# TECHNICAL NOTES

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## PLANT MATERIALS TECHNICAL NOTE NO. 30

# Ability of Pacific Northwest Native Shrubs to Root from Hardwood Cuttings (with Summary of Propagation Methods for 22 Species)

Dale C. Darris
Conservation Agronomist
Corvallis Plant Materials Center

SUMMARY

There is a need for additional information on how well native shrubs root from hardwood cuttings. First, nurseries are seeking to refine vegetative propagation techniques. Second, practitioners in the fields of riparian/wetland restoration and streambank stabilization are looking for species that are easy to root from unrooted dormant material that will provide cost competitive alternatives to native **willows** (*Salix* spp.) and **redosier dogwood** (*Cornus sericea*) for direct sticking of cuttings and soil bioengineering practices. The purpose of this work was to screen 15 shrubs indigenous to the Pacific Northwest USA for their ability to root from hardwood cuttings with and without a rooting compound in a greenhouse mist bench, well drained field, nursery bed, and saturated substrate (artificial pond).

If a species roots easily, it has greater potential for planting as dormant cuttings, live stakes, or whips directly on a revegetation site, and may warrant further evaluation for fascines, brush mattresses, or other soil bioengineering practices. Based on the rooting ability of hardwood cuttings made from 1 (or 2) year old wood, those species with good potential include **black twinberry** (*Lonicera involucrata*), **salmonberry** (*Rubus spectabilis*), **common snowberry** (*Symphoricarpos albus*), and **Pacific ninebark** (*Physocarpus capitatus*). **Coyote brush** (*Baccharis pilularis*) and **red elderberry** (*Sambucus racemosa*) have fair potential. **Indian plum** (*Oemlaria cerasiformis*), **mock orange** (*Philadelphus lewisii*), and **red flowering currant** (*Ribes sanguineum*) may apply under limited circumstances, select uses, or ideal conditions. Results from the outdoor field planting were generally similar to those from the greenhouse mist bench study for all 15 species. When a rooting hormone (plant growth regulator) was applied, there were seldom any statistically significant increases in rooting percentage, root abundance, root length, or shoot length by dipping cuttings in a dilute solution of IBA/NAA. However, there were exceptions as with **snowberry**, suggesting improvements may be possible for some species. Further refinements and evaluations are needed.

Results for the rooting trial in the pond were substantially different. Under saturated soil conditions, cuttings of **Sitka willow** (*Salix sitchensis*) rooted well, while those from most other species died or did poorly. However, **common snowberry** and **black twinberry** rooted at 96-100% and 50-54% respectively. Therefore, like many **willows**, these two species may have potential for direct sticking or live staking along the immediate shoreline of streams or on temporarily ponded sites, in addition to moist, well drained soils.

In general, **California hazel** (*Corylus cornuta* var. *californica*), **tall Oregon grape** (*Mahonia aquifolium*), **blue elderberry** (*Sambucus cerulea*), **cascara** (*Rhamnus purshiana*), **thimbleberry** (*Rubus parviflorus*), and **Oregon viburnum** (*Viburnum ellipticum*) performed comparatively poorly and are not recommended for direct sticking or soil bioengineering practices, regardless of hormone use, site conditions, or soil drainage. However, for these species, a low or variable percentage of hardwood cuttings may root in a controlled environment, such as a greenhouse mist bench, in combination with special techniques. Additional studies are needed.

In addition to information on these 15 species, a summary of traditional vegetative and sexual propagation techniques for **Sitka alder** (*Alnus viridis* ssp. *sinuata*), **vine maple** (*Acer circinatum*), **western redosier dogwood** (*Cornus sericea* ssp. *occidentalis*), **oceanspray** (*Holodiscus discolor*), **Sitka willow** (*Salix sitchensis*), **Pacific serviceberry** (*Amelanchier alnifolia* var. *semiintegrifolia*) , and **Douglas spirea** (*Spiraea douglasii*) are included in a supplemental table. The most effective propagation methods and the potential of each species for direct sticking of cuttings, live stakes, and whips are described. However, for all species listed, individual results can vary widely, even when using the recommended or “easy” methods. Results depend on the health of the mother or donor plant, stock or seed quality, timing, population or clone (genetics), handling and storage techniques, sanitation, pest management, site or growing conditions, and skill level of the propagator or planting crew.

## INTRODUCTION

In the Pacific Northwest USA, landscape horticulturists utilize native shrubs more than ever (Hamilton et. al. 1998). Ecologists and erosion control specialists call on them almost exclusively over exotics for wetland restoration and streambank stabilization, including widely accepted soil bioengineering practices. To this end, propagation technology on regionally important species has increased within the past decade. While methods for more common and ornamental native shrubs are now published (Kruckeberg 1996, Leigh 1997, Rose et. al. 1998), additional refinement is needed for many species.

The most frequently used woody plants for stream side soil bioengineering in western Oregon and western Washington are native **willows** (*Salix* spp.), and to a lesser extent **western redosier dogwood** (*Cornus sericea* var. *occidentalis*) and **Douglas spirea** (*Spiraea douglasii*). The applicability of other indigenous shrubs for practices such as unrooted live stakes, fascines (wattles), and brush mats is not widely known. For example, how well will other species root from older wood or grow when buried as a bundle (fascine) or a mat (brush mattress) along a streambank? In addition, could synthetic plant growth regulators (PGRs) such as IBA (indole-3-butyric acid) be used to treat dormant cuttings or branches on-site and enhance root development and establishment?

While some information exists on the relative ease of rooting hardwood cutting (Leigh 1997, King Co. Dept. of Public Works 1993), rooting potential under various conditions, including the use of PGRs, merits further exploration. Therefore, the purpose of this work was to screen 15 select, indigenous species for their ability to root from hardwood cuttings with and without a rooting compound in a field, nursery bed, greenhouse mist bench, and saturated soil (artificial pond).

## METHODS AND MATERIALS

<u>Selection and Sources</u>: Native shrub species were chosen for the studies based on their relative ease of rooting, natural abundance, or special features. Accession numbers, scientific names, and sources for all material appears in Table 1. Branches were harvested in February 1998 and stored in a cooler (36°F) until processed into cuttings. Healthy, vigorous plants were favored. The cultivar **‘Plumas’ sitka willow** was used as a standard of comparison. The full array of species and sources was used in the greenhouse study, but lack of material for some species prohibited testing them under all experimental conditions.

Table 1. Shrub Names, Symbols, and Origins

| Accession No. | Common Name | Scientific Name | Symbol | Origin |
|---|---|---|---|---|
| 171 | Common snowberry | *Symphoricarpos albus* | SYALL | Skagit Co., WA |
| 172 | Salmonberry | *Rubus spectabilis* | RUSP | Lane Co., OR |
| 173 | Coyote brush | *Baccharis pilularis* | BAPIC2 | Lane Co., OR |
| 174 | Mock orange | *Philadelphus lewisii* | PHELG2 | Lane Co., OR |
| 175 | Oregon viburnum | *Viburnum ellipticum* | VIEL | Linn Co., OR |
| 176 | Red flowering currant | *Ribes sanguineum* | RISA | Lane Co., OR |
| 177 | Pacific ninebark | *Physocarpus capitatus* | PHCA11 | Lane Co., OR |
| 178 | Indian plum | *Oemleria cerasiformis* | OECE | Lane Co., OR |
| 179 | Blue elderberry | *Sambucus cerulea* | SACE | Asotin Co., WA |
| 180 | Pacific ninebark | *Physocarpus capitatus* | PHCA11 | Whatcom Co., WA |
| 181 | Red elderberry | *Sambucus racemosa* | SARAA | Skagit Co., WA |
| 182 | Indian plum | *Oemleria cerasiformis* | OECE | Skagit Co., WA |
| 183 | Thimbleberry | *Rubus pariflorus* | RUPA | Lane Co., OR |
| 184 | California hazel | *Corylus cornuta var. californica* | COCOC | Skagit Co., WA |
| 185 | Cascara | *Rhamnus purshiana* | RHPU | Lane Co., OR |
| 186 | Common snowberry | *Symphoricarpos albus* | SYALL | Lane Co., OR |
| 187 | Black twinberry | *Lonicera involucrata* | LOIN5 | Lane Co., OR |
| 188 | Tall Oregon grape | *Mahonia aquifolium* | MAAQ2 | Skagit Co., WA |
| 189 | Blue elderberry | *Sambucus cerulea* | SACE | Lane Co., WA |
| 190 | Red flowering currant | *Ribes sanguineum* | RISA | Benton Co., OR |

Study Locations: Four study sites were chosen for the experiments to represent a variety of growing conditions. They were an irrigated nursery bed (well drained sandy loam), a greenhouse mist bench (perlite medium), an upland terrace (farm field, moderately well drained silt loam), and an artificial pond (saturated sandy substrate). The nursery bed was located at the Lynn A. Brown (Bow) Plant Materials Center (elevation 200 ft.) operated by the Washington State Association of Conservation Districts, and the other three sites were at the NRCS Plant Materials Center, Corvallis, OR (elevation 225 ft.).

Processing: Stems were cut into 8 and 12 inch segments for the greenhouse and three outdoor studies respectively. Branches were fully dormant except for early bud swell in **red elderberry, Indian plum, red flowering currant**, and **black twinberry**. For consistency among species, apical buds were removed (except for a portion of species at Bow, WA), previous year's growth (1 year wood) was used unless second year wood was required for adequate material, side branches, if any, were removed (except for coyote brush), and stock quality was randomized among all plots. A further exception was made for **blue elderberry** and **red elderberry**. For these species, the standardized lengths were occasionally exceeded in order to insure two nodes per cutting.

Cuttings were left untreated (control) or dipped for five seconds with Wood's rooting compound (WRC: 1.03% Indole-3-butyric acid, 0.51% 1 Naphthalene acetic acid, 78.46% Ethanol SD 3A, and 20% Dimethyl formamide, by weight) diluted with water at a ratio of 5:1 or 10:1 ($H_20$:WRC). At Corvallis, the two broadleaf evergreens, **tall Oregon grape** and **coyote brush**, were further divided into treatments with and without foliage (leaves intact or clipped off).

Experimental Design and Planting: The design was a randomized complete block with four replications and two, three, or four treatments depending on the species (control plus one or two dilutions of WRC, and control plus foliage intact versus no foliage, with and without WRC at 5:1). For the greenhouse mist bench study, 8 inch cuttings were inserted to a depth of 5 inches in moist perlite. Spacing was 2 inches between and within rows. Each plot consisted of 6 cuttings at Corvallis, OR, and 15 cuttings at Bow, WA. For the three outdoor studies, spacing was 6 inches within row and 24-30 inches between rows. The 12 inch cuttings for the outdoor studies were inserted 8 inches into the substrate (soil or sandy medium). All plantings were made in late February or early March.

Management: Greenhouse day length was 16 hours and minimum night temperature was set at 65°F. Temperatures exceeded 90°F on sunny days in May. Cuttings were misted 20 seconds/hour during the day light and once at night. No tent, fertilizer, or bottom heat were used.

All outdoor plantings (nursery bed, farm field, pond) occurred in a firm, moist, weed free soil or substrate. No fertilizer or irrigation water was applied to the field site at Corvallis. The pond substrate was not fertilized, but was sub-irrigated for eight weeks to simulate saturated soil conditions typical of a stream shoreline or seasonally flooded wetland. The field and pond sites were hand weeded once. At Bow, the nursery bed was irrigated five times from March through June and weeded by hand. No herbicides or fertilizers were applied to the bed.

Data Collection and Analysis: Data collection included caliper of cutting, minimum caliper that rooted, length of longest shoot, number of live and dead shoots (not reported here), root length, root abundance (actual root counts or visual rating based on 1 = highest and 10 = lowest or none), location or position of root formation on the cutting [basal end (B,b), nodal (N,n), or internodal (I,i)], age of wood, and percent rooting success. Material that had at least one live root was counted as successful, regardless of the condition or existence of a healthy shoot. Data were collected once at the end of each experiment (after approximately 14 weeks), except at Bow where data was collected after 10 and 14 weeks to gauge rate of root development.

Each accession or species was treated as an individual experiment and analysis of variance (ANOVA) conducted on Factor A (root treatment). The F test was used to compare two means and Fisher's Protected Least Significant Difference (FPLSD) was used to separate three or more means at the P=.05 level of significance. Species means (species as a treatment) were not statistically analyzed.

## RESULTS AND DISCUSSION

The results for the nursery bed experiment are shown in Table 2., and those for the greenhouse mist bench, upland field, and pond studies are shown in Table 3. All data represents the mean of four replications. Means with the same letters are not statistically different at the P=.05 level. Groups of means without letters are not statistically significant or were not statistically separated because of missing values. Further definitions of codes and headings appear at the bottom of each table.

An overall rating (last column of Table 3) was assigned each species/treatment based on root abundance (first letter) and percent of hardwood cuttings rooted (second letter). Performance in the pond (saturated sand) was not factored in because of the extreme conditions. In general, the criteria for rating was applied as follows:

| **Letter Rating** | **Root Abundance** | **Percent Rooted** |
|---|---|---|
| **Poor (P)** | **8-10** | **0-30** |
| **Fair (F)** | **5-8** | **30-50** |
| **Good (G)** | **2-5** | **50-90** |
| **Excellent (E)** | **1-2** | **90-100** |

Table 2. Native Shrub Rooting trial: Nursery Bed (Bow PMC)

| Accession/ Species | TMT | Caliper (mm) | Min. Caliper | Percent Rooted | Number of Roots 17-May | Number of Roots 11-Jun | Root Lgth. (cm) 17-May | Root Lgth. (cm) 11-Jun | Shoot Lgth. (cm) 11-Jun |
|---|---|---|---|---|---|---|---|---|---|
| 184 COCOC | 1 | 7.5 | 4 | 60 | 1 | 9.7 | 0.3 | 17.3 | 22.7 |
| | 2 | 6.3 | 4 | 60 | 2.5 | 6.5 | 1.3 | 14.5 | 17.1 |
| | 3 | 6.8 | 3 | 55 | 2.6 | 13.7 | 1.6 | 18.6 | 16.3 |
| 188 MAAQ2 | 1 | 7.7 | 6 | 40 | 0 | 1.9 | 0.0 | 2.3 | 0.0 |
| | 2 | 7 | 9 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| | 3 | 6.2 | 5 | 20 | 0 | 1.5 | 0.0 | 2.5 | 5.0 |
| 182 OECE | 1 | 6 | 4 | 95 | 4.2 | 14.3 | 1.9b | 31.9 | 33.8 |
| | 2 | 6.2 | 5 | 80 | 4.7 | 11.9 | 1.7b | 23.5 | 24.6 |
| | 3 | 6.8 | 4 | 95 | 4.6 | 12.9 | 2.4a | 26.8 | 34.4 |
| 180 PHCA11 | 1 | 7.4 | 4 | 80 | 4.3 | 11.2 | 2.5 | 23.6 | 51.1a |
| | 2 | 8.1 | 6 | 80 | 3.5 | 9.2 | 2.3 | 24.2 | 46.5ab |
| | 3 | 7.4 | 4 | 75 | 4.5 | 12.1 | 2.0 | 18.4 | 30b |
| Plumas SASI | 1 | 9.4 | 8 | 100 | 18.6 | 29.4 | 2.2 | 56.0 | 250.0 |
| ** | 2 | 9.2 | 8 | 100 | 18.2 | 19.66 | 3.6 | 25.0 | 40.0 |
| | 3 | 9 | 8 | 80 | 28.6 | 30 | 4.4 | 35.0 | 147.5 |
| 179 SACE | 1 | 9.2 | 5 | 60 | 2.8 | 9.9 | 2.7 | 25.4 | 29.2 |
| | 2 | 9.2 | 6 | 70 | 0 | 15.1 | 0.0 | 19.6 | 26.9 |
| | 3 | 8.6 | 8 | 60 | 3.3 | 10.4 | 2.0 | 21.7 | 28.6 |
| 181 SARAA | 1 | 10.25 | 6 | 65a | 4.8 | 15.2 | 3.1 | 24.4 | 33.6a |
| | 2 | 8.7 | 5 | 60a | 1.8 | 14.8 | 1.9 | 22.3 | 25ab |
| | 3 | 9.9 | 8 | 35b | 0 | 12.1 | 0.0 | 25.6 | 18.8b |
| 171 SYALL | 1 | 7 | 5 | 75 | 5 | 12.3 | 3.5 | 21.6b | 49.7b |
| | 2 | 7.3 | 4 | 65 | 4.3 | 13.7 | 2.7 | 27.4ab | 60.8ab |
| | 3 | 7.1 | 4 | 75 | 4 | 13.7 | 2.0 | 37.8a | 76.4a |

TMT = treatment. Treatment 1 = untreated. Treatment 2 = 5:1 dilution Wood's Rooting Compound (WRC).
Treatment 3 = 10:1 dilution WRC. Means with different letters are significantly different at P =.05.
Means without letters were not significantly different or were not analyzed because of missing data.
**SASI not replicated.

Table 3. Native Shrub Rooting Trial: Greenhouse, Field and Pond (Corvallis PMC)

| Accession/ | | Min. Caliper (mm) | | Percent Rooted | | | Root Abundance | | | Root Lgth | Shoot Length (cm) | | | 2 Yr | Root | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | TMT | GH | FD | GH | FD | PD | GH | FD | PD | (cm) | GH | FD | PD | Wood | Loc. | Rating |
| 171 SYALL | 1 | 2.9 | 3.0 | 100 | 100 | 96 | 4.5 | 3.0 | 4.3 | 16.3 | 15.0 | 17.2 | 8.5 | yes | Bnic | GE |
| | 2 | 2.8 | 3.0 | 100 | 100 | 100 | 3.8 | 2.1 | 5.0 | 16.4 | 17.8 | 21.1 | 7.4 | yes | Bnc | GE |
| 172 RUSP | 1 | 3.6 | 2.5 | 92 | 85 | 0 | 5.6 | 4.7 | 10.0 | 17.3a | 7.1b | 9.9 | 0.0 | ? | Bni | GG |
| | 2 | 2.7 | 3.4 | 88 | 79 | 0 | 4.6 | 3.9 | 10.0 | 15b | 10.3a | 14.5 | 0.0 | ? | Ni | GG |
| 173 BAPIC2 | 1 | 4.5 | 2.5 | 62 | 100a | <> | 7.7ab | 7.1 | <> | 13.5 | 5.6 | 5.1 | <> | yes | Bi | FG |
| | 2 | 3.1 | 2.9 | 71 | 79b | <> | 6.5a | 6.7 | <> | 12.6 | 6.3 | 5.0 | <> | yes | Bni | FG |
| | 4 | 2.4 | 2.0 | 42 | 88ab | <> | 9.0b | 7.7 | <> | 9.2 | 2.9 | 3.1 | <> | ? | Bi | PG |
| | 5 | 2.2 | 2.0 | 54 | 96a | <> | 7.6ab | 7.7 | <> | 12.4 | 5.6 | 4.6 | <> | yes | bNi | FG |
| 174 PHLEG2 | 1 | 4.0 | 4.3 | 79 | 88 | 21 | 6.5 | 6.6 | 8.5 | 9.9 | 7.0 | 5.6 | 7.2b | yes | bnIc | FG |
| | 2 | 3.5 | 3.5 | 79 | 92 | 13 | 5.8 | 6.8 | 9.3 | 10.9 | 8.2 | 5.5 | 6.3a | yes | bnIc | FG |
| | 3 | 4.5 | <> | 83 | <> | <> | 5.1 | <> | <> | 9.9 | 11.1 | <> | <> | yes | bIc | FG |
| 175 VIEL | 1 | 6.4 | 2.8 | 5 | 21 | <> | 9.9 | 9.7 | <> | 1.5b | 2.6 | 2.2 | <> | ? | c | PP |
| | 2 | 3.6 | 3.2 | 21 | 21 | <> | 9.6 | 9.8 | <> | 4a | 1.5 | 2.7 | <> | ? | c | PP |
| 176 RISA | 1 | 3.2 | 4.3 | 46 | 42 | 0 | 8.9 | 9.4b | 10.0 | 6.5 | 3.0 | 2.0 | 0.0 | yes | bni | PF |
| | 2 | 2.8 | 3.9 | 53 | 46 | 0 | 8.5 | 8.6a | 10.0 | 6.2 | 2.3 | 4.8 | 0.0 | yes | bni | PF |
| 177 PHCA11 | 1 | 4.4 | 4.2 | 96 | 96 | 0 | 2.4 | 4.1 | 10.0 | 19.8 | 8.8 | 12.7 | 0.0 | yes | BNI | GE |
| | 2 | 3.2 | 2.9 | 96 | 100 | 8 | 3.6 | 3.8 | 9.0 | 17.2 | 11.2 | 12.6 | 8.5 | yes | BNI | GE |
| | 3 | 4.8 | 3.4 | 96 | 96 | <> | 3.1 | 4.2 | <> | 20.2 | 11.2 | 9.1 | <> | yes | BNI | GE |
| 178 OECE | 1 | 4.0 | 6.1 | 21 | 17 | 0 | 9.5 | 9.3 | 10.0 | 9.2 | 2.7 | 11.4 | 0.0 | yes | b | PP |
| | 2 | 3.5 | 4.6 | 21 | 21 | 0 | 9.4 | 9.0 | 10.0 | 8.8 | 2.7 | 10.2 | 0.0 | yes | bn | PP |
| 179 SACE | 1 | 5.1 | 7.0 | 23 | 4 | 0 | 9.7 | 9.9 | 10.0 | 3.3b | 1.3b | 1.0 | 0.0 | ? | nc | PP |
| | 2 | 4.1 | <> | 23 | 0 | 0 | 9.4 | 10.0 | 10.0 | 18.8a | 2.9ab | 0.0 | 0.0 | ? | nc | PP |
| | 3 | 6.2 | <> | 21 | 9 | 0 | 9.5 | 9.9 | 10.0 | 8.7b | 4a | 1.7 | 0.0 | ? | n | PP |
| 180 PHCA11 | 1 | 2.3 | 3.4 | 71 | 87ab | 0 | 5.3 | 5.2 | 10.0 | 22.2 | 13.2 | 9.4 | 0.0 | yes | BNI | FG |
| | 2 | 4.4 | 2.8 | 83 | 75b | 0 | 4.4 | 5.0 | 10.0 | 18.7 | 11.8 | 10.5 | 0.0 | yes | BNI | GG |
| | 3 | 5.5 | 4.2 | 92 | 96a | <> | 4.0 | 4.2 | <> | 16.8 | 12.1 | 11.0 | <> | yes | BNI | GE |
| 181 SARAA | 1 | 4.5 | 6.6 | 71 | 63 | 4 | 6.3 | 6.8b | 8.8 | 22.0 | 4.0 | 8.2 | 4.0 | ? | BNc | FG |
| | 2 | 4.4 | 5.0 | 75 | 88 | 13 | 6.2 | 3.3a | 9.3 | 17.1 | 4.9 | 8.8 | 4.3 | ? | BNi | FG |
| | 3 | 3.3 | <> | 83 | <> | <> | 5.0 | <> | <> | 19.2 | 4.4 | <> | <> | ? | BNc | FG |
| 182 OECE | 1 | 2.5 | 2.9 | 71 | 79 | 0 | 7.8 | 6.4 | 10.0 | 7.9 | 1.8 | 9.4 | 0.0 | yes | Bn | FG |
| | 2 | 3.6 | 2.3 | 54 | 92 | 0 | 8.1 | 5.4 | 10.0 | 9.7 | 2.4 | 11.8 | 0.0 | yes | BNc | FG |
| 183 RUPA | 1 | 5.3 | 6.5 | 4 | 38 | 0 | 9.9 | 9.5 | 10.0 | 9.0 | 2.1 | 4.0 | 0.0 | ? | c | PF |
| | 2 | 4.8 | 4.6 | 9 | 29 | 0 | 9.9 | 9.2 | 10.0 | 2.0 | 2.7 | 4.2 | 0.0 | ? | bi | PP |
| | 3 | <> | 3.4 | <> | 54 | 0 | <> | 9.0 | 10.0 | <> | <> | 3.8 | 0.0 | <> | <> | PF |

Table 3. Continued. Native Shrub Rooting Trial: Greenhouse, Field and Pond (Corvallis PMC)

| Accession/ Species | TMT | Caliper (mm) GH | Caliper (mm) FD | Percent Rooted GH | Percent Rooted FD | Percent Rooted PD | Root Abundance GH | Root Abundance FD | Root Abundance PD | Root Lgth (cm) | Shoot Length (cm) GH | Shoot Length (cm) FD | Shoot Length (cm) PD | 2 Yr Wood | Root Loc. | Overall Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184 COCOC | 1 | 4.0 | 8.2 | 17 | 4 | 0 | 9.8 | 9.9 | 10.0 | 3.8 | 2.6 | 1.1 | 1.8 | ? | c | PP |
| | 2 | 4.6 | 3.5 | 38 | 13 | 0 | 9.4 | 9.9 | 10.0 | 4.6 | 2.0 | 1.5 | 0.0 | yes | c | PP |
| 185 RHPU | 1 | 5.5 | <> | 22 | <> | <> | 9.7 | <> | <> | 9.0 | 1.7 | <> | <> | ? | b | PP |
| | 2 | <> | <> | 0 | <> | <> | 10.0 | <> | <> | 0.0 | 0.0 | <> | <> | <> | <> | PP |
| | 3 | 3.0 | <> | 9 | <> | <> | 9.8 | <> | <> | 5.5 | 2.5 | <> | <> | ? | bni | PP |
| 186 SYALL | 1 | 2.3 | <> | 92 | <> | <> | 6.8b | <> | <> | 11.3 | 9.5b | <> | <> | yes | Bni | FE |
| | 2 | 1.9 | <> | 96 | <> | <> | 4.8a | <> | <> | 18.6 | 12.5a | <> | <> | yes | Bnic | GE |
| 187 LOIN5 | 1 | 1.8 | 2.8 | 88 | 100 | 50 | 4.0 | 3.1 | 7.7b | 18.1 | 10.2 | 18.4 | 7.4b | yes | Bnic | GE |
| | 2 | 2.5 | 2.9 | 92 | 100 | 54 | 4.0 | 3.4 | 5.3a | 17.2 | 10.2 | 15.9 | 9.9a | yes | Bnic | GE |
| 188 MAAQ2 | 1 | 5.7 | 4.3 | 10 | 21 | <> | 9.6 | 9.5 | <> | 4.6 | 2.5 | 2.0 | <> | yes | bn | PP |
| | 2 | 6.0 | 6.1 | 15 | 21 | <> | 9.9 | 9.5 | <> | 1.5 | 0.0 | 1.9 | <> | yes | n | PP |
| | 4 | 3.5 | 7.8 | 6 | 6 | <> | 9.9 | 9.9 | <> | 1.0 | 0.0 | 1.3 | <> | ? | n | PP |
| | 5 | 2.9 | 3.8 | 6 | 15 | <> | 9.9 | 9.8 | <> | 4.0 | 0.0 | 1.5 | <> | ? | n | PP |
| 189 SACE | 1 | <> | 7.8 | <> | 17 | <> | <> | 9.8 | <> | <> | <> | 4.2 | <> | <> | <> | PP |
| | 2 | 6.6 | 10.9 | 19 | 28 | <> | 9.8 | 9.3 | <> | 4.0 | 1.8 | 3.1 | <> | ? | n | PP |
| 190 RISA | 1 | 2.6 | <> | 72 | <> | <> | 8.0 | <> | <> | 10.3 | 2.5 | <> | <> | yes | bNi | PG |
| | 2 | 2.8 | <> | 62 | <> | <> | 8.3 | <> | <> | 7.1 | 3.9 | <> | <> | yes | bNI | PG |
| Plumas SASI | 1 | 8.0 | 7.8 | 100a | 96 | 100 | 1.2a | 1.4 | 1.3 | 31.6a | 39.1a | 54.6 | 42.8 | ** | I | EE |
| | 2 | 7.2 | 5.7 | 29b | 100 | 100 | 7b | 1.3 | 1.0 | 10.3b | 26.6b | 41.6 | 42.1 | ** | I | *** |

TMT = treatment: 1 = untreated. 2 = 5:1 dilution Wood's Rooting Compound (WRC). 3 = 10:1 dilution WRC. 4 = untreated w/ foliage intact. 5 = 5:1 dilution WRC w/ foliage intact.

GH = greenhouse. FD = field. PD = pond. Min. Caliper = minimum caliper which still rooted. Root Abundance based on scale of 1=best, 10=none.

2 yr Wood refers to root formation on second year wood: Yes or ? (unknown). Means with different letters are significantly different at P = .05.

Root Loc. refers to location of roots on the cutting: B(b) =basal. N(n) = nodal. I(i) = internodal. c = callus w/ roots. Upper case letters indicate predominant position of roots.

Overall rating: 1st letter refers to root amount. 2nd letter refers to rooting success. P = poor. F = fair. G = good. E = excellent. <> = data not taken or available.

** SASI roots readily from 2nd year growth (not evaluated here). *** SASI rooted readily in the FD and PD with WRC, but poorly in the GH due to toxcity.

For all experiments, any consistent improvement in cutting performance from the use of Wood's rooting compound (WRC) was difficult to statistically detect for most species and data sets collected. However, for both accessions of **common snowberry**, treatments always decreased the minimum caliper of cuttings that successfully rooted and increased the number and abundance of roots, root length, and shoot length by the end of the experiment (excluding pond data). Differences were not always statistically significant, but the combined trends across all three experiments were consistent. When **salmonberry** was treated, root abundance and shoot length were greater in the greenhouse and field, but root length was less in the greenhouse. **Red elderberry** (in the field), **coyote brush**, and **Indian plum** (in the greenhouse) demonstrated increased nodal rooting when treated with WRC, but not necessarily more roots.

Any detrimental effect from using WRC rooting compound is not obvious from the data except for **'Plumas' sitka willow** in the greenhouse. Wherever the willow cuttings came in contact with the solution their roots died, causing high mortality in the plots. In contrast, no similar negative response occurred in the field or pond studies. Results for **sitka willow** in the nursery bed were mixed.

**Red elderberry** also demonstrated inconsistent tendencies. Treatments with WRC significantly improved root abundance (and increased rooting percentage) in the field, but had no effect in the greenhouse, and significantly reduced rooting percent at the 10:1 dilution level in the nursery bed. The reasons for these discrepancies are unknown. Other research has shown the benefit of low concentrations of IBA for this species (Table 4.).

The experiment using saturated (flooded) sandy substrate as a rooting medium in the pond provided very different results. **Sitka willow** performed very well as expected and most other species did poorly or completely failed to root and survive (Table 3.). However, **common snowberry** and **black twinberry** were an exception, rooting at a rate of 50-54% and 96-100% respectively. This suggests that cuttings from these two shrubs have greater tolerance to saturated conditions (at least for an initial two month period) compared to other species. If so, they may be more appropriate than others for use as live stakes or unrooted cuttings planted along the immediate shoreline of a stream or area with shallow ponding, but further evaluation is needed.

Based on these studies, it appears that additional native shrubs (or at least certain clones or populations) besides native **willows, western redosier dogwood,** and **Douglas spirea** have the potential to be planted as hardwood cuttings directly on revegetation sites. This also suggests they may work as live stakes, whips or other unrooted materials such as fascines and brush mattresses, but further testing is needed. Those with the highest potential include **black twinberry, common snowberry, Pacific ninebark**, and **salmonberry**. Species with fair potential are **red elderberry** and **coyote brush**. The utility of species with variable results, like **Indian plum**, may improve with the use of vigorous shoots from healthy cutting blocks or ecotype selection based on fast rooting clones.

Other species might be considered under limited, special, or ideal circumstances. For example, **mock orange** remains a possibility for testing on stream sites as unrooted cuttings, live stakes, and fascines because it rooted readily. Unfortunately, its roots did not penetrate a somewhat compacted silt loam soil. It may be limited in use to moist or well watered, well drained, coarse textured soils. Despite fair survival, **red flowering currant** appears marginal at best because it was relatively slow to root. However, given its high ornamental and wildlife value, high density plantings of unrooted cuttings may be worth the effort in benign environments with high quality, well drained soils and supplemental irrigation.

**Blue elderberry** and **thimbleberry** rooted poorly (low root abundance and/or only poor to fair rooting percentage) and slowly from hardwood cuttings, in contrast to good success in some reports (Leigh 1997). Based on uncertain results, they are not recommended for direct sticking, live staking, or whips at this time. Differences in performance could be related to donor plant health, timing, handling and storage techniques, genetics, growing conditions, sanitation, pest management, and the skill of the propagator. These variables can and will substantially affect results regardless of the species in question.

As this work and the literature suggests, **cascara, tall Oregon grape, Oregon viburnum** and **California hazel** are most effectively propagated by other means. Refer to Table 4. for a summary of vegetative and sexual propagation techniques for 22 Pacific Northwest native shrub and trees species, including these.

## FUTURE WORK

Future work should include evaluating how well the most favorable species root from 3-5 year old wood or as live stakes, establish from horizontal bundles (fascines or wattles) or brush mattresses, and perform when planted or installed at different times of the year (fall versus winter or early spring) using these methods. For most shrubs tested, the efficacy of treating material with plant growth regulators under difficult, on site conditions remains a question. Ultimately, the goal is to improve shrub rooting success for growers and increase the number of indigenous species applicable to environmentally friendly soil bioengineering practices or low cost methods like direct sticking and live staking. This will provide further opportunity for revegetation and erosion control specialists to diversify plant communities and restore wildlife habitat along streams, shorelines and wetlands.

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## LITERATURE CITED

Hamilton, C.W., M. Murai, and C. Gilbert. 1998. Northwest natives: ten years after. Hortus West (:2 98-100.

Kruckeberg, A.R. 1996. Gardening with native plants of the Pacific Northwest. University of Washington Press, Seattle and London, Greystone Books/Douglas and McIntyre, Vancouver/Toronto.

King County Department of Public Works. 1993. Guidelines for bank stabilization projects. Seattle, WA. pp. 6-5 to 6-9.

Leigh, M. 1997. Grow your own native landscape: a guide to indentifying, propagating and landscaping with western Washingon native plants. Cooperative Extension Service, Washington State University, Thurston Co., WA.

Rose, R., C.E.C. Chachulski, and D.L. Haase. 1998. Propagation of Pacific Northwest native plants. Oregon State University Press, Corvallis, OR.

## Table 4. Review of Traditional Propagation Methods for 22 Pacific Northwest Native Shrubs and Small Trees

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Acer circinatum* Vine maple | Very difficult. No reports of success with this method. | Moderately difficult. Callusing and root formation are extremely slow (23). Half ripened greenwood has worked in some cases (1), as have standard semi-hardwood cuttings. | Moderately easy to salvage seedlings or smaller trees if done when dormant (1). Avoid over watering potted and transplanted seedlings (15). Sprouts from root crowns have rooted in some cases. Also by layering but rooting is very slow (5,15). Air layering has also been reported. | Preferred method, but follow precautions. Seed should be collected when it is just starts to turn from green to tan, usually in late August or September. Green seed will also germinate (5). Seed should not be allowed to dry out as it can becomes more physically dormant and/or may lose viability. Fall sow immediately or cold moist stratify for 3 to 6 months (19). Nearly 100% germination has been reported with 3 months of cold stratification (26). Germination can occur in the dark. Others recommend 2 to 3 months of warm moist stratification prior to the cold moist treatment (19). If the seed is very dry, some suggest softening the pericarp (seed coat) by soaking it for 5 days in water then cracking it (with a hard, heavy roller) prior to fall sowing (17). Untreated, dry seed can still germinate the second spring (5). | Not recommended. |
| *Amelanchier alnifolia* Var. *semiintregrifolia* Pacific serviceberry | Very difficult. No reports of success with this method. | Highly variable results reported. Difficult from softwood cuttings based on our trials with only 1-6% success (8). Timing appears critical (5): late May to early June prior to terminal bud set may be best. Results vary widely depending on variety, subspecies, population, etc. Rooting medium must be very well drained (sand, perlite), and do not over mist (11). A wide range of hormonal concentrations, 1000 to 10,000 ppm IBA-talc and IBA solutions have helped (10). Success rate of 22% reported with 12 to 17 cm long semi-hardwood cuttings taken in late June and treated with 4000 ppm Hormex rooting powder (11). | Can be salvaged as seedlings or plants under 3 ft. tall. Propagation by layering (15) or division in early spring has been reported. Also by root cuttings: 5 cm cuttings of fleshy, pencil thick roots taken in December to February near the base of the crown is reported to work. Cuttings are treated with fungicide, stuck vertically with proximal end at soil level, and covered with 1.5 cm of perlite (19). Propagation of variety *semiintegrifolia* needs evaluation as root cuttings. | Best method, but can be problematic. Collect the fruit as it ripens in summer or cover trees with netting to protect from birds. Macerate to remove the pulp. Do not let the seed dry out beyond surface dry (10). Seed can be stored several years in sealed containers under refrigeration. Fungi carried on the seed coat can be a problem. Surface sterilization with 5 to 10% hydrogen peroxide solution for 15 minutes (12), or 3% for 20 minutes followed by a 24 to 48 hour water rinse, and weekly seed rinses are considered beneficial (16). Others also use a fungicide (Captan) while in storage (19) or prior to sowing, but it may reduce germination (8). Sow seed immediately in the fall (20) or cold moist stratify for 2 to 6 months, depending on the population. All viable seed may not germinate until the second spring (19,20). Three to 4 months warm stratification prior to cold stratification has been used successfully, as has scarification with sulfuric acid for 30 min. to reduce the stratification period (5,10). | Not recommended. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Alnus viridis* spp. *Sinuata* Sitka alder | Very difficult. No reports of success with this method. No cuttings rooted in our trials. | Very difficult. Softwood and semi-hardwood cuttings have generally not been successful, even with hormonal treatments. | Easy to salvage if under 3 ft. tall. Root cuttings and layering need to be tried. | Best method. Collect seed (winged nutlets) in late September to early November when the cone-like catkins turn woody and scales begin to open. "Cones" may be hand collected or the branches flailed over a tarp, then thoroughly dried and the seed removed by tumbling or shaking (24). Cones can also be kiln dried at 80 to 100°F. (20). Seed stored in cool, air tight containers can be viable for 1 to 2 years (5). Seed is considered non-dormant and no treatment may be needed (12), but higher or more uniform germination may be obtained with 2 months cold moist stratification of dry seed (4, 24). Fungicide (Captan) treatment may reduce germination. Fresh seed may be less dormant than dry or stored seed. | Not recommended. |
| *Baccharis pilularis* Coyote brush | Easy (50-90%). Roots as evergreen hardwood cuttings taken in late winter after flowering is complete. Remove at least lower half of foliage. Intact leaves may senesce even under mist. IBA not required and did not improve rooting in our trials. | Not widely reported. Semi-hardwood cuttings (5 cm long) taken April-June and treated with 3000 ppm IBA powder have worked with 70% success (28). | Root cuttings and tip cuttings. Propagation for landscaping is usually from males to avoid cottony seed production of females. Can be salvaged. | Species is dioecious and a member of the Aster family. Female plants flower from October through December. Seed is a small black nut with white, cottony fluff. It matures November through January. Mature flowers are white and seeds are dark brown at maturity. No special seed treatment required.(6, 27). Seed can be stored dry under cool, low humidity conditions. Seed can germinate 14 days after sowing (27). | Moderate potential for direct sticking of cuttings and live stakes. Successfully used for soil bioengineering in California (9). Note: this is a drought tolerant species adapted to poor soils (sand or clay) and harsh coastal conditions. |
| *Cornus sericea* spp. *Occidentalis* Western redosier dogwood | Very easy (75-100%). No treatment needed. IBA solutions (1000 to 5000 ppm) not required, but may be beneficial in some cases (4). Reports of increased disease and stem dieback in wild stands from harvest of cuttings suggests commercial sources or cutting blocks may be a better source. Can use older wood. | Easy (90%). Collect cutting in June-July. 1000 ppm IBA solution is usually suggested, but may not be needed (5). Remove lower foliage. Also from branch tips in late summer (19). | Layering (can also be done in summer if soil moisture is present. Known to layer naturally). Easy to salvage (15). | Collect seed/fruit (drupes) in August or Sept. Plant fresh drupes in flats or macerate to separate pulp from seed, then dry. Fall sow or cold moist stratify 2 to 3 months (19,20). Some germination will be immediate, but the rest will be staggered or in the spring (15). Benefits from scarification (1 hr with sulfuric acid), 2 months warm stratification in lieu of acid (6)., or soaking with water for 1 to 2 days also reported to be beneficial (12). | Fair to good success for live stakes, fascines, and brush mattresses if moisture is favorable and weed competition and deer browse are kept in check. Wounding may enhance rooting (3), or try pre-plant hormonal dips (IBA/NAA) solutions to maximize potential. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Corylus cornuta* var. *californica* California hazel | Variable. Moderately difficult and not widely reported. However, while root development was slow, 4-60% of the cuttings rooted in our trials. May benefit from dilute IBA/NAA solution. | Not widely reported. Semi-hardwood cuttings (5 inches with at least 3 nodes) taken from July through October and treated with 3000 ppm IBA powder has worked with 50% success (29). | Easy to salvage if under 5 ft (15). Also by layering. Does not sprout from root suckers like its close relative, *Corylus cornuta* (beaked hazel) does (35). | Preferred method, but nuts must be collected in September-November before wildlife harvests them. Collect as soon as the edges of the husk turn brown and allow to dry until completely brown. Husks can be left on or removed. Seed requires 2 to 6 months of cold stratification (15,20,30). Note: Can be stored for a year, but only under high humidity, such as in sealed plastic containers under cool conditions. Fresh seed can be soaked for 24 hours, placed in bags with a medium such as perlite, and refrigerated for cold stratification. Staggered germination will occur while in stratification (30). Nuts can also be fall sown, but predation may occur. | Not recommended. |
| *Holodiscus discolor* Oceanspray | Variable (0-20%). Can be difficult. Some report fair to good success when collected in late January to early February (15, 19), but our results have been very poor except for a small percentage of clones or populations (2 of 76). IBA powder and bottom heat did not help (7). | Marginally satisfactory (13-16%) for some ecotypes from June softwood cuttings and may benefit from IBA treatment (7), but not recommended over seed propagation. Others report that softwood cuttings do not work well. Semi-hardwood cuttings have been successful for some (13). | Root crown buds (19) or suckers (13). Easy to salvage. | Easy and preferred method. Cold moist stratification for 4 to 5 months will maximize germination (7,20). Otherwise, fall sow at heavy rate. | Not recommended. |
| *Lonicera involucrata* Black twinberry | Very easy (90-100%). Best method. No treatment needed. While some suggest using IBA treatments (19), dilute IBA/NAA treatments provided no consistent benefit in our trials. Can use older wood. | Easy (75-90%). Collect cuttings in spring or summer. May benefit from 1000 ppm IBA solution (5), but not required. Also by soft tip cuttings treated with 500 ppm water based liquid hormone (21). | Easy to salvage but keep very moist first year (15). Also by layering. | Collect seed/berries in July and August when ripe. Macerate to remove pulp, then dry seed. Fall sow or cold moist stratify for 1 ½ to 2 [3] months (12,19,20). Some suggest surface sterilization for 15 min. with 5 to 10% hydrogen peroxide (12). | Good potential for live staking and direct sticking of cuttings and whips on restoration sites. Roots in standing water. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Mahonia aquifolium* Tall Oregon grape | Variable. Can prove difficult and slow to root as evergreen hardwood cuttings (0-20%). No benefit from dilute solution of IBA/NAA in our trials. Conflicting information on the best time to take cuttings. Late November worked best for some. 3000-8000 ppm IBA-talc recommended in the literature (5,10). All leaves or all but the top leaf should be removed. | Variable. Can be difficult. Some reports of good success (84%) with late summer cuttings and 3000 ppm IBA-talc (5). May be best as "heeled"(includes portion of previous years wood), basal (basal end is firm, lignified), and nodal (soft tip) cuttings taken into late autumn. All spines and leaves should be removed and the basal end treated with hormone (19). | Salvage is difficult (15). Can propagate from leaf bud cuttings (5), root cuttings (19), and air layering (10). | Preferred method but can be complex. Collect fruit in August and September. Macerate to remove pulp then dry seed. Fall sow or at a minimum, cold moist stratify for 3 to 5 months prior to spring seeding (6, 15,20). Seed may need to be leached of inhibitors prior to stratification (10). Warm stratification for 4 months prior to cold stratification is also recommended to allow time for embryo to mature (5). | Not recommended. |
| *Oemleria cerasiformis* Indian plum, osoberry | Variable. Moderately difficult (20%) to easy (90%). At least one propagator reports that male clones root easier than females (personal comm, Ron Robinson, Balance Restoration Nursery). Dilute IBA-NAA solution did not improve rooting in our trials. Results may also differ widely by clone or population. Good results often reported (13,15). Breaks bud early, so cuttings must be collected in November-Decemeber. | Not widely reported. Needs further evaluation. | Layering, root cuttings or root suckers. Easy to salvage if under 5 ft (15). | Species is dioecious. Collect fruit from females promptly in June before bird predation. Dry the whole fruit, or macerate to remove pulp and dry the seed. Fall sow or cold moist stratify for 4 to 5 months (15,20). Germination is sporadic and will occur during stratification (15). | Not fully recommended for live staking or direct sticking of cuttings, but warrants further testing. |
| *Philadelphus lewisii* Lewis mock orange | Easy (70-90%). Cuttings to 20 cm long taken in fall, winter or early spring from 1 year old shoots. IBA solutions (2500-8000 ppm IBA) may improve rooting in some cases (5), but does well without. Use sandy medium or 1:1 perlite/peatmoss. | Very easy (90-100%). Harvest in June and July. Apply 1000 ppm IBA solution for best root system and mist (5). One report says do not use pithy fast growing stems (21). | Rooted basal suckers transplant easily from salvage sites (15). Possibly by layering also (5). . | Easy. Seed matures in late summer. Fall sow untreated, dry seed or cold moist stratify for 1 to 2 [or 5] months (5,12,15). Also requires light for germination (5) so will not sprout in cold stratification. Seed production is very abundant so it can be sown directly on restoration sites in the fall. | May have limited potential as live stakes and direct sticking of cuttings, but needs further testing. Such use may be restricted to well watered, (moist but well drained), coarse textured soils. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Physocarpus capitatus* Pacific ninebark | Easy (75-100%). Recommended over softwood. Can use older wood. Dilute IBA/NAA solution can improve rooting of some clones or populations, but many will do very well without. Stick in sandy medium. | Generally not preferred over hardwood but can be rooted anytime (15) and considered easy (21). | Easy to salvage if under 6 ft (15). Potential for layering. | Collect seed in late August and September and fall seed (19). Otherwise, needs 2 to 3 [4] months cold-moist stratification (6,12,15). Seedlings subject to damping off fungal attack (12) | Fair to good potential as live stakes or cuttings that are directly stuck. May also root as whips. Best results have occurred where soils are moist, well drained and surface mulched. Try pre-plant hormonal dips (IBA/NAA solutions) to improve success. . |
| *Rhamnus purshiana* Cascara | Variable. Difficult. Not well documented. Poor or marginal results (0-22%) from our trial with February cuttings. | Some success reported with cuttings taken in September-October (19). | Can be salvaged if under 4 ft (15). Layering also reported (20), at least in early spring (19). | Recommended method. Collect berries in July-August 2 weeks before fully ripe and before eaten by birds. Macerate to remove pulp and fall sow or cold moist stratify seed for 3, 3 ½ (15,19,20), or 4½ months (2). | Not recommended. |
| *Ribies sanguineum* Red flowering currant | Moderately easy (25-60%). Collect vigorous 1 year old shoots well before spring bud swell. Requires good drainage. Basal heat (70°F), "heel" of 2 year wood, and 8000 ppm IBA talc reported to help (10). | Moderately easy (21). Harvest vigorous shoots summer to early Sept. Basal heat, "heel" of 2 yr wood, and IBA talc is reported to help (10). | Whole plant salvage (moderately successful), layering (15). | Collect seed as soon as ripe in July, August, or Sept. Fall sow dry or cold moist stratify for 3 to 5 1/2 months (15). Others report that no pre-treatment (stratification?) was used other than cool, dry storage and germination occurred in 12 days (31). | Not recommended for live stakes. Minor potential for direct sticking of unrooted cuttings, but only on the most favorable sites and with supplemental irrigation. |
| *Rubus parviflorus* Thimbleberry | Variable. Proved difficult in our greenhouse trials, but others report it is easy (15). Moderately successful in our field trial. Specific methods are not widely documented. Further testing needed. | Not well documented and needs further evaluation. Good success (60%) reported for 5 inch semi-hardwood cuttings taken June-July and treated with 1000 ppm IBA powder, bottom heat and mist (32). | Easy to salvage if small. Propagate by divisions or dormant rhizome cuttings (15,19,22). Also from suckers and by tip layering (14). | Variable. Collect seed as soon as the berries are ripe. Seed is tan at maturity. Soak in water for a few days before macerating. Some report that seed germinates easily and require no pretreatment (19). Other recommendations include fall sowing or cold moist stratification for 3, 4 or 5 months (12,15, 25). Some suggest acid scarification with concentrated sulfuric acid for 20-60 minutes or with 1% sodium hypochlorate (household bleach) for 7 days is helpful (6, 14). Seed drying, acid scarification, and warm stratification are known to affect seed dormancy in other species of *Rubus* and need to be investigated for thimbleberry. | Not recommended. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Rubus spectabilis* Salmonberry | Easy (60-90%). No consistent benefit from dilute IBA/NAA solution in our trials, but hormone treatments recommended by some. Others suggest cuttings be least 45 cm long with 3 or more nodes (19). May not root well from older wood. | Not well reported. Greenwood cuttings in summer have worked but specific methods are lacking. Further testing needed. | Easy from rhizomes or root cuttings, suckers under 4 ft tall (salvage), basal sprouts, and layering (15,19). | Variable. Easiest if fall sown rather than stored dry and later stratified. Collect fruit in June through August before the birds. Macerate to remove pulp and dry for storage. Scarify with sulfuric acid (20 to 30 minutes), followed by 1 ½ to 2 months warm and 4 months cold moist stratification (20,21). Others report that 3 months cold moist stratification is sufficient (6,15). | Has potential for direct sticking on restoration sites using current year (1 year old) wood. Live staking with older wood not recommended at this time. Needs testing as whips. |
| *Salix sitchensis* Sitka willow | Very easy (100%). Do not treat with IBA or other rooting hormones which can be detrimental. | Very easy (100%). Will root anytime of the year. Do not treat with IBA or other rooting hormones. Strip foliage. | Layering. Very easy to salvage seedlings and small trees under 5 ft. | Species is dioecious. Practices specific to Sitka willow seed are not reported but the following generally applies to willow species in our area: collect capsules (from female trees) when they turn from green to yellow, as soon as the seed ripens. Do not store or let dry out. Seed is short-lived, even if kept moist and dark. If fresh seed is not dormant (assumed but needs testing) sow immediately on the surface. Do not cover, and keep constantly moist. Should germinate in 1-5 days (15,20). | Excellent for live stakes, direct sticking of cuttings, whips, poles, fascines, brush mattresses, live cribwalls, branch packing, brush layering. Roots in standing water. |
| *Sambucus cerulea* Blue elderberry | Variable (0 to 50%). Can be difficult. Our results and those of others have been poor. Some report good rooting (15), but real improvement may be due to inclusion of a "heel" from previous years growth at the base so as not to expose the pith (19). Cutting must have at least 2 nodes or 1 plus a heel. | Specific information not widely reported. However, if true of the elderberries in general, should be easy from cuttings taken in spring or summer (10). Consider inclusion of "heel" as with hardwood cuttings. Cutting should have at least 2 nodes. | Layering and salvage (15). | Difficult. Collect fruit in late summer or early fall and remove pulp. Most agree seed requires a period of 2 to 3 months cold moist stratification (15,20), even for fresh seed (6). Dry (and fresh?) seed may require or germinate better with 2 to 3 months warm moist followed by 3 to 4 months cold moist stratification (FS), or a 10 to 15 minute soak in concentrated sulfuric acid followed by 3 to 5 months cold moist stratification (6). Or, fall sow early when soil is still warm. | Not recommended for direct sticking or live stakes, although some report good results (15). |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Sambucus racemosa* Red elderberry | Easy (60-90%). Can benefit from IBA solutions or IBA-talc, but rooting is satisfactory without. Cuttings require at least 2 nodes. Collect from October to December, before bud swell. Needs well drained rooting medium. Some report that inclusion of "heel" from previous years wood may reduce rotting, as does fungicide (Captan-talc) treatment of basal end. Use cool air temperature and do not tent (5). In contrast, others suggest hot and humid conditions (19). | Easy (70-90%). Take cuttings in spring (June) or summer once the wood hardens. Cuttings require at least 2 nodes. Make basal cut just below a node and remove 1/3 of foliage or trim leaflets to ½ length. May benefit from IBA (3000 ppm powder) (33) and fungicide (Captan) solutions (19). Beds must have good drainage. "Greenwood to semi-ripe cuttings with thicker stems root easily" (21). | Layering, rhizome cuttings. Can be salvaged but include as much fleshy root as possible (15). | Difficult due to complex dormancy. Collect seed in August-Sept and remove pulp. Most agree that 2-3 [5] month cold moist stratification is required, even for fresh seed (6). One report indicates germination with cold storage alone (19). Others indicate that dry or even fresh seed germination requires or improves with both a 1-2 [5] month warm moist followed by 2-4 month cold moist stratification. Or, sow immediately after collection in late summer to provide both warm (fall) and cold (winter) periods for conditioning. (2,5,6,10,15,20). Other sources also suggest a 5 minute soak in concentrated sulfuric acid in addition to or as a replacement for warm stratification. | Cuttings of one year old wood can be too weak for direct insertion on stream restoration sites. Successful use as live stakes has been reported (15). |
| *Spiraea douglasii* Douglas spirea | Easy (90-100%). Roots readily without treatment. However, root development may improve with 5000 ppm IBA solutions, but without fungicide treatment Captan-talc (4). | Not widely reported. Fall cuttings with rooting hormone have been used (19). | Easy from root cuttings, layering, root suckers, and division (15). | Collect seed in fall. Fresh seed will germinate without pretreatment. Dry seed must be fall sown or cold moist stratified for 1-3 months (5,15). | Fair to good potential for live stakes, and whips (of narrow caliper), as well as fascines. Pre-planting hormonal treatments (IBA/NAA dips) could be tried. |
| *Symphoricarpos albus* Common snowberry | Easy to very easy (75-100%). Will root readily from all but the narrowest cuttings (4mm+), as well as thick, older stems, as in our trials. Dilute 2000 ppm IBA (18) or IBA/NAA solutions may improve root development, but it does well without. Some suggest 2 nodes should be below the soil surface (18). | Very easy (90-100%) from softwood (May-June) or semi-hardwood cuttings taken June through August. 3000 ppm IBA-talc reported to help (5), but it does well without. Others use 8000 ppm IBA with softwood cuttings. May perform better with at least 2 nodes beneath the soil surface (18). | Easy from root cuttings, division, root suckers taken most times of the year. Can be easily salvaged (15). | Difficult due to complex dormancy. Collect fruit in late fall or winter and separate seed from fruit by maceration. Fall sown seed germinates the second spring (15). Otherwise, 2 [4] months warm moist followed by 6 [3] months cold moist stratification (15,19,20,34). Or, simulate 2 year cycle with 3 months warm, 3 months cold, 3 months warm and 3 months cold stratification (21). Store in moist media to encourage further development of embryo, or store dry for up to 2 years. | Good potential for direct sticking of cuttings and whip on site as well as live staking (albeit long, narrow stakes). Will root in temporarily saturated soil. Pre-plant IBA/NAA treatments merit investigation. |

| Species name/ Common name | Hardwood cuttings[1] | Softwood and semi-hardwood cuttings[1] | Other methods of vegetative propagation | Propagation from seed | Direct planting as hardwood cuttings, live stakes, whips, etc.[1] |
|---|---|---|---|---|---|
| *Viburnum ellipticum* Oregon viburnum, oval-leaf viburnum | Variable. Difficult. Not well documented. Slow root development in our trial with 5-21% rooting success. One grower reports improved rooting (50%) using vigorous shoot cuttings and a 2-3 minute dip with dilute IBA solution (personal comm., Julie Whitaker, 4th Corner Nursery). | Not well documented, but softwood recommended over hardwood cuttings. Cut back to set new shoots and collect from vigorous sprouts or suckers. More evaluation needed. | Not reported. Most viburnums can be propagated by layering. Probably can be salvaged. | Difficult due to complex dormancy. Remove pulp from seed, dry, and sow early in the fall. Conditioning requirements are not reported, but most viburnums require several months of warm followed by a month of cold moist stratification (2,20). Testing is needed to determine exact requirements for this species. | Not recommended.<br><br>(Underutilized species that needs more research and wider use). |

[1]**Table Definitions**:
Air layering = rooting technique whereby an aerial stem is wounded in some fashion, then treated with rooting hormone and covered with moist sphagnum moss at the point of the wound. The moss is held in place with a plastic wrap tied at both ends. Once roots develop, the stem is separated from the main plant and potted or planted.
Division = technique where the crown or base of a plant is divided up so that each section contains at least one shoot or shoot bud.
Dioecious = plant species with incomplete flowers (flowers with only male or female parts, not both) that are found on separate plants. Examples here are willow, Indian plum, and coyote brush.
Hardwood cutting = a piece of woody stem collected when the plant is dormant, normally in winter (after leaf fall and before bud swell for deciduous broadleaf shrubs). Current year (1 year old) shoots are most commonly used, but older wood can be used for some species. Usually at least two stem nodes are included.
Heel = a small section or piece of older wood that is left attached to base of the cutting.
IBA = indole-3-butyric acid, a synthetic plant growth regulator or hormone that mimics natural auxin or IAA (indole-3-acetic acid) by stimulating root development and other plant responses.
Layering = encompasses several techniques, but generally refers to the rooting of a stem at the point it touches a moist surface or is buried under moist soil. The stem remains attached to the parent plant until root development is judged sufficient. Layering can occur naturally as in the case of redosier dogwood, or as the result of a branch or shoot being held down on the ground by mechanical means.
Live stake = a 30-36 inch long, sturdy stake made from a live, dormant branch or the main bole of a tree or shrub species that roots easily. The basal end is cut at an angle for easier insertion and the top end is flat for tapping or “pounding”. Maintaining proper polarity and minimizing damage to the distal (top) end are important.
NAA = Naphthalene acetic acid, a synthetic plant growth regulator or hormone that mimics IAA.
Node = point along a stem or shoot where leaf and/or flower buds occur. Branch joints can also be considered nodes.
ppm = parts per million. Concentration of a chemical dissolved in a solution of water, alcohol or other solvent. Note that 1000 ppm equals a 0.1% solution, 5000 ppm equals 0.5% solution, etc.
Rhizome cutting = similar to a root cutting, but utilizes a piece of rhizome or lateral, underground stem from which shoots and roots naturally arise. Rhizome formation is synonymous with suckering shrubs like common snowberry and Douglas spirea.
Root cutting = piece of fleshy root usually collected close to the main stem in winter. Root cuttings show polarity so the end closest the main stem is planted upright. Such cuttings are usually 1/16 to 1/4 inch in diameter and 3 to 4 inches long, or 3/8 to ½ inch in diameter and 1 ½ to 3 inches long. Method only works for species capable of forming adventitious shoots from roots.
Scarification = physically changing the surface characteristics, integrity, or thickness of a seed coat, typically by abrasion, acid treatment, or bacterial actions. Usually done to allow moisture uptake by the seed and overcome physical dormancy.
Semi-hardwood cutting = (also known as greenwood cutting) a piece of woody stem collected from current years wood after expansion has ceased and the tissue has hardened (lignified) for the summer.
Softwood cutting = piece of woody stem collected from newly expanded or actively growing shoot in spring.
Stratification = a period of warm moist or cold moist treatment of seed placed on or in a medium such as moist peat moss, sand, or paper. It allows for after ripening or other physiological conditioning of the seed necessary to overcome dormancy. Cold moist stratification can often be achieved by fall sowing and overwintering the seed outdoors under natural conditons.
Whip = a very long cutting (3-6 ft) or unbranched stem that is inserted with at least ½ of its length below ground in order to reach the water table or zone of prolonged soil moisture.

**Disclaimer**: The use of brand names is for informational purposes only and not intended to be an endorsement of that product. Use of any pesticide, acid, plant growth regulator (hormone), or other chemical must follow all label instructions, applicable laws and safety precautions.

**REFERENCES FOR TABLE 4.**

(1) Anonymous. 1976. *Acer circinatum* Pursh. Vine Maple. Davidsonia 7(3):33-37.

(2) Baskin, C.C., and J.M. Baskin. 1998. Seeds ecology, biogeography, and evolution of dormancy and germination. Academic Press. San Diego, CA and London, England. 666 p.

(3) Bentrup, G. and J.C. Hoag. 1998. The practical streambank bioengineering guide. Users guide for natural streambank stabilization techniques in the arid and semi-arid Great Basin and Intermountain West. Interagency Riparian/Wetland Project. USDA Natural Resources Conservation Service, Plant Materials Center, Aberdeen, ID. 165 p.

(4) Darris, D.C., T.R. Flessner, and J.D. Conrod Trindle. 1994. Effect of cold moist stratification on germination of Sitka alder seed. IN Corvallis Plant Materials Center Technical Report: Plant Materials for Streambank Stabilization 1980-1992. p. 104-105.

(5) Dirr M.A. and C.W. Heuser Jr. 1987. The reference manual of woody plant propagation, from seed to tissue culture. Varsity Press, Athens, GA. 239 p.

(6) Emery, D.E. 1988. Seed propagation of California native plants. Santa Barbara Botanic Garden, Santa Barbara, CA. 115 p.

(7) Flessner, T.R. 2001. Seed and plant increase of oceanspray. IN Corvallis Plant Materials Center Annual Technical Report 2000. USDA Natural Resources Conservation Service, Corvallis, OR. p 5-6.

(8) Flessner, T.R. 2001. Plant and seed increase of select ecotypes of Pacific serviceberry. IN Corvallis Plant Materials Center Annual Technical Report 2000. USDA Natural Resources Conservation Service, Corvallis, OR. p 3-4.

(9) Gray, D.H. and A.T. Leiser. 1982. Biotechnical slope protection and erosion control. Krieger Publishing Company, Malabar, Florida. 271 p.

(10) Hartmann, H.T., D.E. Kester, and F.T. Davies, Jr. 1990. Plant propagation principles and practices. Prentice Hall, Englewood Cliffs, NJ. 647 p.

(11) Hosokawa, J. T. Luna. 2001. Propagation protocol for vegetative production of *Amelanchier alnifolia* Nutt. Glacier National Park, West Glacier, Montana. IN: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 3 p.

(12) Hudson, S. and M. Carlson. 1998. Propagation of interior British Columbia native plants from seed. British Columbia Ministry of Forests, Research Program. Kalamalka Forestry Centre, Vernon, B.C., Canada. 30 p.

(13) Kruckeberg, A.R. 1996. Gardening with native plants of the Pacific Northwest. Greystone Books/Douglas & McIntyre, Vancouver/Toronto. University of Washington Press, Seattle and London. 282 pp.

(14) Lady Bird Johnson Wildflower Center. *Rubus parviflorus* (Rosaceae). IN Wildflower Center. URL: http://wildflower.avatartech.com/Plants_Online/Native_Plants/Detail.asp?ID-943 (accessed 27 August 2002). 1 p.

(15) Leigh, M. 1999. Grow your own native landscape. A guide to identifying, propagating and landscaping with western Washington native plants. Native Plant Salvage Project, Cooperative Extension Service, Thurston Co., WA. 116 p.

(16) Luna, T., J. Hosokawa, D. Wick, and J. Evans. 2001. Propagation protocol for production of container *Amelanchier alnifolia* Nutt. plants Glacier National Park, West Glacier, Montana. IN: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 4 p.

(17) McGrath, J.M. 1992. Vine maple propagation at Wind River Nursery. IN General Technical Report RM-221. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, T.D. Landis, ed.

(18) Potter, R., J. Lapp, D. Wick, T. Luna, J. Evans, J. Hosokawa, and S. Corey. 2001. Propagation protocol for vegetative production of container *Symphoricarpos albus* (L.) *var. laevigatus* (Fern) Blake plants. Glacier National Park, West Glacier, Montana. IN: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 4 p.

(19) Rose, R., C.E.C. Chachulski, and D.L. Haase. 1998. Propagation of Pacific Northwest native plants. Oregon State University Press, Corvallis, OR. 248 p.

(20) Schopmeyer, C.S. Tech. Coor.1974. Seeds of woody plants in the United States. Agricultural Handbook 450. USDA Forest Service. Superintendent of Documents, Washington, D.C. 883 p.

(21) Taylor, J. 2001. Propagation successes, failures and lessons learned. IN Proceedings of the Conference: Native Plant Propagation and Restoration Strategies. Haase, D.L. and R. Rose, editors. Nursery Technology Cooperative and Western Forestry Conservation Association. December 12-13, 2001. Eugene, OR. Oregon State University, Corvallis, OR. p. 45-54.

(22) Teachout-Teashon, D. 1999. *Rubus parviflorus*. IN Maritime Pacific Northwest Gardening, Two Rainy Side Gardeners. URL: wysiwyg://44/http://www.rainyside.com/features/plant_gallery/nativeplants/Rubus_parviflorus.html (accessed 27 August 2002). 3 p.

(23) Vertrees, J.D. 1975. Observations on *Acer circinatum* Pursh. Propagation. Plant Propagator. 21 (4): 11-12.

(24) Wick, D., T. Luna, and J. Hosokawa. 2001. Propagation protocol for production of container *Alnus viridis* (Chaix. DC. ssp. *sinuata* (Regel) Love & Love plants. Glacier National Park, West Glacier, Montana. IN: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 4 p.

(25) Wick, D., S. Corey, and T. Luna, 2001. Propagation protocol for production of container R*ubus parviflorus* Nutt. plants. Glacier National Park, West Glacier, Montana. IN: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 3 p.

(26) Wott, J.A. *Acer circinatum*. IN Plant Picks, www.greenbeam.com/features/plant102698.stm accessed 8/26/02. 2 p.

(27) Young, B. 2001. Propagation protocol for production of container *Baccharis pilularis* DC. plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 23 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 2 p.

(28) Young, B. 2001. Propagation protocol for vegetative production of container *Baccharis pilularis* DC. plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 23 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 2 p.

(29) Young, B. 2001. Propagation protocol for vegetative production of container *Corylus cornuta* (A. DC) Sharp var. *californica* (A. DC) plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 2 p.

(30) Young, B. 2001. Propagation protocol for production of container *Corylus cornuta* (A. DC) Sharp var. *californica* (A. DC) plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 23 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 2 p.

(31) Young, B. 2001. Propagation protocol for vegetative production of container *Ribes sanguineum* Pursh var. *glutinosum* (Bentth.) Loud. plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery.  2 p.

(32) Young, B. 2001. Propagation protocol for vegetative production of container *Rubus parviflorus* Nutt. plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery.  2 p.

(33) Young, B. 2001. Propagation protocol for vegetative production of container *Sambucus racemosa* L. plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery.  2 p.

(34) Young, B. 2001. Propagation protocol for production of container *Symphoricarpos albus* (L.) *var. laevigatus* (Fern) Blake plants. Golden Gate National Parks, San Francisco, CA. IN Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 22 August 2002). Moscow, ID. University of Idaho, College of Natural Resources, Forest Research Nursery. 2 p.

(35) Zimmerman, M.L. 1991. *Corylus cornuta* var. *californica*, IN Fire Effects Information System. URL: http://www.fs.fed.us/database/feis/plants/tree/corcorc/all.html. (accessed 8 August 2002). USDA Forest Service.