent these plants are – especially since they are in many countries outside of the United States and the Pacific Northwest. From this, it is still important to restrain yourself from picking more than 10% of the seeds within the known populations in order to not affect their natural growth outdoors
PROPAGATION DETAILS: VEGETATIVE	
Ecotype	<p>Seeds and vegetative material will be collected from any of the natural areas listed – as long as the removal of the plant material will not cause any major consequences to the local habitat. From this, it is recommended to visit sites with high volumes of Big Blueberry to ensure the removal of material will not have a major effect on the environment. Areas that can be considered include natural zones in Whatcom County, Pierce County, Yakima County, and Cowlitz County in Washington State.</p> <p>Additionally, it is important to note that when they are collected, they will be derived from multiple sites and will only consist of <10 percent of the total seeds and/or vegetative material found in that location. If extras are picked, it is best to disperse them within that region to aid in new plant growth. This is also called the 10 Percent Rule in plant conservation – which is especially followed with rare or threatened seed harvesting.</p> <p>Influential Text: USDA Plant Database 2014 and Kimmerer 2013</p>
Propagation Goal	We will be propagating from cuttings derived from native Bog blueberries.
Propagation Method	Vegetative propagation method.
Product Type	<p>The product type will be propagules (i.e. cuttings). After they have been collected, small deepots will be used to help grow these cuttings after they have rooted in 100% water jars. When they are placed in the deepots with dirt, they will then be placed into a greenhouse setting to provide optimal growing conditions and to allow environmental manipulation (i.e. Temperature, humidity levels, sunlight access). Deepots are used because of their tight, rounded structure to help allow the roots to grow downwards. Furthermore, the drainage ends will allow for air pruning of the roots and keep the Bog blueberries at a smaller size before repotting/transplanting.</p> <p>Additionally, it is important to note that this plant type can be easily grown outdoors as well, especially since they are relatively resilient to acidic soils and temperate climates. Thus, if hoophouses or outside zones are considered, these can be an inexpensive alternative.</p>

<p>Stock Type</p>	<p>In the USDA Forest Service, they have been known to recommend using stocktypes (i.e. bareroot, container, and “plug plus”) when trying to grow plants that are accustomed to high elevation and tend to be slow growing. This can also help make bigger specimens and are usually relatively successful – especially since seedlings that are grown in containers can be easily transported to specific sites</p> <p>Thus, for this case study, we will utilize containers when trying to grow these cuttings.</p> <p>Text Source: Dumroese and Owston 2003</p>
<p>Time to Grow</p>	<p>Since these cuttings can be taken at any time, this window is up to the grower. Because these plants do well when growing during the spring to summer months, it may be advantageous to make these cuttings during early spring (if it’s natural specimens) or late winter (if it’s indoor specimens) to influence their growth during the spring and summer months. Since the cuttings already have leaves and a stem, they can easily be scored/cut – both on the distal and basal ends – to apply auxin hormone and allow the cutting to begin forming roots.</p>
<p>Target Specifications</p>	<p>The target specifications includes reaching a height of approximately 7.87 to 23.6 inches, producing fruits measuring about 5-7 mm, and showcasing healthy 1-3 cm long leaves with 1-4 in flower petals (if possible).</p> <p>These trait specifications may change depending on what the grower is looking for. Some growers, for example, will remove the flowers as the plant grows to provide more energy into root development and stem growth. From this, it may be advantageous to remove flowers in the beginning stages of growth and then allow for cross pollination (i.e. manually or with beneficial insects) to strengthen adaptive capabilities through gene variations.</p> <p>Additionally, if the plants produce blueberries in the greenhouse, they can be collected and thus allow for more plants to be grown.</p> <p>Source: WTU Herbarium n.d.</p>
<p>Propagule Collection Instructions</p>	<p>Making cuttings can happen at any time and could even be prepared by taking the mother plant and prepping the desired region for cutting. This is called air layering and will allow the cutting to produce roots and receive nutrients from the mother plant before their separation by cutting a long sliver in a sizeable branch, applying auxin hormone, and wrapping</p>

	<p>sphagnum moss and a plastic bag around the wound. This, as said before, can be done at any time. If the grower was aiming to have these cuttings ready by spring, this layering can be prepared during late spring to early summer– before the mother plant has gone dormant. If the mother plant is from a natural habitat, however, then it may be a good idea to make the air layer directly in the field (when the plant is alive during the Spring/Summer) and come back to cut it off in late summer when the roots have developed in the sphagnum moss.</p>
<p>Propagule Processing/Propagule Characteristics</p>	<p>Since we are only making cuttings and not handling seeds, we will only focus on the factors that surround propagation via cuttings.</p> <p>The propagules will need to have 2-3 nodes in order to increase the chances of survival. They will also need 2-3 leaves to help them photosynthesize during their acclimation period. Therefore, the air layered pieces will need to be checked to see if roots have developed in the sphagnum moss, then the branch can be cut off if roots are visible and put into a small depot after they are removed from the mother. Since cuttings will need to immediately be put into soil and watered, if the material isn't relatively available, it is also advantageous to put the cuttings in a bucket of water while the grower begins to collect the materials. They should be planted within 48 hours of removal.</p>
<p>Pre-Planting Propagule Treatments</p>	<p>Since the cuttings aren't seeds, they can't necessarily be stored before planting (Unless put in water for less than 48 hours). From this, they won't need to be cleaned (unless they have contaminants on them/pests) and can be directly put into water or soil depending on root presence.</p> <p>One treatment that may aid in growth is applying auxin powder to exposed ligaments towards the root apex. This will allow the plant to receive essential hormones that can help the region begin to grow roots faster than usual. If this was already done prior to making the cuttings (i.e. air layering), then the cutting can directly be placed into wetted soil and thus grown in a greenhouse directly after.</p>
<p>Growing Area Preparation / Annual Practices for Perennial Crops</p>	<p>Since this propagation protocol will utilize containers for growth, there is no need for outside preparation (i.e. garden weeding, old soil tilled with new soil added). The growing media fit for these seeds would be basic peat moss or sunshine mix #.</p> <p>It also may be helpful to fluff up the soil manually by using a tarp or a sifter to increase aeration in the soil and allow for the seeds to root and easily move within the media. Later, it may be advantageous to replot the cuttings – once they begin to mature - in media consisting of higher</p>

	<p>amounts of perlite, bark, and rocks to help it acclimate before it is transplanted into rocky terrain after the hardening phase later.</p> <p>Furthermore, container sizes from 4” to 5” for beginner sizes may work the best – especially if they already have roots. If the cuttings are bigger and the roots take up more space than anticipated, then it is worth going a size or two up. Furthermore, a ½ gallon watering can may be used if a hose is unavailable. Fertilizer may also help in the later stages of growth, as well as having pruners, a clear top to go over the pots to maintain moisture during germination, plant tags, and pencils to make labels (These can be made from old food containers).</p> <p>Later on, when the plants reach dormancy after maturing, it may help to refrain from watering the plant, let it slowly die back, and don’t water it until late winter/early spring of next year. This can also be dependent on greenhouse conditions (i.e. May be able to grow them out of dormancy earlier).</p> <p>Source: Bañados & Stik 2002</p>
<p>Establishment Phase Details</p>	<p>Since we are using cuttings, we will not be considering traditional germination from seeds. As previously mentioned, the potential cutting will either develop roots within soil media itself (i.e. sphagnum moss) while being connected to the mother plant, or they can be directly cut first and placed into water until roots are visible.</p> <p>An example of air layering is shown to the right where parts of the plant are placed into the medium wrap to help allow them to begin growing their roots. This phase may last 2 weeks to 4 weeks depending on the air layering success.</p>  <p>Image Source: Jamie 2025</p>
<p>Length of Establishment Phase</p>	<p>As described previously, it may take approximately a month or less for the seeds to germinate and being to grow in the deepots. Now, in the case of vegetative material, it may take as quick as a week or two for them to root in and begin to uptake nutrients and needed material. It is still important to carefully monitor the planted cuttings to observe whether or not growth has occurred – especially in the root regions.</p>

<p>Active Growth Phase</p>	<p>These plants are continued to be grown and will bloom around late spring to early summer. The first generation might not produce seeds from berries, thus it is important to allow these plants to go dormant around winter and fall and come back the following year. This is done because they are perennials and will increase yields of flower and berry production, as well as overall growth, if they are allowed a time of dormancy.</p> <p>For vegetative material, the growing process may be able to be expedited because instead of growing new generations of plant material via seed, cuttings can be made instead and increase the population immensely. The only downfall, which should be noted, is the lack of genetic variation when taking solely cuttings and not encouraging seed production simultaneously.</p> <p>Source: Bañados & Stik 2002</p>
<p>Length of Active Growth Phase</p>	<p>Since we are looking at cuttings, the time in which they begin to grow and before the hardening phase will be much quicker than the time it takes a seed to germinate and approach this phase.</p> <p>Cuttings will usually reach maturity in less than 6 months – which was the estimated time frame that would take seeds to reach the hardening phase. Specifically, it may even take a cutting 2 months or less to begin to grow to maturity – depending on the size of cutting</p> <p>Furthermore, these cuttings – when beginning to mature and end new growth – will begin to slowly die off and enter dormancy. A transition into dormancy can be facilitated by the greenhouse from manipulating the environmental control settings or by placing the plants in a specific grow chamber that allows colder temperatures to be used. They will then go dormant for roughly 4 months and begin to grow again when they experience warmer temperatures. From this, they can continue this cycle for another 3 or so years because the Bog blueberries are perennials (i.e. Can come back year after year).</p>
<p>Hardening Phase</p>	<p>As stated above, they can be either placed outside in colder fall temperatures or placed into a growth chamber to aid in the transition into dormancy from exposure to colder temperatures (i.e. approximately 25 degrees Fahrenheit).</p> <p>Additionally, it may be helpful to consider different soil types that may be closer to the soil the plant will be transplanted into within the wild. From this, it can be assumed that the hardening phase lasts roughly 2-3 months.</p>

	<p>This time frame will start during the Fall and end at the beginning of Winter when the plant has gone fully dormant.</p>
<p>Length of Hardening Phase</p>	<p>Since the Bog blueberry tends to bloom in June through August, the end of the growing season would be within late summer to early fall months. This is when the plants begin to go dormant and emerge with new growth next spring. From this, it is important to consider how a greenhouse may change this timeframe – especially since the main contributing factor towards whether or not a plant becomes dormant is change from warmer seasons to colder ones (i.e. Longer, hotter, and sunnier days change to shorter, colder, and cloudier days).</p> <p>Thus, if the active growth phase ends around mid-summer (i.e. July), then the end of growing season may occur a few months after no sign of growth is observed (i.e. October).</p> <p>Source: WTU Herbarium n.d.</p>
<p>Harvesting, Storage and Shipping</p>	<p>Harvesting cuttings is usually done before the plants die and at peak bloom or even before this time. Ultimately, as long as the plant is mature, healthy, and not experiencing any major changes before or after the cutting is made. They typically bloom around late spring to early summer (June – August) but may also last until the end of summer if temperatures are ideal. From this, it is important to collect the cuttings sometime during this window and plant them as soon as they are collected due to storage difficulties.</p> <p>Furthermore, it is recommended to clean them after harvesting and process them to remove the blueberries and cut the leaves halfway. Futhermore, ensure there are 2-3 nodes present and – if choosing to air layer – that the cutting has roots already made.</p> <p>After the cuttings are removed from the mother plant, they can be put into water and planted 1-2 days after (ideally).</p> <p>Source: U.S. Dept. of Agriculture 2020</p>
<p>Length of Storage</p>	<p>Seeds can be stored for no more than a few years. Ideally, it is good practice to sow them as soon as they are harvested – or at least after wintertime. It is also worth using viability tests to check the seeds every year and ensure they are still alive.</p> <p>However, since we are talking about vegetative ways of propagation, this would refer to the cuttings themselves and how to store them. For</p>

	<p>cuttings, they can last a day or two, but must be kept in water from the time they are cut off the mother plant to the time they are planted.</p> <p>For seedlings, they should be grown until they fully acclimate to a 1-gallon pot. This can take a few months and if timed correctly, can be grown in a Greenhouse from the end of fall (November) to the beginning of spring (March-April). From this point, they may be prepared to be out planted after they've reach maturity.</p>
<p>Guidelines for Outplanting / Performance on Typical Sites</p>	<p>If the seeds are conditioned and slowly subjected to slightly colder temperatures in the Greenhouse, as well as wind and rocky terrain, then they should be prepared enough to survive in their outdoor habitat. Some may be sensitive to colder temperatures during spring freezing, but for the most part, the survival percentage may be relatively high (i.e. >75%).</p> <p>The end product should look thick, woody, and branched. The stems should be between 2-6 dm. tall with leaves of about 1-3 cm long. The flowers should be 1-4 in and 5-6 mm long towards the sepals deltoid. Furthermore, they should later produce berries that measure from about 5-7 mm.</p> <p>In regard to their elapsed time before flowering, they typically take a few months (i.e. 3 months) to acclimate to their environment before flowering. This could be from late March to early June before flowering. They will then proceed to bloom up until August.</p> <p>Source: WTU Herbarium n.d.</p>
<p>Other Comments</p>	<p>No collection restrictions are known; however, it is important to mention how relatively dispersed and prevalent these plants are – especially since they are in many countries outside of the United States and the Pacific Northwest. From this, it is still important to restrain yourself from making major cuttings from more than 10% of the viable plants within the known populations in order to not affect their natural growth outdoors</p>
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