Proceedings of the 5th Annual British Columbia Mine Reclamation Symposium in Cranbrook, BC, 1981.
The Technical and Research Committee on Reclamation

EROSION CONTROL IN THE QUEEN CHARLOTTE ISLANDS

by

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INTRODUCTION

The Queen Charlotte Islands consist of approximately 150 islands, grouped into a triangular shape, that lie off the northwest coast of British Columbia (Calder and Taylor 1968). The Charlottes are approximately 250 km long and have a maximum width of 85 km. The two major islands are Graham and Moresby. The mountains of the Queen Charlotte Range form the backbone of the Islands with most peaks between 800 m and 1,100 m and a few above 1,300 m.

CLIMATE

The climate of the Charlottes can be summarized by this statement from Calder and Taylor's Flora of the Queen Charlotte Islands (1968):

> "The main distinguishing features of the climate of the Queen Charlotte Islands are the very cool summers, the very mild winters, the prevalence of cloudy skies and strong winds, and the excessive late fall and early winter precipitation."

The precipitation ranges from 1,550 mm per year on the east side of the Islands to in excess of 7,500 mm on the west coast. The average number of days per year with measurable precipitation ranges from 205 to 249. The 24-hour rainfall may be as high as 12 cm or 15 cm (Toews and WiIford 1978). It is this type of event that causes much of the problems associated with land instability.

VEGETATION

The Queen Charlotte Islands are within the Coastal Western Hemlock Biogeoclimatic Zone and the lower elevations are for the most part forested with commercial stands (Toews and Wilford 1978). These stands are composed of western hemlock, Sitka spruce, western red cedar, and yellow cedar. The forested lands are highly productive and still contain a high percentage of large old-growth timber. Forestry is only one of the main industries in the Charlottes, fishing is another.

FISHERY RESOURCE

All five species of Pacific salmonids and the steelhead trout occur in the Queen Charlottes. Approximate average annual escapements of the anadromous salmonids (the number of adult fish returning to spawning streams) are indicated in Table 1 for four watersheds on the south-eastern quarter of Graham Island (Toews and Wilford 1978). The Yakoun is the largest river in the Queen Charlottes and has an extremely high even year pink salmon run as well as providing spawning habitat for the only significant local Chinook salmon stock.

It has been noted that escapements of pink salmon were historically much higher than current levels (Toews and Wilford 1978). A decline in the quality and extent of spawning habitat due to forest harvesting practices is thought to be partially responsible for this decline (Toews and Wilford 1978).

THE PROBLEM

This decline in spawning habitat quality can be partially attributed to forest harvesting and road construction which can lead to an increased incidence of soil mass wasting in steep terrain (Rice et al 1972). Although there are numerous incidences of natural slope instability in the Charlottes, windthrow along clearcut boundaries, debris accumulation in gullies, and changes in drainage as a result of gouging during yarding have all been shown to contribute to accelerated mass wasting in clearcuts.

Forest roads have been recognized as a major source of sediment through both surface erosion and mass wasting. Road caused mass wasting is most often associated with inadequate or poorly maintained road drainage structures and overloaded fill/sidecast material. Surface erosion associated with forest roads may not be as spectacular as mass wasting but it can move large volumes of soil for up to 5 years after road construction (Rice et al 1972). In addition, all mass wasted sites are surface erosion sites following the initial soil movement.

THE CONFLICT

In August 1979, cutting permit #144 of Queen Charlotte Timber became the focal point of a clash between the fisheries and forestry industries.

TABLE 1

AVERAGE SALMONID ESCAPEMENT FROM 1966-1976

	RIVERS			
	Honna	Mamin	Tlell	Yakoun
Chum	4,800			
Coho	1,600	2,300	13,000	7,400
Pinks (even year)	18,700	40,000	6,200	348,000
Pinks (odd year)	500		4,000	800
Sockeye		200		11,000
Chinook				1,700
Steel head		450		5,800

Federal Fisheries revoked their approval for logging in the Riley Creek watershed in Rennell Sound after the scale of mass soil movement was greater than anticipated. They issued a closure to further logging in an effort to prevent further damage to the spawning areas. However, the B.C. Ministry of Forests ordered the company to continue logging based on the initial approval from Federal Fisheries and the fact that over $2 million dollars had been invested in road development. The company followed the orders of the Ministry of Forests and the fallers were arrested by RCMP on charges laid by Federal Fisheries.

The resource conflict here and in other parts of the province is far from resolved, but it did serve to focus attention on the negative impact of some forest harvesting activities on the fishery resource. It also pointed out the lack of cooperation between the resource agencies involved.

THE EROSION CONTROL PROGRAM

In 1978, the B.C. Fish and Wildlife Branch requested the Ministry of Forests Research Branch to begin investigating methods of controlling erosion in the Charlottes. It was recognized that controlling surface erosion from roads and mass wasted areas would be an important step in alleviating the sediment problem. The re-establishment of vegetation on denuded slopes was chosen as the most effective and efficient method of achieving this goal.

Thus

E.P. 834: The Rehabilitation of Severely Disturbed Forest Land

and

E.P. 863: The Propagation of Native Shrub and Tree Species for Controlling Erosion

became involved in the Queen Charlotte Islands. E.P. 834 deals primarily with grass-legume establishment on denuded soil to control surface erosion and to aid in the return of this land to productive forest. E.P. 863 is concerned with the establishment of woody shrubs on disturbed sites to aid in surface erosion control, as well as enhancing slope stability through the development of a root network.

OBJECTIVES

1. Control of surface erosion from forest road slopes;

2. Control of surface erosion from mass wasted areas;

3. Enhancement of slope stability on mass wasted areas (or potentially unstable slopes) to prevent further slope de gradation.

Objective 1:

Surface erosion control from forest road slopes can be accomplished through revegetation with grasses and legumes. Since most of the forest road slopes in the Charlottes are greater than 2:1 and receive rather high intensity rainfall, hydroseeding was deemed as the most practical method of slope revegetation.

Initial roadside seeding by the Research Branch in the Charlottes was very successful, even on some very steep cut and fill/sidecast slopes. Since these early efforts, the Research Branch has assisted MacMillan Bloedel, Crown Zellerbach, and Western Forest Products in the conversion of forest fire tankers into hydroseeders through the addition of a recycling agitation system. All three multi-purpose units will be in full operation in 1981.

Objective 2:

Once again, grass-legume establishment was chosen as the best method to halt surface erosion on these denuded slopes. However conventional application equipment could not begin to cover the types of slopes encountered. Dry-seed application by helicopter was disregarded due to its questionable success on steep slopes with high rainfall and strong winds. A better solution would be the application of a hydroseed slurry, containing seed, fertilizer, and a soil binder. The soil binder would hold the seed and fertilizer in place on the steep slopes until germination.

The first efforts at applying a hydroseed slurry to the slopes were with a Hughes 500 helicopter and a monsoon bucket. Although there was no agitation or gradual dispersion of the slurry to the slopes, these

efforts were somewhat successful in establishing grass-legume cover on a portion of the slopes.

Over the winter 1980-81, Bill Marson (then Chief Engineer with Queen Charlotte Helicopters Ltd.) and Bill Carr (contractor with the B.C. Ministry of Forests) designed another method of spreading the slurry over the slope. Bill Marson built the new helicopter hydroseeder in the early spring of 1981 and this unit was operationally tested in May 1981.

The new seeder was a helicopter pod that could keep the slurry agitated and also apply it evenly over the slope. A 3 hp engine drives a central shaft which has an impellor inside the bucket for agitation, and a spreading disc underneath. Opening and closing of the drain port can be done electrically by the pilot. Although there are still some torque problems to be worked out, the unit was fairly easy to manoeuver and highly effective in covering the slope with the hydroseed slurry. The results so far have been very promising, with good vegetative establishment on some extremely steep sidewalls in the seeded gullies. The unit also proved to be very cost efficient. Tables 2, 3, and 4 provide a breakdown of the materials used and the costs incurred in the seeding of Crown Zellerbach Spur 29.

Future operations of this bucket are somewhat tenuous due to a change in the personnel and management of Queen Charlotte Helicopters Ltd., but we have devised a methodology for the seeding of previously inaccessible areas. The unit has proven to be fast and effective in the hydroseeding of steep slopes, as well as very cost efficient.

Objective 3:

Mass wasted slopes not only pose a serious surface erosion problem, but also remain unstable and are often subject to further soil movements until there is nothing left but bedrock. In this situation, the use of shrubs becomes an integral part of a revegetation program. The shrubs not only add diversity to the erosion control vegetation, but more importantly, they add a deep, strong root network. This root network has been shown to significantly increase the shear strength of soil (Endo and Tsuruta 1969, O'Loughlin 1972) as well as anchoring the soil mantle to more stable bedrock.

TABLE 2

HELICOPTER HYDROSEEDlNG: C-Z SPUR 29

General Information

Total Area Seeded	3 hectares (approximately)
Total Slurry Applied	1,000 gallons
Total Materials Applied:	
Fertilizer (20-24-15)	450 kg
Seed Mix	100 kg
Soil Binder (Ecology M-I)	55 kg

TABLE 3

HELICOPTER HYDROSEEDING: C-Z SPUR 29

Flight Information

Total Flight Time	1 hour
Average Pay load	85 gal Ions
Number of Turns	12
Average Time Per Turn:	
Filling of Bucket	1.0 minute
Flight Time to Site	1.5 minutes
Spreading of Slurry	1.0 minute
Return Flight	1.5 minutes
Total	5.0 minutes

TABLE 4

HELICOPTER HYDROSEEDING: C-Z SPUR 29

Cost Breakdown

	Per Hour	Per Hectare
Helicopter Rental -Hughes 500	$ 450	$150
(including bucket) Truck Hydroseeder	300	100
(including labour) Materials Applied:		
Seed Mix	275	92
Fertilizer	145	48
Soil Binder	290	97
Total	$1,460	$487

For the Queen charlotte Islands, only native shrubs such as *Vaccinium ovatum, Rubus parviflorus,* and *Salix* sp. were considered for use because:

1. These native species are adapted to the local climate and soils;

2. There was great concern over the possible escape of an intro duced species and the creation of a weed problem.

Table 5 provides a complete listing of the shrub species collected on the Charlottes for propagation. Hardwood cuttings, softwood cuttings, and seed were collected locally and transported to UBC for propagation. Shrub propagation methods and strategy are outlined in Appendix A.

As an example of our propagation methods, the following procedure for hardwood (dormant) cuttings is used. The cuttings are taken during the dormant season and shipped back to UBC. Upon arrival, they are trimmed to size (leaving 3 or 4 buds), dipped in root hormone, bundled in groups of 15, and placed in a cold-frame over winter. In the spring, rooted cuttings are lined out in the nursery field for "growing on."

The rooting results for the Queen Charlotte shrubs are given in Table 6. Both hardwood and softwood cuttings were for the most part very successful. If possible, hardwood cutting is the preferred method due to its simplicity and ease of handling. Softwood cuttings require much more attention and handling, including greenhouse facilities with a mist system. Our seed program is just getting under way and we have no tabulated data at this time. However, when dormancy and other technical problems are ironed out, seed propagation is likely to be the most operationally and cost efficient method for most species.

Last November, shrubs from 6 species were lifted from the nursery bed, transported back to the Charlottes, and planted at 4 test sites. For the most part we selected large rooted stock grown in beds, but did include some rooted willow sticks *(Salix* sp.) that were still in the cold-frame. Table 7 includes a list of the chosen species and the numbers planted.

Three of the test sites were V-notch gullies that had been hydroseeded in May 1980. The other site was a recent road failure that resulted

TABLE 5

SHRUBS COLLECTED FOR THE QUEEN CHARLOTTE ISLANDS

Species	Seed	Cuttings	
		Hardwood	Softwood
Sambucus racemosa	X		X
Symphoricarpos albus		X	X
Spirea douglasii	X	X	X
Rubus spectabilis		X	X
Rubus parviflorus			X
Cornus stolonifera		X	
Salix sp.		X	X
Rosa sp.	X	X	X
Vaccinium parviflorus	X		X

TABLE 6

ROOTING SUCCESS OF COLLECTED SHRUBS

Species	Cuttings	
	Hardwood	Softwood
Sambucus racemosa		98%
Symphoricarpos albus	90%	77%
Spirea douglasii	96%	95%
Rubus spectabilis	61%	88%
Rubus parviflorus		21%
Cornus stolonifera	63%	
Salix sp.	99%	99%
Rosa sp.	19%	79%
Vaccinium parviflorus		61%

TABLE 7

QUEEN CHARLOTTE FIELD TRIALS: NOVEMBER 20-21, 1980

Species Planted	Numbers
Symphoricarpos albus	96
Rubus parviflorus	73
Rubus spectabilis	118
Cornus stolonifera	50
Spirea douglasii	30
Salix spp.	
- Big stock	55
- Rooted stick	258
	680

from the overloading of the fill slope. Planting on the steeper slopes was much easier when there was a well established grass-legume cover. These areas were also subject to far less surface erosion, which on some non-grassed slopes exposed some of the shrubs' root systems. In one instance, at least 5 cm of soil eroded from a portion of an uncolonized part of a slope which totally uncovered some of the planned shrubs.

As of June 1981, the majority of the planted shrubs were growing well (Table 8). Although the numbers of some species are small, these preliminary results are very promising. Most shrubs were subjected to some degree of deer browse, but so far it has been a problem only with willow *(Salix* sp.). The large rooted stock appears to be able to tolerate low levels of browse activity.

TABLE 8

QUEEN CHARLOTTE FIELD TRIALS: SPECIES ESTABLISHMENT AS OF JUNE 3, 1981

Species P!anted	Survival Percent
Symphoricarpos albus	99
Rubus parviflorus	60
Rubus spectabilis	100
Cornus stolonifera	100
Spirea douglasii	100
Salix sp.	
- Big stock	100
- Rooted stick	55

APPENDIX A

SHRUB PROPAGATION METHODOLOGY AND STRATEGY B.C. MINISTRY OF FORESTS #EP 863 - CHRIS MARCHANT

Objective; To control mass movement, soil creep, minor sheer failure, ravelling and to rehabilitate slopes through the use of live root systems of smaller woody plants.

Method depends on mechanical strength and on water absorptive capacity of the roots. Probably also depends on the development of ramifying subsurface water movement channels along these root systems.

Species Selection and Choice of Method for Each

There are about 50 potentially suitable native or naturalized species in B.C. (Table 9). Total studied to date in EP 863 is 30 species (Table 10). To each of these can be applied a set of considerations and parameters before outplanting on a site as follows:

1. Choice of Propagule Type (bare root or containerized)
   Depends on:
   - Site conditions (accessibility, etc.)
   - Soil conditions (degree of moisture)
   - Ravelling or slumping on slope.
   - Aspect (wind, sun, frost, etc.)
   - Steepness
   - Elevation
   - Regional occurrence
   - Availability at time of collection (e.g. seed source, location, collection and cleaning has to be timed for each species and elevation)

2. Size of propagule
   Similar consideration as in 1. above:
   - Economics of production, transportation
   - Speed of outplanting growth vs. percent survival
   - Relative ability to establish in a given site

3. Time of Outplanting in Field Plots

Dependent on:

- Season (snow melt date)
- Elevation
- Occurrence *of* highest and most destructive rainfall
- Periods and frosts (heaving)
- Availability of material
- Allowance of enough time for good root establishment before winter or before summer heat

4. Block Patterns and Spacing Arrangement

Trial and Error; Some logical application to slope mechanics or run-off characteristics. Spacing approximately 1 m but dependent on the species.

5. Monoculture Vs. Mixtures of Species

Attempt to predict the successional characteristics of the site. Assess the soil levels of a given site in which root development is required.

6. Engineering Influences

Road construction timing and cooperative effort (e.g. Rover Creek). Road maintenance timing (clearing ditches, sidecasting etc.). Log hauling (interfering with access to site or work on a roadside site).

7. Animal Browse

Determining the susceptibility of species to browse damage where game plentiful or overstocked (QCI).

Summary

Selection of best shrub species depends not only on field site performance but on ease of propagation and subsequent growth response + specific rehabilitation value.

e.g. Symphoricarpos vs. Ceanothus

Propagation Methods

Softwood cuttings		*Lonicera involucrata*
Hardwood cuttings	e. g.	*Cornus ceriseus*
Seed		*Philadelphus lewisii*
Offsets and layering		*Corylus cornuta*

Great variation in response and ease of application between species.

1. Methods - Hardwoods

Gathering strong dormant current year shoots, cutting, dipping, bundling, storing (sawdust, fridge) line-out next spring.

a. Advantages

Rapid growth once rooted (compared to some seed) Avoids problems of seedling propagation (timing of stratification, etc.)

b. Drawbacks

Slow and unreliable with many species
Needs careful storage
Bulky collection and storage
Difficult to control water content during storage
Often difficult to find healthy and suitable material

2. Methods - Softwoods

Gathering from plump current year shoots without disease damage. Transfer to propagation facility. Cutting, dipping and inserting in medium under mist irrigation. To be done in summer when shrubs sufficiently grown and matured.

a. Advantages

Fast rooting (e.g. *Lonicera involucrata)*
Easy to monitor progress
Usually easy to find suitable field material (e.g. *Shepherdia canadensis)*

b. Disadvantages

Often short growth season (July to September)

Resulting young plants tend to have poor root development by the onset of winter - poor survival

Plants not large enough to outplant by the first fall (e.g. *Salix* from higher elevations)

Often deteriorates during transport from field material collection site to facility in summer

3. Methods - Offsets and Layering

Only usable for a few suitable species (e.g. *Corylus).*

a. Disadvantages

Need to build stock plants at a nursery facility (layering)

Fairly slow process requiring field space

4. Root Cuttings

Labourious field collection

Slow results

Suitable for very few species (e.g. *Shepherdia).*

5. Seed Propagation

a. Advantages

Generally most efficient process

Large stocks can be held in storage

Germination can be timed

Even-aged progeny develop with good form

b. Disadvantages

Location of abundant wild sources of wide range of provenances not easy

Stratification needed to break dormancy often complex and precise. Sometimes unknown (e.g. *Symphoricarpos).*

Seedlings of some susceptible to damping off or "shock"

Sometimes seed almost impossible to collect (e.g. *Salix, Ceanothus)*

Sometimes large quantities of fruit yield few seeds *(Shepherdia)*

In conclusion, before there can be adequate field planting trials there must be successful propagation methods established. This is the key to a native shrub program and one upon which every applied effort is worthwhile.

Results at the end of this second year are very promising. Upwards of 7,000 propagules of 30 species are under development this fall. Planting trials will be expanded in QCI, the Eraser Canyon and West Kootenays.

The end product of the study will be publication of an established set of guidelines for shrub propagation methodology and for field utilization of native shrubs in soil rehabilitation.

TABLE 9

SPECIES RECOMMENDED FOR EROSION CONTROL AND THEIR SUCCESSFUL METHODS OF PROPAGATION

SPECIES	SEED		HARDWOOD		SOFTWOOD		ROOT OR OTHER	
Acer glabrum var. douglasii	/	-			/	-		
Alnus viridis ssp. sinuata	/	-						
Alnus incana ssp. tenuifolia	/	+?						
Amelanchier alnifolia	/	-						
Arctostaphylos uva-ursi	/	-						
Berberis aquifolium	/	+						
Betula lenta	/	+						
Betula papyrifera	/	+						
Betula pendula	/	+						
Betula sp.			/	-				
Ceanothus sanguineus	/	+?	/	p-	/	-		
Ceanothus velutinus								
Cornus sericeus	/	+	/	-				
Corylus cornuta			/	-				
Crataegus douglasii	/	+						
Gaultheria shallon								
Holodiscus discolor	/	+	/	p-	/	-		
Juniperus horizontalis			/	-				
Lonicera involucrata			/	-	/	+		
Pachistima myrsinites			/	-	/	+		
Philadelphus lewisii	/	-	/	p-	/	+		
Populus trichocarpa			/	-				
Physocarpus capitatus					/	-?		
Prunus virginiana var. demissa	/	+						
Prunus sp.			/	-				
Ribes laxiflorum					/	-		
Ribes sp.					/	-		
Shepherdia canadensis					/	+	/	-
Sambucus cerulea	/	p+			/	+?		
Sambucus racemosa var. arborescens								
S. racemosa var. melanocarpa	/				/	+		
Salix sp.			/	+	/	+		
Symphoricarpos albus	/		/	+				
Spiraea douglasii	/	+	/	+				
Rubus parviflorus	/	+	/	-				
Rubus spectabilis	/	+	/	-				
Rubus leucodermis	/		/	+				
Robinia pseudoacacia	/	+						

Method Tried: / = yes

Successful: + = yes; - = no; p = poor; +? = unsure; ? = unknown awaiting results.

TABLE 10

SHRUB AND TREE SPECIES TESTED, METHODS AND SITE PREFERENCES - SUMMARY -TENTATIVE

Species Name	Region: Coast/ Interior	Type of Rooting	Method of Propagation		Ease of Propagation	Suitable Outplanting Site	Cultivation Method Suited to Outplanting
			Cutting	Seed			
Salix ssp.	Both	Deep	S H	X	Moderate	Moist to Wet	Container or Stick
Populus trichocarpa	Both	Deep	H	X	Good	Moist to Wet	Container or Stick
Betula papyrifera	Interior	Moderate to Deep	X X	S	Good	Dry to Moist	Container or Bare Root
Alnus incana ssp.	Interior	Deep	X X	S	Moderate	Moist to Wet	Container
Alnus viridis ssp. sinuata	Interior	Deep	X X	S		Moist to Wet	Container
Cornus sericeus	Both	Fibrous	H	S	Easy	Moist to Wet	Bare Root
Amelanchier alnifol.	Both	Moderate to Deep	XXX	S	Fair	Dry, Rocky	Container
Acer glabrum var. douglasii	Interior to Coastal	Deep	L	S	Fair	Dry to Moist Rocky	Container
A. circinnatum	Coastal, southern	Moderate	XXX	S	Fair	Moist	Container
Sambucus racemosa var. arborescens	Coastal	Moderate	S.	S.	Fair	Moist	Container
Sambucus racemosa var. melanocarpa	Interior	Moderate		S		Moist	Container
Sambucus cerulea	Interior	Moderate		S	Fair	Moist	Container
Physocarpus capitata	Both			S	Good	Dry to Moist	
Prunus virginiana	Both	Moderate	XXX	S	Moderate	Dry-Moist	Container or Bare Root
Prunus emarginata	Both	Moderate	XXX	S	Moderate	Dry-Moist	Container or Bare Root
Crataegus douglasii	Interior and Coast		XX	S	Good	Dry	Container
Crataegus columbiana	Interior			S		Dry	Container
Ceanothus sanguineus	Both	Deep	XXX	S	Poor	Dry	Container
C. vellutinus	Interior	Deep	XXX	S	Poor	Dry	Container
Spiraea douglasii	Coast	Shallow, rhizomes	SLH	S	Easy	Moist to Wet	Container or Bare Root

TABLE 10 (Continued)

Species Name	Region: Coast/ Interior	Type of Rooting	Method of Propagation		Ease of Propagation	Suitable Outplanting Site	Cultivation Method Suited to Outplanting
			Cutting	Seed			
S. betulifolia	Interior	Shallow+ rhizomes	H	S		Dry	Container
S. densiflora	Interior Montane						
Mahonia aquifolium	Coast to Interior	Shallow, rhizomes		S	Moderate	Dry, Rocky	Container
M. nervosa	Both	Shallow, rhizomes		S	Moderate	Moist, Shady	Container
M. repens							
Lonicera involucrata	Both	Moderate	S H	S	Easy	Dry to Moist	Container or Bare
Symphoricarpos albus	Both	Shallow+ rhizomes	S H	S	Easy, Seed Slow	Dry to Moist	Container or Bare
S. mollis							
Viburnum edule							
Ribes lacustre	Both	Fibrous	S	S		Moist to Wet	
Ribes sanguineum	Both	Fibrous		S		Dryish to Moist or Shade	
Ribes lobbii	Coast						
Ribes cereum	Interior			S		Dryish	
Ribes viscosissimum	Interior			S		Dry-Moist	
Rubus spectabilis	Coast	Moderate and rhizomes	X X	A	Good	Moist to Wet	Container or Bare Root
Rubus parviflorus	Coast and Interior	Moderate	X X	S		Moist	
Rubus leucodermis	Both	Moderate	L	S	Good	Moist	Container or Bare Root
Vaccinium membranaceum	Both	Shallow		S	Fair	Dry to Moist	Container
Vaccinium ovalifolium	Coast	Moderate	S H	S	Fair	Moist	Container
Vaccinium parvifolium	Coast	Moderate	S H	S	Fair	Moist	Container
Arctostaphylos uva-ursi	Both	Shallow		S	Fair	Dry	Container

TABLE 10 (Continued)

Species Name	Region: Coast/ Interior	Type of Rooting	Method of Propagation		Ease of Propagation	Suitable Outplanting Site	Cultivation Method Suited to Outplanting
			Cutting	Seed			
Gaultheria shallon	Coast	Moderate		S	Easy	Moist to Wet	Container
Shepherdia canadensis	Interior	Deep	S X	S	Difficult	Dry to Moist	Container
Holodiscus discolor	Both	Moderate	X H	S	Moderate	Dry to Moist	Container
Philadelphus lewisii	Interior	Moderate	H	S	Good	Dry	Container
Robinia pseudoacacia*	Both	Deep	X X	S	Good	Dry to Moist	Container
Eleagnus commutata	Interior	Deep		S		Dry	Container
Total: 47							

Note:

1. 29 tried to date; these marked -
2. * = naturalized

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