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Considerations for the Use of Hardwood Stem Cuttings

in surface management programs

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ABSTRACT

Little new research has been started on use of woody plants in revegetation, although a major regeneration program has been begun in which several million woody plants will be collected and planted along the trans-Alaska oil pipeline. Exploratory work with hardwood cuttings has been done intermittently for about four years and has led to a cooperative study in Fairbanks, Alaska, by the U. S. Forest Service and the University of Alaska to examine rooting potential and field performance of stem cuttings of selected species. Research is ongoing but provides insight into variables that must be considered in work with hardwood cuttings. Variables included are species differences, within species and within plant differences, season of collection and planting, type of storage, planting medium, length and diameter of cutting, artificial treatment, and planting techniques. Both government-funded and private

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nurseries are needed to produce the broad range of plant materials needed. Good records of early woody plant revegetation research are necessary to the success of continuing research.

Since the surface protection seminar held about one year ago, there has been little additional research designed to assess the use of woody plants in revegetation. A major regeneration program has been started by Alyeska [Pipeline Service Company], however, which will result in the collection and planting of several million woody plants. In fact, it is proposed that about one million willow cuttings be planted north of the Brooks Range. Although several types of plant materials will be utilized, the vast majority of the plantings will involve the use of rooted and unrooted cuttings. Based upon practical and research experience with cuttings at northern latitudes, the program being undertaken is roughly analagous to a casual jogger being told to run a four-minute mile. In other words, we know that it is possible, but do not really know what it takes under our conditions.

I would like to zero in on the use of hardwood cuttings. (Hardwood cuttings are stem materials collected during the dormant season [winter] and used for propagation immediately or after a period of storage.) This work has been conducted intermittently over the last three to four years. As a result of this exploratory work, the U. S. Forest Service and the University of Alaska are conducting a cooperative study to examine the rooting potential and field performance of stem cuttings of selected species. Results of this study to date are summarized here but the bulk of this work is ongoing and results will be reported later.

It is necessary to distinguish between the two types of work that have provided the data for this report. Much of what is discussed concerns rooting potential; that is, what is the inherent ability of treated or untreated cuttings to produce roots under "optimum" conditions? Through these studies, we try to determine the relative ability of different species to root. Knowing this, it is possible to recommend the type of use for different species. The other type of work concerns field testing. These studies examined the ability of cuttings to produce established plants under environmental conditions commonly found in interior Alaska.

The majority of our research and observations has been conducted with materials collected in the Fairbanks area. Within the past month, however, we had the opportunity to collect and examine the rooting potential of feltleaf willow (Salix alaxensis) from the Yukon River north to the Toolik and Ivishak Rivers. (This work was done in cooperation with Alyeska Pipeline Service Company.) Using the results from this work, we would like to examine briefly some of the variables affecting the performance of unrooted cuttings. I want to stress that these studies are not definitive. The quantity of materials used and the geographical area from which they were collected were limited. In general, however, our data appear to be similar to those of others.

Cuttings from nine sites north of the Yukon River were examined for rooting potential; five of these sites were north of the Brooks Range (Table 1). All cuttings are from the same species, feltleaf willow. Those from north of the Brooks Range, however, are S. alaxensis var. alaxensis and those south of the range S. alaxensis var. longestylis (Argus 1973). Cuttings were rooted in perlite and under intermittent mist (5 seconds of mist every 15 minutes). The results, although variable, show two trends. First, the material formed in 1976 performed poorest, regardless of area collected. Second, considering the pre-1974 and 1974-1976 material, there was a general increase in percent of cuttings rooted as age of material increased. The main exception to this was the Happy Valley #2 collection. In general, the percent rooting obtained from these cuttings was not as high as would have been expected from our previous experience with feltleaf willow cuttings from the Fairbanks area. (Alyeska Pipeline Service Company collected about one million cuttings from these areas in late winter and spring of 1977. Rooting success was in the range of 80 to 90 percent. The 1976 growth was not used, and the cuttings were rooted in small peat pots.)

Marked differences were observed in the ability of hardwood cuttings of five common interior Alaska willows to produce roots in aerated water (Table 2). S. alaxensis and S. novae-anglicae, two common flood-plain species, performed best. Cuttings collected in the spring rooted more rapidly than those collected in the fall. Two basic rooting patterns were observed (Chmelar 1974). The diffuse type had roots formed uniformly over the stem; in the basal type, root production is restricted to the base of the cutting. S. alaxensis and S. novae-anglicae exhibited the diffuse pattern (Densmore and Zasada, in press).

Table 1. Rooting of feltleaf willow cuttings collected from north of the Yukon River.

Year of formation	Yukon	Over-flow	Jim Creek	Cold-foot	Atigun	Ivashek R.	Gal-braith	Happy Valley #1	Happy Valley #2	Average by age or type cutting
					percent rooted					
1976	71(27)*/	20(28)	19(16)	17(13)	17(9)	48(30)	12(22)	36(25)	60(5)	34
1975	87(11)	50(13)	50(9)	22(8)	57(9)	70(10)	56(9)	59(6)	--	57
1974	--	63(4)	--	--	--	67(6)	69(8)	--	--	67
pre-1974	--	--	50(4)	23(13)	80(5)	--	84(3)	64(11)	50(6)	51
Heel cutting †/	--	--	69(11)	38(29)	25(10)	--	43(20)	--	43(7)	42

*/ Numbers in parentheses indicate the number of cuttings per replication. There were two replications for each area-age combination.

†/ Heel cuttings are those which included growth from two years.

Note: Three replications of six cuttings each rooted in aerated water performed as follows:

Source	Year of Formation			
	1974	1975	1976	
			lower 1/2 of growth	upper 1/2 of growth
Yukon	--	100	100	50
Galbraith	100	100	56 (not separated)	

Table 2. Rooting ability of untreated stem cuttings of five taiga willows (from Densmore and Zasada, in press).

	Riparian Willows						Forest Willows								
Species	*S. alaxensis*			*S. nova-anglicae*			*S. scouleriana*			*S. bebbiana*			*S. glauca*		
Season	fall		spring	fall		spring	fall		spring	fall		spring	fall		spring
Days	30	60	30	30	60	30	30	60	30	30	60	30	30	60	60
% of cuttings rooting	75	98	94	40	44	88	2	4	10	0	0	0	0	1.0	2.5
Average number roots per rooting cutting	3.5	6.8	7.6	2.3	3.9	8.4	1.0	1.0	4.5	0	0	0	0	1.0	2.5

Further experiments using standard horticultural techniques (e.g. intermittent mist to maintain high humidity and rooting media of sand or perlite) have resulted in rooting of 60 to 80 percent of S. scouleriana hardwood cuttings. S. bebbiana rooted poorly even under these conditions (about 1 percent of hardwood cuttings produced roots). Under these conditions S. alaxensis had the diffuse type of root distribution and S. scouleriana the basal type. The relative success we have had with rooting hardwood stem cuttings of interior Alaska trees and shrubs may be summarized as follows:

Very easy to root
- Balsam poplar (Populus balsamifera)
- Feltleaf willow
- Tall blueberry willow (S. novae-anglicae)
- Sandbar willow (Salix interior)

Moderately easy to root
- Scouler willow (S. scouleriana)
- Bearberry (Arctostaphylos uva-ursi)

Difficult to root
- Blueberry (Vaccinium uliginosum)
- Labrador tea (Ledum groenlandicum)

No success in rooting to date
- Alder (Alnus crispa and Alnus tenuifolia)
- Highbush cranberry (Viburnium edule)
- Buffaloberry (Sheperdia canadensis)
- Aspen (Populus tremuloides)
- Birch (Betula papyrifera)
- Bebb willow (S. bebbiana)
- Greyleaf willow (S. glauca)

The species which we have found to be difficult to root or have had no success in rooting may root readily under other environmental conditions or by using softwood cuttings. For example, in Finland, good success has been reported with rooting of alder and birch.

The results of several field trials are summarized in Table 3. It must be stressed that these studies are not definitive as they represent plantings made in one growing season on one site. They are used as examples, and we hope they may provide a basis for more detailed research. In experiment 1, it was observed that the longer cuttings dried out and those which did survive produced shoots from buds located at or just below the soil surface. In experiment 2,

Table 3. Effect of selected variables on field performance of untreated hardwood stem cuttings of willow*/. Results based on survival after two growing seasons.

Experiment no.	Description of Experiment	Variables	Percent survival
1	Effect of length on survival of feltleaf willow cuttings; cutting length 10 and 36 inches; three replications with 100 cuttings in each or 300 cuttings per treatment; cut and planted in early May.	10-inch cuttings (2 inches above ground)	58
		36-inch cuttings (28 inches above ground)	16
2	Effect of species on survival; 2 species *S. alaxensis*, *S. scouleriana*; 4 replications with 50 cuttings in each or 200 per species; cut in February, frozen and planted in early May; 10-inch cuttings planted with 8 inches below the soil surface.	*S. alaxensis*	62
		S. scouleriana	17
3	Effect of planting medium on survival of feltleaf willow cuttings; two soil types, mineral soil (74% sand, 24% silt, 2% clay) and organic matter (6-8 inches of feather moss and other organic matter); three replications with 50 cuttings in each or 150 cuttings per species; cuttings 10 inches and planted as above; cut and planted early May.	Mineral soil	60
		Organic matter	4

(continued)

Table 3-continued.

Experiment no.	Description of Experiment	Variables	Percent survival
4	Effect of storage on feltleaf cutting survival; two treatments, cut and planted same day and cut in February, frozen (0-5°F) and planted early May; 10-inch cuttings planted as above; four replications with 50 cuttings in each or 200 per treatment.	Cut and planted on same day	58
		Cut, stored, and planted	62

*/Cuttings from stem sections which were two growing seasons old; 36-inch cuttings in experiment 1 contained both two- and three-year-old wood.

S. *alaxensis* exhibited higher survival than S. *scouleriana*. These results are in line with those from much of our laboratory work, i.e., unless S. *scouleriana* is kept moist (e.g. under intermittent mist) rooting success is generally low. Experiment 3 suggests that we can expect little success with cuttings planted in organic layers on relatively warm, dry sites. These layers dry out rapidly and become unsuitable as a growth medium for most of the growing season. In experiment 4 there was no difference in survival rate between feltleaf willow cuttings which were cut and planted immediately and those which were cut during late winter and stored at 13° F for two months prior to planting. The cuttings were wrapped in wet paper and stored in sealed plastic bags before storage.

The research summarized here provides insight into some of the variables which must be considered when working with hardwood cuttings. Many of these insights could be gained by studying a horticulture text such as Hartmann and Kester (1975). Unfortunately, this type of background information is frequently overlooked in the rush of last-minute planning that seems to have characterized use of woody plants to date. These variables are species differences, within species and within plant differences, season of collection and planting, type of storage, planting medium, length and diameter of cutting, artificial treatment (e.g. use of hormones, intermittent mist, etc.) and planting techniques (e.g. depth of planting, surface treatment, mulching, etc.).

For most of the work with willow cuttings that is currently being considered in Alaska, it seems that the following variables are critical to success:

1. Species--Use only those species that are easy to root.

2. Storage--If cuttings have to be stored they should be stored under conditions that prevent drying, accumulation of excessive moisture, and breaking of dormancy.

3. Age of material--Use material that is two to four years old; older and younger material may not root as successfully.

4. Cutting length and diameter--Do not use longer cuttings than needed. From our experience, we suggest 10- to 12-inch material if unrooted materials are to be planted. Diameter is also critical but we have not examined this variable.

5. Site--Site conditions are most critical to success. Even the best plant materials will fail to grow on poor sites. Growing conditions on a given site may vary from year to year and within a given year. Because of this, planting methods that worked one year on a specific site may not be as successful on the same site the next year or at another time during the growing season. Many sites which must be revegetated provide marginal conditions because of poor soil conditions. Practices such as fertilization, saving and replacing topsoil after construction, or use of various types of mulches can be important in improving revegetation success.

Before closing, I would like to consider two points briefly. First, if we are to make our efforts in woody plant revegetation the most efficient in terms of materials, energy, and labor, we will not be able to depend solely on collection of plant materials produced under natural, unmanaged stand conditions. What is needed is a State or Federally funded nursery in conjunction with private facilities to produce the broad range of plant materials required in the future (e.g. rooted and rooted vegetative material and seed). A combination of public and private nurseries appears generally compatible in other States. Second, and finally, we need to maintain good records of these early woody plant revegetation projects. These records should include at least the five variables mentioned above. Without these records there is little chance of learning from our successes and failures.

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