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COLLECTION, ESTABLISHMENT, AND EVALUATION OF UNROOTED WOODY CUTTINGS TO OBTAIN PERFORMANCE TESTED ECOTYPES OF NATIVE WILLOWS AND COTTONWOODS

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Abstract

The Interagency Riparian/Wetland Plant Development Project collected 81 accessions, 12 *Populus* and 69 *Salix*, in 1993. Accessions are specific numbers assigned to individual collection sites. These were collected from various locations in the Project's 5 state service area. This area includes parts of ID, OR, CA, NV, and UT (Figure 1). Six different species were collected to: 1) set up a controlled research project, and 2) establish a riparian planting increase block. By using previously developed storage, preparation, and planting techniques, without the use of hormones, we had over 80% survival in the first season for the following accessions: Coyote Willow (*Salix exigua*), Yellow Willow (*Salix lutea*), Geyers Willow (*Salix geyeriana*), Booth Willow (*Salix boothii*), Pacific Willow (*Salix lasiandra*), and Narrowleaf Poplar (*Populus angustifolia*). Preliminary results show that cutting size, collection time, collection location, preparation methodology, and planting techniques are the most important factors for a high success rate.

Introduction

Some of the most widely distributed woody plants are those of the Salicaceae family. Many species of this family, which includes the genera *Salix* and *Populus*, are found in and around riparian zones (Brunsfield, 1985). Riparian areas are ecologically important systems for many reasons. These include: high plant diversity, water quality improvement of surface and ground water, streambank stabilization, and wildlife habitat. Past management has caused the destruction of riparian zones and vegetation, which in turn has degraded the stability of streambanks, bottoms, and water quality.

The Interagency Riparian/Wetlands Development Project, USDA Natural Resources Conservation Service (SCS) Plant Materials Center (PMC), Aberdeen, Idaho, along with other State and Federal agencies have been working together to develop riparian plant revegetation techniques that will help reduce and rehabilitate the problems of riparian degradation. Our long range plan is: 1) the development and release of new plants for revegetation of shoreline and riparian areas, and 2) the development of efficient planting techniques to improve the establishment of new plants in these areas.

Objectives

The objectives of the Interagency Riparian/Wetland Plant Development Project are seven-fold.

1) Assemble, collect, evaluate, and select performance tested ecotypes of the following species for commercial production, and to provide plant materials for advanced testing.

Coyote Willow, *Salix exigua*
Geyers Willow, *Salix geyeriana*
Booth Willow, *Salix boothii*
Drummond Willow, *Salix drummondii*
Lemmon Willow, *Salix lemmonii*
Peachleaf Willow, *Salix amygdaloides*
Black Willow, *Salix nigra*
Yellow Willow, *Salix lutea*
Pacific Willow, *Salix lasiandra*
Narrowleaf Poplar, *Populus angustifolia*
Black Cottonwood, *Populus trichocarpa*

2) Develop design criteria for establishing and maintaining native riparian plant communities.

3) Develop design criteria for establishing and maintaining riparian plants to maximize their performance in revegetation of riparian zones for water quality improvement and stabilization.

4) Develop and manage a riparian plant attribute database.

5) Coordinate input into riparian restoration/development training courses.

6) Coordinate preparation of videos, slide presentations, publications, and other means of information exchange.

7) Develop demonstration sites to show plant materials and techniques for the establishment of riparian zones.

In 1993, 81 accessions of willows and cottonwoods were collected to research the performance traits of selected ecotypes. Presently, the project has several sites where these plant materials are being tested. These sites include: riparian areas that have been overgrazed, constructed wetland systems for wastewater clean-up, research plots, and reservoir shoreline. The project has developed several techniques for the planting of cuttings in these areas and have published papers on developed techniques for planting, uses and research of willows and cottonwood cuttings.

Methods

Willow Collection

Willow cuttings were collected throughout the service area from February 9 through May 3, 1993. Three types of willows were collected. The first were tree-type willows. Tree-type willows are usually a tall shrub to a medium-sized tree that may be 15 to 25 meters. They can be single or multi-stemmed and may reach diameters of 90 cm. Second were shrub-type willows. Shrub-type willows are usually rounded shrubby-like and may reach heights up to 15 meters. They are multi-stemmed and can reach a diameter of 20 cm on some of these stems. Third are creeping-type willows. Creeping-type willows are shrubby with numerous thin, slender stems that rarely reach 10 cm in diameter. These willows are highly rhizomatous and create dense thickets of vigorous shoots that may reach 8 meters in height (Wilson 1977).

The cuttings were harvested by using a hand saw or pruning shears, depending on the stem diameter. All lateral branches and terminal ends were removed. Each collection was then bundled, tagged and transported to a storage cooler, kept at approximately 3-5 C. Before being placed into the cooler, the terminal ends of the cuttings were dipped in a 50/50 mix of white latex paint and water. This is to prevent the desiccation of the cuttings while in storage and after planting. It also serves as an identification of the terminal end for planting crews and for evaluations (Hoag, 1992; Hoag, 1993).

Field Preparation

The cuttings were planted in a replicated random complete plot design. The cuttings were taken from the cooler and bundled in five groups of four. These were then trimmed to cutting lengths of 0.5, 0.75, or 1.0 meter. Prior to planting, the bundles were placed in an irrigation ditch to soak for twelve days.

While the cuttings were being soaked, the field was prepared by plowing, discing, and pre-irrigation. The plot was squared and flagged to correspond to each accession and its cutting height. Each 15.24 cm hole was drilled with a tractor-mounted post hole digger. The hole spacing was based on the type of willow or cottonwood being planted. Tree-type willows and cottonwoods were spaced at 1.8 meters apart, shrub-type willows were spaced at 1.2 meters, and the creeping-type willows were spaced at 0.9 meters. The depth of the holes were based on leaving 15 cm of the cutting above the soil surface. This ensured at least one lateral bud would be exposed.

Planting

The holes were filled with water prior to planting. Each bundle of four was placed next to the hole according to the planting plan, starting with the tree-type willows in the first four rows, shrub-type in the next five rows, and creeping willows in the last two rows. Cuttings were then placed into the holes and tamped in by hand. Two days after planting, the cuttings were re-tamped to ensure the removal of air spaces.

Sprinkler irrigation was used to keep the soil saturated. The irrigation system had an output of 0.64 cm per hour. To stay at a saturated level, the irrigation system in combination with natural precipitation was operated on average of twelve hours per week.

Evaluations

Evaluation measurements were taken on August 2-3, 1993. Measurements were taken on longest leader length, total height, and cutting diameter. The data collected were entered onto a spreadsheet to record, average, and calculate the information to determine scores and ranking. The scores show a number based on the greatest growth, cutting diameter, and cutting length. A higher number indicates the accession showed a combination of prolific growth and larger all around cutting size (both diameter and length). The rank was based on these numbers, with 1 being the best.

Results

In 1993, a total of 1520 cuttings were planted. We had an overall survival rate of 81%. Survival rates were somewhat dependent on species. *Salix lutea* had the second highest overall survival rate, which was 0.05 less than *Salix exigua*. It also had the smallest deviation between the mean score. This species showed the greatest overall average growth. *Salix exigua* had the highest average score, but it also had the greatest deviation between the mean. The *Populus angustifolia* showed the lowest survival rate and average score. The tree-type willows had the overall lowest survival and score. The shrub-type willows had the highest survival rate, but the creeping-type willows had the highest average score.

For creeping-type willows or Coyote Willow (*Salix exigua*), 292 cuttings survived out of 380 total cuttings planted for an overall survival rate of 76.8%. Figure 2 shows accessions 3, 4, 5, 7, 8, and 18 with 100% survival. Accession 3, had the highest score of the creeping willows with 17.60 and a rank of 1 (Table 1). Cuttings were 1.0 meter and had an average diameter of 2.48 cm. Average leader length was 41.95 cm and total height of 54.45 cm. Accession 16, had the lowest score of 0.70. The cuttings were 1.0 meter and had a diameter of less than 0.40 cm. One cutting survived and had minimal growth. Accession 1, from Willow Bay on the American Falls Reservoir, had a 0% survival. These cuttings were 1.0 meter in length and had a diameter average of 2.35 cm. The average score for creeping-type willows was 11.43.

Tree willows and cottonwoods had a total survival rate of 75.9%, 334 alive out of 440 planted. The average score of tree-type willows and cottonwoods was 7.8.

For Narrowleaf Poplar (*Populus angustifolia*), accession 3 had a 100% survival rate (Figure 3). Table 2 shows this accession with a score of 11.74 and a rank of 1. This accession had a average diameter of 1.15 cm and cutting length average of 0.6 meter. Accessions 4, 9, and 12 had very low scores. These accessions all had cutting diameters of less than 0.5 cm and cutting lengths were 0.75 meters or less. The average score for this species was 5.32. This species had 167 survive out of 240 for a survival rate of 69.6%.

For Pacific Willow (*Salix lasiandra*), accessions 2, 6, and 10 had 100% survival (Figure 4). Accession 10 had the highest score of 19.03 for a rank of 1 (Table 3). This accession had cutting lengths of 1.0 meter and an average diameter of 3.34 cm. Accession 5 had the lowest score of 2.20. It had an length average of 0.5 meter and average diameter of 0.52 cm. The average score of these willows was 10.28, with 167 out of 200 cuttings surviving for a rate of 83.5%.

Shrub-type willows had 605 survive out of 700 planted. This was a survival rate of 86.4%. All three species combined had an average score of 9.91.

Geyers Willow (*Salix geyeriana*), had 147 survive out of 200. This is a 73.5% survival rate. Accessions 5, 6, and 7 had 100% survival (Figure 5). Accession 7 had the best rank with a 13.81 score (Table 4). Accession 10 had nearly as high of a score, but only an 80% survival. The score was due to larger cutting sizes, high leader length, and total height averages. Both accessions 1 and 9 had low scores of 1.55 and 1.57 respectively. The average score for Geyers Willow was 8.17.

For Booth Willow (*Salix boothii*), there was an overall survival rate of 88.2%. This was from 194 surviving out of 220. Accession 5 was the only one with 100% survival (Figure 6). This accession had a rank of 6 (Table 5), because of small cutting size and low growth. Accession 10 had the rank of 1 with a 95% survival rate and a score 13.24. Accession 10 had an average diameter of 2.05 cm and an average cutting length of 0.60 meter. Accession 6 had the lowest score of 4.21, average cutting diameter of 0.53 cm, and average cutting length of 0.50 meter. The average score for Booth Willow was 10.19.

For Yellow Willow (*Salix lutea*), there was an overall survival rate of 94.3%, 264 out 280. Accessions 2, 3, 4, 5, 7, and 14 all had a survival rate of 100% (Figure 7). The 1st ranked accession was 11 (Table 6), which had a 90% survival. This accession had all cutting lengths of 0.75 meter and an average diameter of 2.75 cm. The lowest ranked accession, 12, was at a score of 9.41. This accession also had a survival rate of 95%. The average score of this species 11.38.

Discussion

When observing all species, there are several factors that contributed to the success rate of unrooted woody cuttings. The most important factor seems to be the cutting diameter (Figure 8). The larger the diameter, the higher survival rate. There also seems to be a correlation between the success rate of smaller diameters and cutting length. The shorter cuttings seem to have a higher survival rate when the diameters are smaller than do the longer cuttings. Although this rate is higher, it is still not at an acceptable rate. The 0.5 meter cuttings did not have any accessions with diameters that were greater than 2.0 cm, therefore the linegragh stops abruptly at 1.5-<2 cm.

Survival rates may have been influenced by the amount of irrigation and precipitation received from the time of planting to the date of the evaluation. Each species is found in a different area or zone of a riparian corridor. These areas or zones influence the optimal growth of the various species by the amount of water that is available for growth. The field received 33.02 cm of

irrigation and 4.57 cm of precipitation. Exactly how much moisture is needed for each species must be determined and an irrigation schedule designed to fit these requirements.

Other important variables that affect survival rates are collection times, collection locations, preparation methods, actual planting, and physical damage to the cuttings. All species from Meeker, CO were collected at the end of April when they were just starting to come out of dormancy. Each accession scored low. The diameters were also less than 1.0 cm and the lengths were 0.5 meters. Willow Bay, ID, on the American Falls Reservoir, had a collection of *Salix exigua* that had an optimal cutting size of 1.0 meter in length and an average diameter of 2.35 cm. There was a 0% survival of this collection which was collected in early February. It is unknown whether collection time, location, or preparation methods contributed to the failure of this accession.

Preparation methods for planting are important. Desiccation of the cutting before and after planting is a detrimental factor. This can occur in several forms. The first is an inadequate covering of latex on the terminal end of the cutting. The second is not immersing at least one-half to two-thirds of the cutting into water for 7-14 days prior to planting. When planting, care must be taken to ensure good contact between the moist soil and the cuttings. Air spaces will not allow the cutting to root.

In addition, physical damage due to grazing and insects can affect survival rates. Accession 1, from *Salix lutea*, had galls from *Mayetiola rigidea* (willow beaked-gall midge). This gall does not detrimentally affect the plant unless it is present for several years. However, the gall does show the potential for damage is present.

In conclusion, overall cutting size plays the most important role in the success of unrooted woody cuttings. The cuttings need the larger amounts of stored nutrients for root growth, but highest success rates of unrooted woody cuttings is dependent on a combination of all these factors.

References

Brunsfield, S.J., F.D. Johnson, 1985. Field guide to the willows of East-Central Idaho. University of Idaho, Forest, Wildlife, and Range Experiment Station, Moscow, ID. Bulletin No. 35, June 1985. 95 pp.

Hoag, J.C., 1992 Use of willow and poplar cuttings for vegetating shoreline and riparian areas. In: Proceeding, U.S. Army Corps of Engineers workshop on reservoir shoreline erosion: a national problem. Oct. 26-30, 1992, McAlester, OK. US Army Corps of Engineers, Waterways Experiment Station. p. 115-123.

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Wilson, R.R. 1977. Illustrated fundamentals of tree identification. R.R. Wilson, Litho Printing Co., Pocatello, ID. 31 pp.

If you would like further Information Series technical papers or Technical Notes, write or call:

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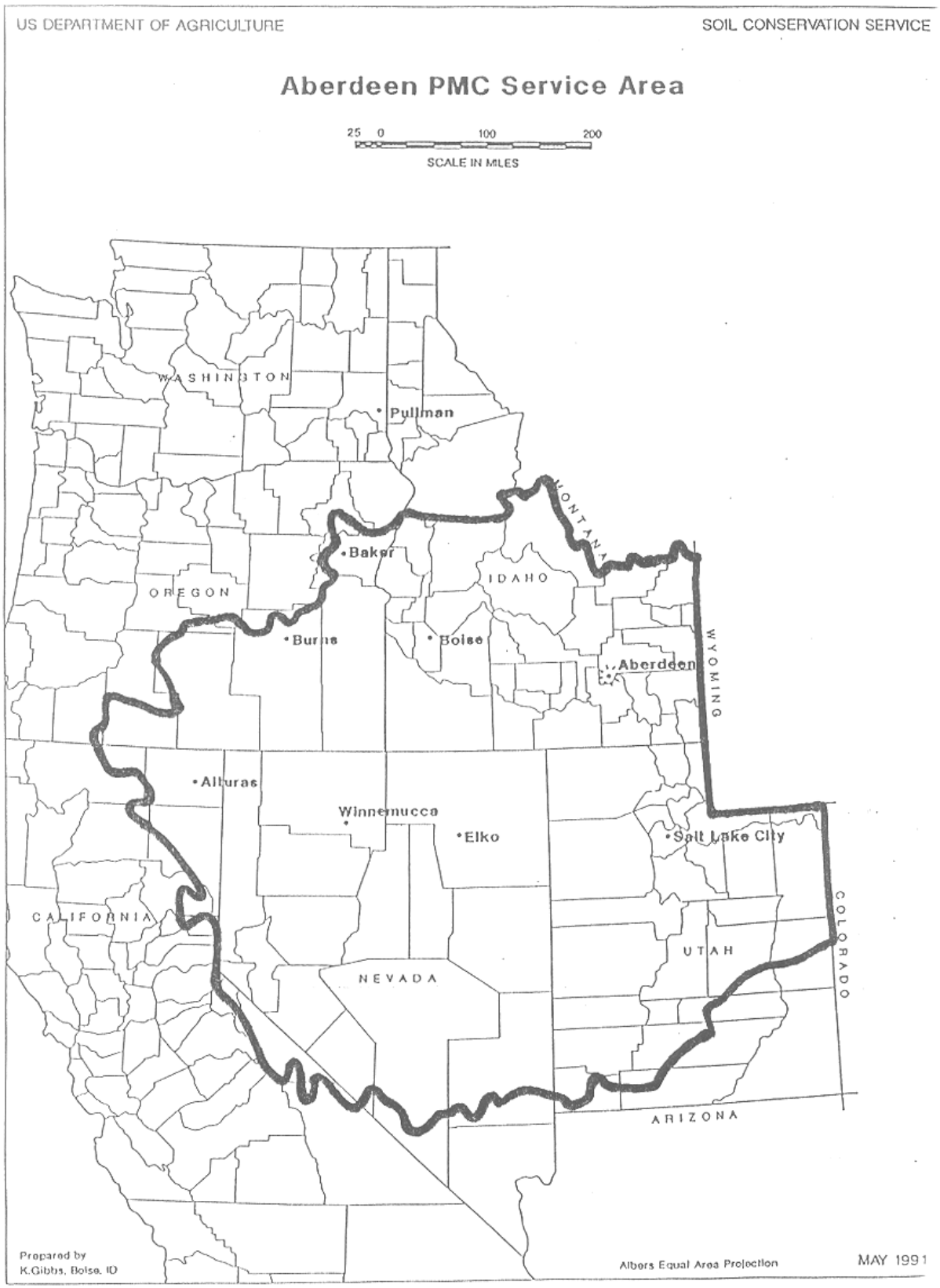


Figure 1. Aberdeen PMC Service Area

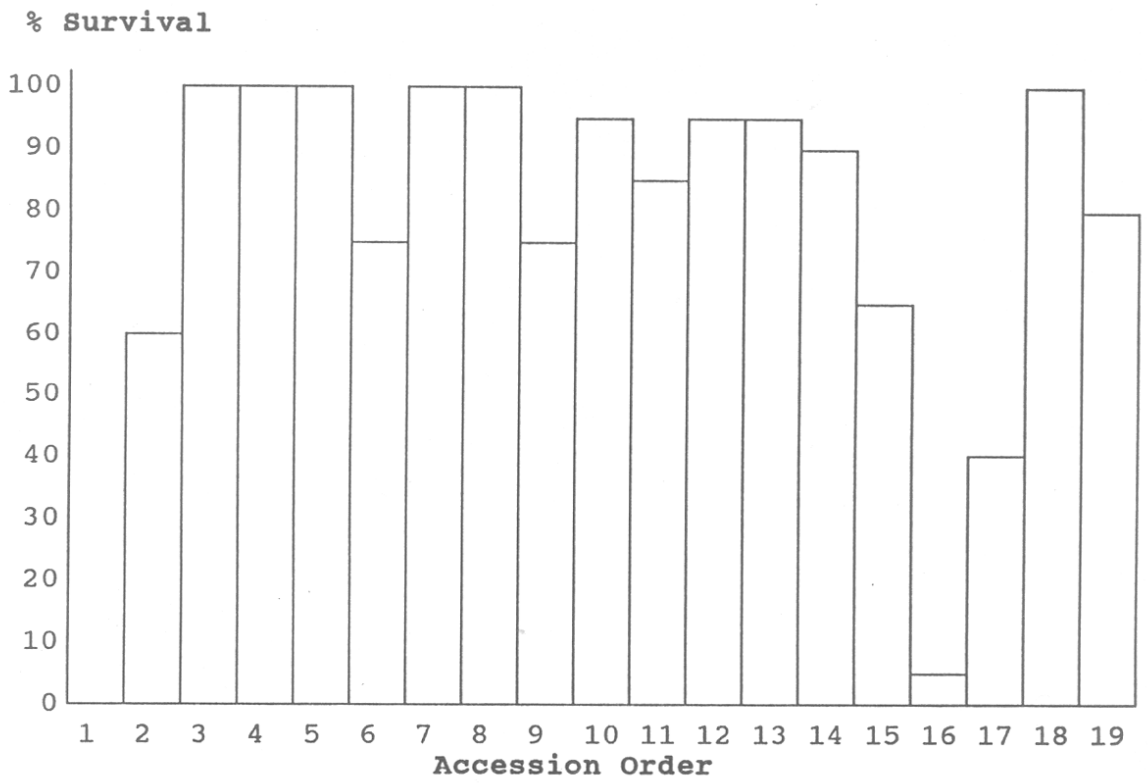


Figure 2. **1993 Survival for *Salix exigua* in Field 28**

Table 1.**Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067433	Willow Bay-ID	0.84	18
2	**9057590**	**Sandy Cove-ID**	**9.33**	**15**
3	9067445	Rock Creek- Twin Falls,ID1	17.60	1
4	**9067462**	**Little Wood River-Boise,ID**	**17.57**	**2**
5	9067465	Rick Springs-Logan,UT	16.44	3
6	**9057506**	**Trout Creek, NV**	**8.93**	**16**
7	9067473	Wells, NV	14.11	7
8	**9067476**	**F.S. 077-Palisades,ID**	**16.14**	**5**
9	9067499	Winnemucca,NV	10.03	13
10	**9067485**	**E Walker Ri.-Yerrington,NV**	**16.27**	**4**
11	9067490	Camp Cr. Rd-Lakeview,OR	13.73	8
12	**9067495**	**HWY 140- Lakeview,OR**	**10.24**	**12**
13	9067496	Whitehorse Ranch-NV	10.46	11
14	**9067456**	**Grimes Cr.-Boise,ID**	**13.34**	**9**
15	9067438	Roosevelt-UT	9.46	14
16	**9067440**	**Jordanelle-Lone Peak,UT**	**0.70**	**19**
17	9067442	Draper-Lone Peak,UT	4.08	17
18	**9067502**	**Ruby Marsh-NV**	**12.76**	**10**
19	9026075	Field32-SCS-Aberdeen,ID	15.09	6

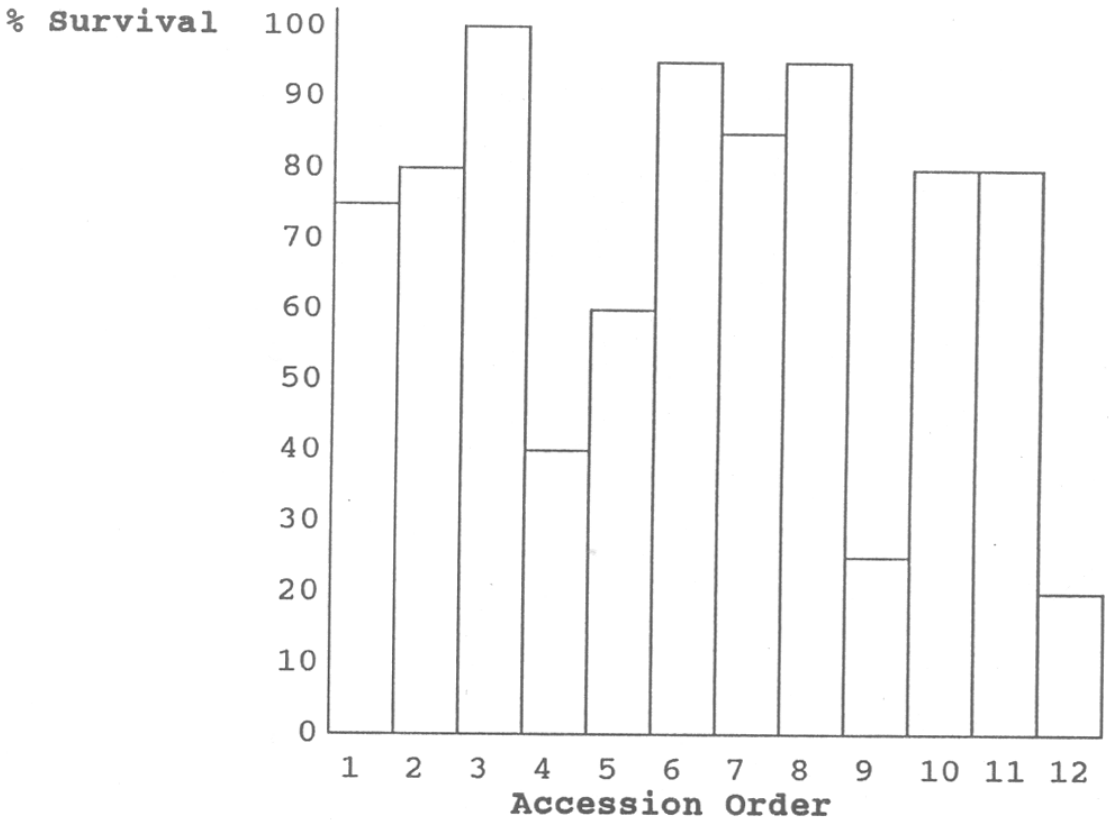


Figure 3. **1993 Survival for *Populus angustifolia* in Field 28**

Table 2. **Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067461	Little Wood River-Boise,ID	7.02	4
2	**9067455**	**Horseshoe Bend-Boise,ID**	**7.63**	**3**
3	9067504	McTucker Isl-Aberdeen,ID	11.74	1
4	**9067408**	**Logan Cave-Logan,UT**	**1.88**	**10**
5	9067479	Spring Cr.-Palisades,ID	3.13	9
6	**9067472**	**Lamoille Canyon-Wells,NV**	**6.34**	**5**
7	9067484	E. Walker R.-Yerrington,NV	4.29	7
8	**9067502**	**Ruby Marsh,NV**	**9.64**	**2**
9	9067439	Jordanelle-Lone Peak,UT	1.62	11
10	**9067441**	**Currant Creek-Lone Peak,UT**	**3.44**	**8**
11	9067443	Salt Creek-Lone Peak,UT	5.80	6
12	**9067444**	**Diamond Fork-Lone Peak,UT**	**1.28**	**12**

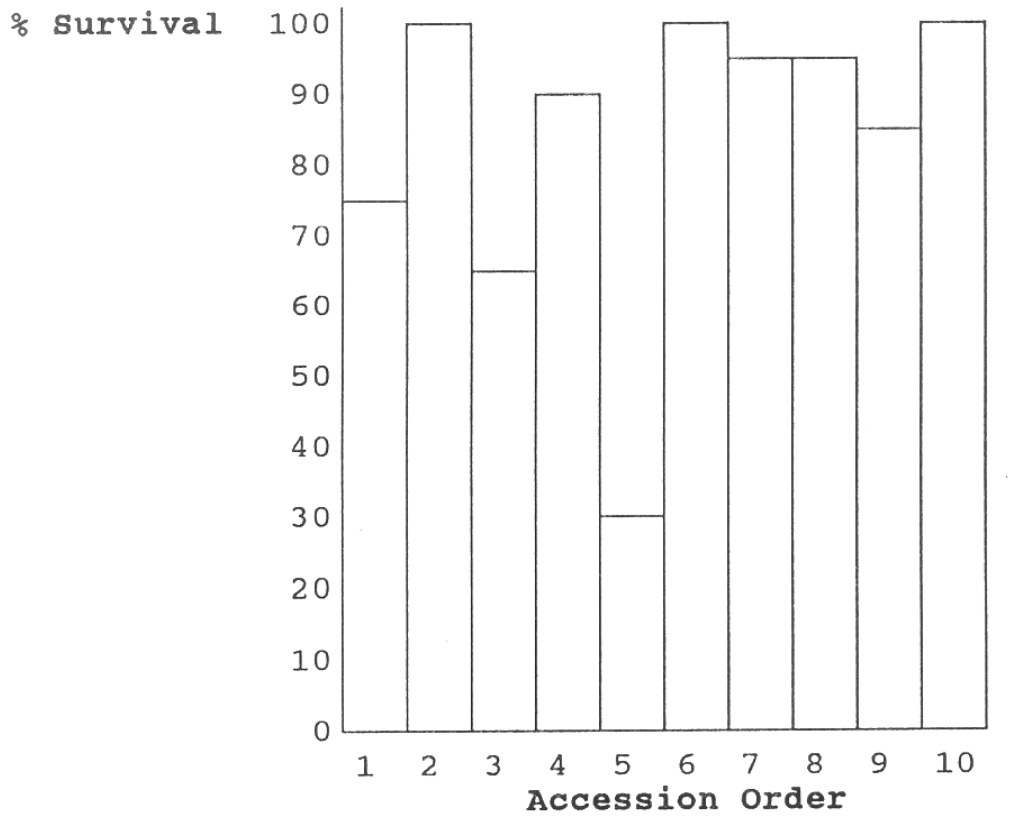


Figure 4. **1993 Survival for *Salix lasiandra* in Field 28**

Table 3. **Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067486	Bear Creek-Lakeview,OR	7.52	7
2	**9067492**	**Chandler-Lakeview,OR**	**16.19**	**2**
3	9067471	Thomas canyon-Wells,NV	3.43	9
4	**9067498**	**Winnemucca, NV**	**11.69**	**4**
5	9067464	Franklin Basin-Logan,UT	2.20	10
6	**9067453**	**Banks-Boise,ID**	**10.82**	**6**
7	9067460	Huelen Meadow-Ketchum,ID	13.41	3
8	**9067429**	**Roosevelt,UT**	**11.54**	**5**
9	9024833	Grouse Creek-Meeker,CO	7.01	8
10	**9067449**	**Magic Mt.-Cassia Co,ID**	**19.03**	**1**

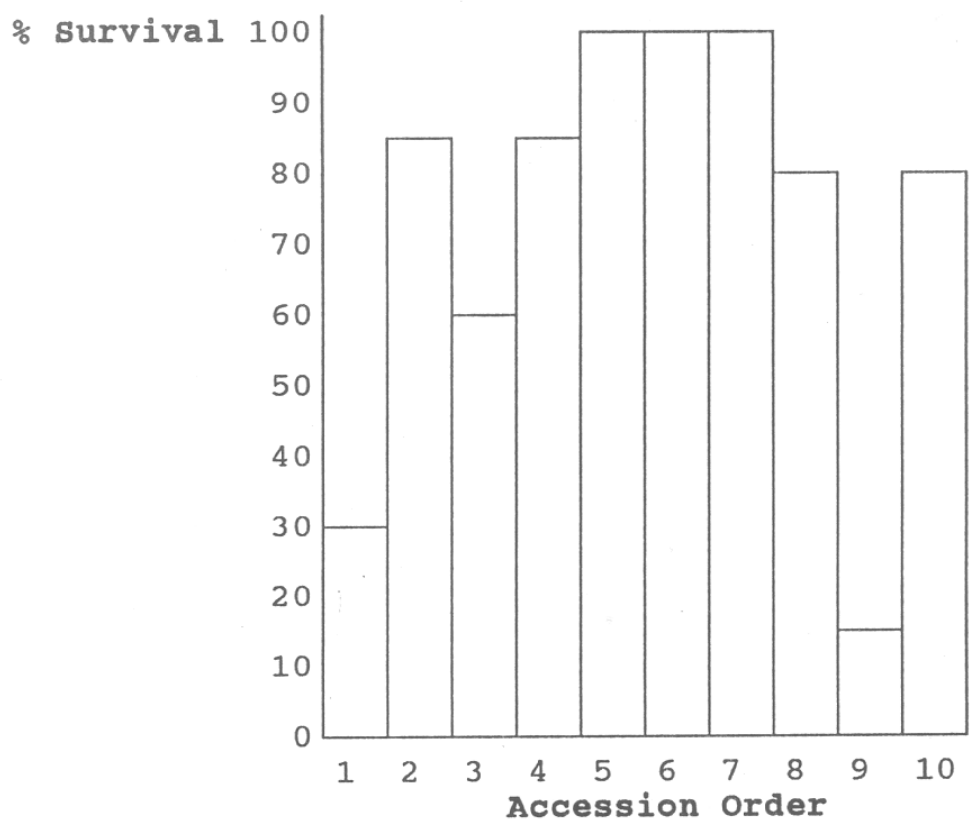


Figure 5. **1993 Survival for *Salix geyeriana* in Field 28**

Table 4. **Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067467	Logan,UT	1.55	10
2	**9067483**	**Trail Canyon-Soda Springs,ID**	**6.24**	**7**
3	9067457	Stanley Creek-Boise,ID	5.64	8
4	**9067497**	**Whitehorse Ranch-Lakeview,OR**	**7.22**	**6**
5	9067474	Fleming Canyon-Palisades,ID	12.95	3
6	**9067491**	**Chandler-Lakeview,OR**	**10.12**	**4**
7	9067487	F.S.135-Malheur N.F.,OR	13.81	1
8	**9067448**	**Walstrom Hollow-Cassia Co,ID**	**8.99**	**5**
9	9024822	Ashley N.F.-Meeker,CO	1.57	9
10	**9067435**	**Roosevelt,UT**	**13.65**	**2**

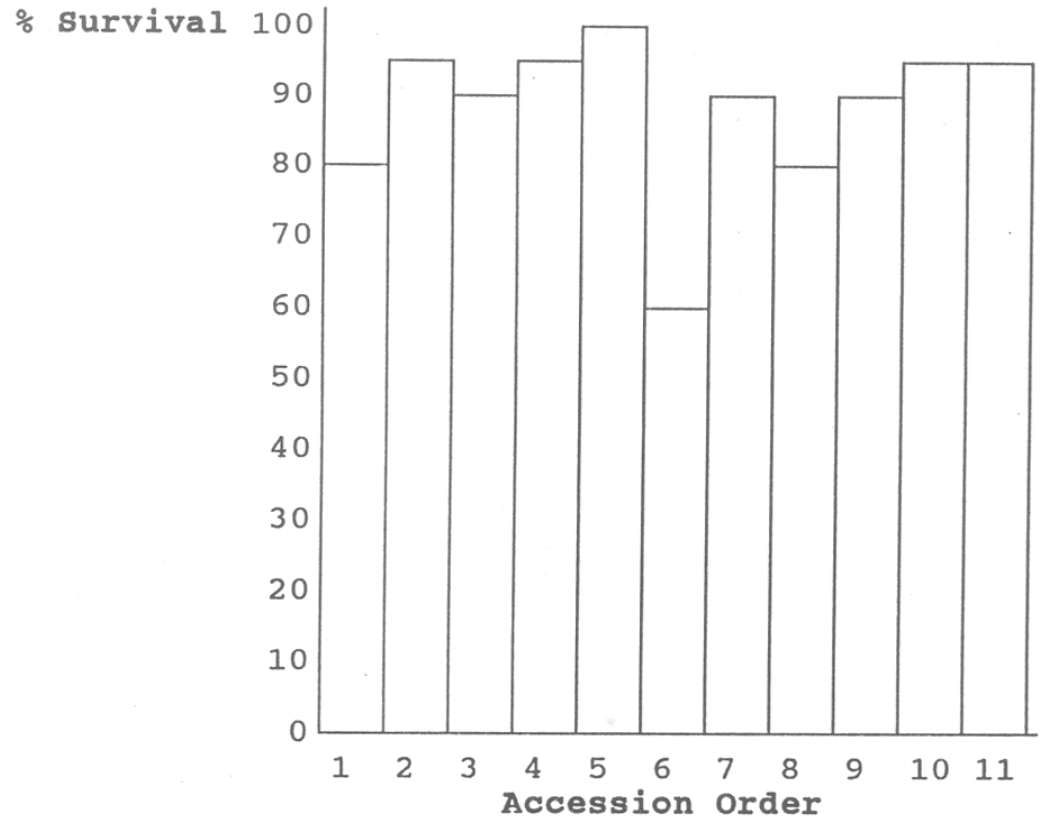


Figure 6. **1993 Survival for *Salix boothii* in Field 28**

Table 5. **Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067446	Walstrom-Cassia Co,ID	9.46	8
2	**9024825**	**Indian Canyon-Meeker,Co**	**10.11**	**7**
3	9067482	Trail Canyon-Soda Springs,ID	10.77	5
4	**9067494**	**Fremont N.F.-Lakeview,OR**	**11.35**	**4**
5	9067488	McCoy Creek-Malheur N.F.,OR	10.64	6
6	**9067463**	**Franklin Basin-Logan,UT**	**4.21**	**11**
7	9067478	Snake R.Work Cnt-Palisades,ID	9.44	9
8	**9067437**	**Roosevelt,UT**	**11.71**	**3**
9	9067469	Wells,NV	8.23	10
10	**9067454**	**HWY 55-Boise,ID**	**13.24**	**1**
11	9067458	Stanley Creek-Boise,ID	12.96	2

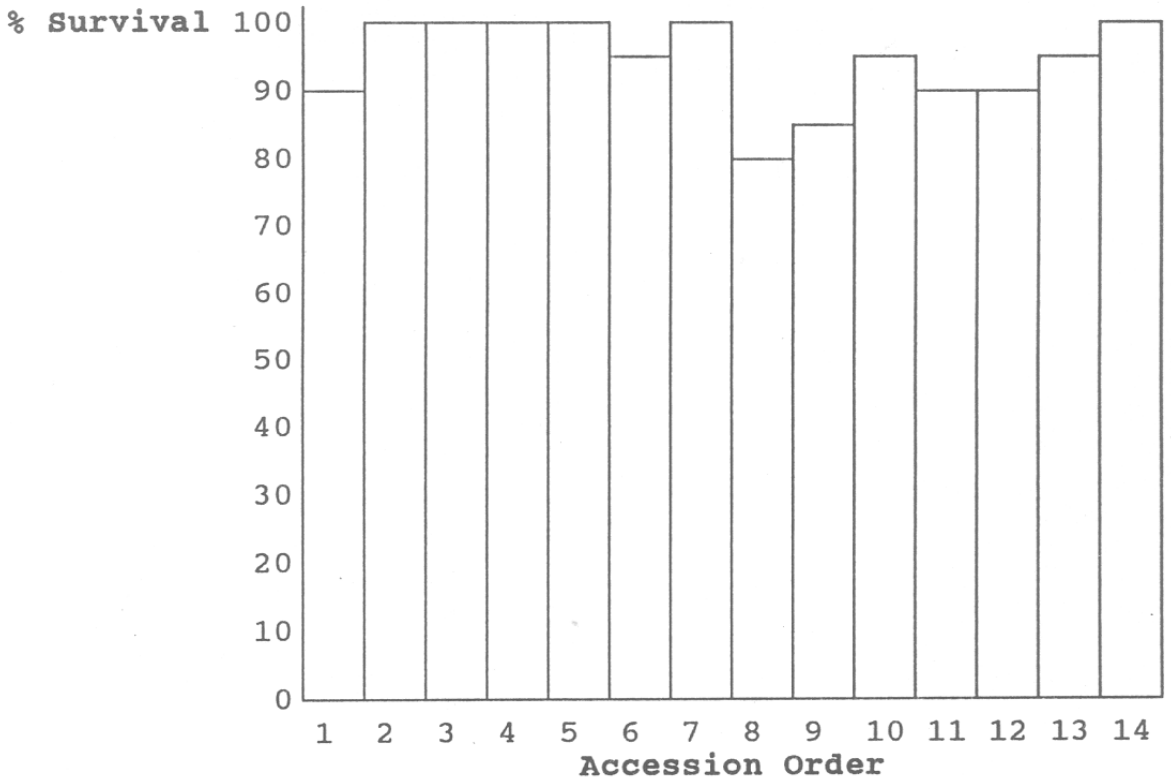
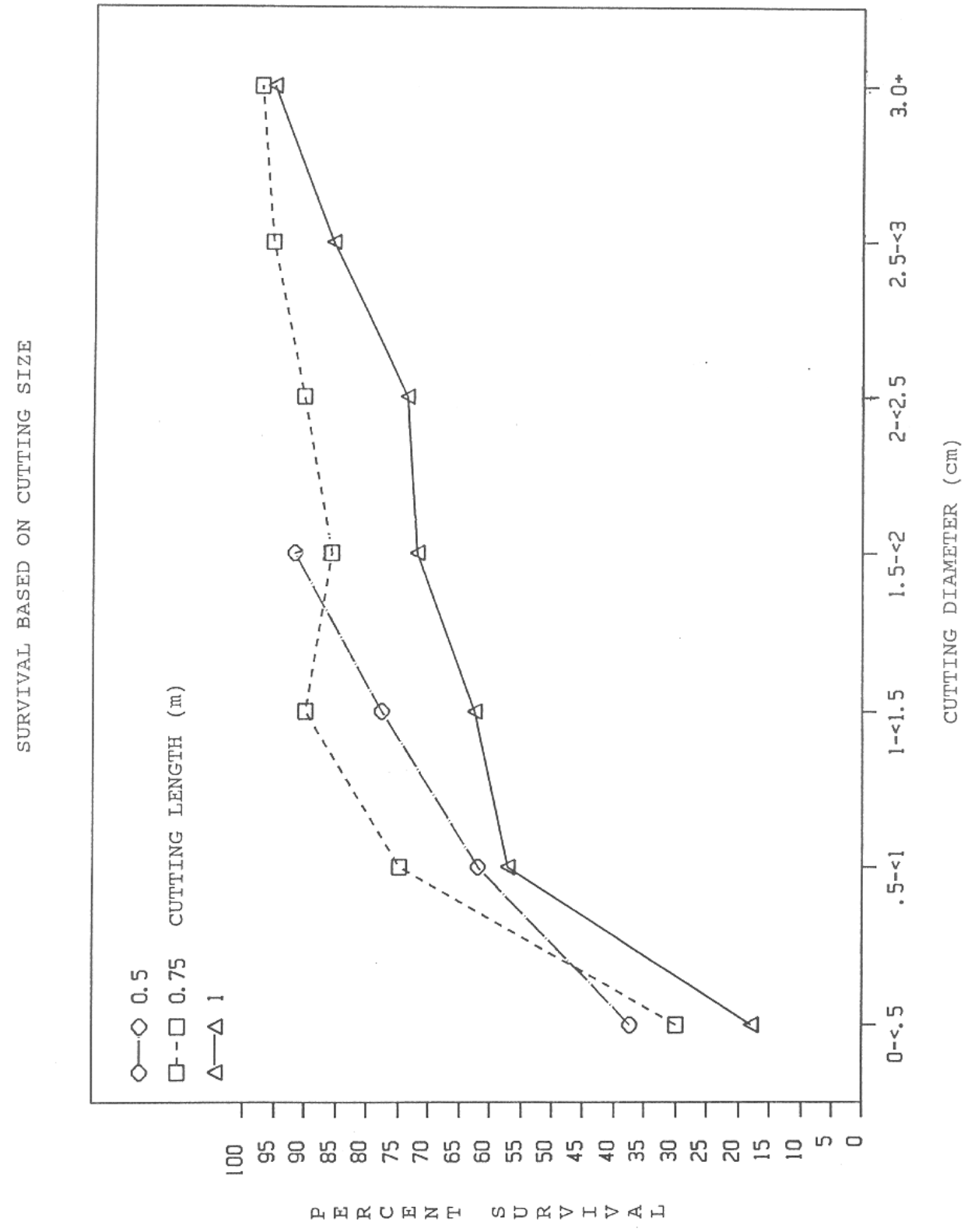


Figure 7. **1993 Survival for *Salix lutea* in Field 28**

Table 6. **Evaluation Rank**

Order	Accession	Location	Score	Rank
1	9067489	McCoy Cr-Malheur N.F.,OR	13.25	3
2	**9067500**	**Winnemucca,NV**	**11.37**	**5**
3	9067452	HWY 21-Boise,ID	10.75	8
4	**9067450**	**Big Bluff-Twin Falls,ID**	**12.92**	**4**
5	9067470	Lamoille Canyon-Wells,NV	13.41	2
6	**9024834**	**Indian Canyon-Meeker,CO**	**10.30**	**11**
7	9067493	Sky Trail-Lakeview,OR	10.90	7
8	**9057507**	**Trout Creek,NV**	**11.14**	**6**
9	9067436	Roosevelt,UT	10.72	9
10	**9067477**	**Snake R. Work-Palisades,ID**	**9.82**	**13**
11	9067459	Huelen Meadow-Ketchum,ID	14.73	1
12	**9067475**	**Echo Canyon-Palisades,ID**	**9.41**	**14**
13	9067505	McTucker Isl-Aberdeen,ID	9.94	12
14	**9067466**	**Logan,UT**	**10.61**	**10**

Figure 8.


SURVIVAL BASED ON CUTTING SIZE
0.5
0.75
1
CUTTING LENGTH (m)
PERCENT SURVIVAL
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0-<.5
.5-<1
1-<1.5
1.5-<2
2-<2.5
2.5-<3
3.0+
CUTTING DIAMETER (cm)