EFFECTS OF PLANTING LOCATION ON SURVIVAL AND GROWTH OF BOOTH'S WILLOW PLANTINGS

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INTRODUCTION

Willows (Salix sp.) have high moisture requirements, limiting their distribution to riparian areas, lowlands with shallow water tables, or high elevation areas receiving water inputs from snowmelt (Brunsfeld and Johnson 1985). Willow plants often occur in mixed-species stands that are closely associated with unique soil and water table features (Hudack and Ketcheson 1991, Winward and Padgett 1987). Brunsfeld and Johnson did not find evidence to suggest soil nutrients were a major factor in determining willow distribution in general, though it may be an important factor in species distribution (1985). They suggested distribution is further influenced by elevation, temperature, and soil aeration. Many willow species are poor competitors as seedlings and often require disturbed sites to establish, favoring the dynamic environment of riparian systems (Winward and Padgett 1987, Winward 1989). However, as willows establish and mature, they are better able to withstand competition from a variety of other species.

Willows can be a critical factor in maintaining streambank stability, especially during periods of high flow, serving to capture sediment and debris and dissipate the energy of overland flows (Kovalchik and Elmore 1991). Willow root biomass corresponds to aboveground growth, and as a result larger species are better able to reinforce streambanks and diffuse the force of high water flows (Winward 1989). Stream stability refers to the ability of the stream to "properly distribute the flow and sediment produced by its watershed in order to maintain the dimension, pattern and profile without either aggrading or degrading" (Rosgen 1996 p. 6-9).

Management activities that promote healthy, stable riparian systems also promote clean water resources and improved forage values for domestic livestock and wildlife. Current knowledge is insufficient to accurately predict the responses of riparian vegetation to changes in management practices. Therefore further investigation of where willow cuttings establish with respect to streambank morphology will improve our ability to anticipate willow and stream channel responses to changes in management. This improved understanding will aid in developing management strategies compatible with the system's capabilities.

Further understanding the response of willows to cattle grazing has the potential to improve future management practices, and to develop grazing strategies that focus on retaining native plant species responsible for maintaining stream channel stability. The key to this success will be to establish willows in appropriate settings.

In the spring of 2002, a study examining the use of Booth's willow (Salix boothii) cuttings in streamside plantings was initiated. The primary objectives of this study are to determine the streambank location (i.e. point bar or floodplain) where willow planting survival and growth is greatest; determine the relationship of soil moisture and depth to water table to the survival and growth of willow plantings; and determine the effects of three grazing treatments (early, late, and none) on the survival and growth of willow plantings. The overriding hypotheses for this project are that willow survival and growth will be influenced significantly by i) the morphological location of each plant; ii) depth to water table; and iii) percent soil moisture. For the purpose of this report, results pertaining to planting location will be discussed; results associated with grazing treatments will not be presented.

STUDY LOCATION

The study site is located in south central Grant County, Oregon. Grant County is situated in the Central Blue Mountains of east-central Oregon, and lies between 44° and 45° north latitude and 118° and 120° west longitude. The average summer and winter temperatures are 14 to –5°C, respectively, and the mean annual precipitation is 33 cm, the majority of inputs arriving as snow. Soils are of the Damon silty clay loam series, and are poorly drained and formed in mixed alluvium.

The study reach is a Rosgen C-type channel, and flows through a pasture used for season long grazing of yearlings. Flow regimes of this stream are moderated by irrigation control upstream, and the pasture is influenced by subsurface irrigation inputs from an adjacent pasture. This site is almost devoid of willows, with the exception of some old small plants in the downstream end of the pasture. It is not known if this pasture historically supported a willow community.

STUDY DESIGN AND IMPLEMENTATION

EXCLOSURES

Twelve 25m x 12m exclosures were constructed along inside turns of the study reach. Wells were installed on two locations, point bar and floodplain (Figure 1), within each exclosure to monitor the depth to water table at each planting location. Each well was installed to a depth of approximately 15 centimeters below the deepest part of the stream channel.

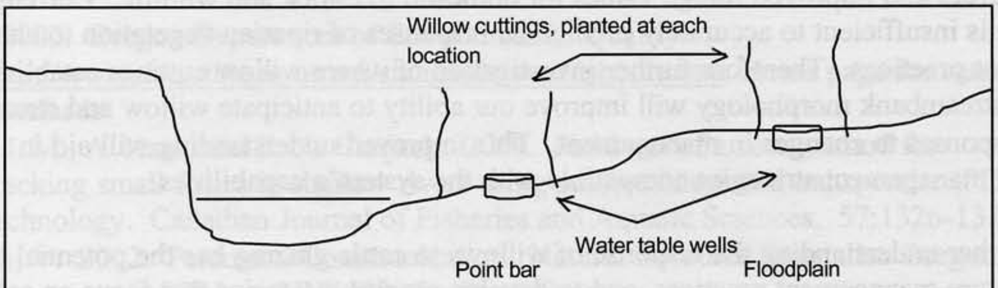

Figure 1. Cross-sectional view of the inside turn of a Rosgen C-type stream. One well has been installed on each point bar and floodplain, and 20 willow cuttings have been planted on either side of each well, for a total of 40 plants per location.

WILLOW COLLECTION AND PLANTING

Cuttings were collected from mature Booth's willow shrubs at a location approximately 3 km upstream in early April 2002. The apical buds and branches of each cutting were removed to direct growth to shoots and roots, not flowers, and the cuttings were put in cold storage (0^{o} C) for thirty days. Once removed from cold storage, the cuttings were placed in a shady location outdoors and soaked in water for two days prior to planting in early May. Figure 1 illustrates the willows planted in relation to the point bar and floodplain locations. The average length of each cutting was approximately 75 cm, and each willow was planted to a depth of 40 cm.

TREATMENTS

There are two treatment factors within this study; planting position at two levels, point bar and floodplain, and grazing treatment at three levels, early, late, and no grazing (control). Early grazing occurred in late June, a time frame that allowed a six-week establishment period for the willow plantings, and late grazing occurred in early August. It was expected that willows would be grazed differently depending on forage availability, therefore to address the confounding factors of timing and intensity of grazing, grazing treatments were to be considered complete when the percent utilization of willows was approximately 50%.

MONITORING ACTIVITIES

Depth to water table was recorded every ten days from the time willows were planted throughout the growing season. Gravimetric soil moisture was measured at two depths of 15 cm and 30 cm, at the same time water table measurements were made.

Median stubble height of forage species was measured on both point bar and floodplain locations prior to and after each grazing treatment to investigate the relationship between stubble height and the percent browse of the willow plantings.

Survival, leader density (total number of shoots) and number of grazed leaders were assessed for each willow prior to and after each grazing treatment. A plant was considered alive if any above ground growth was visible. For the purpose of this paper, survival in relation to planting position, irrespective of grazing treatment, will be discussed.

RESULTS AND DISCUSSION

It was discovered over the course of the first field season that the well depths were insufficient, and that the water table had dropped below the depth of most of the wells by mid-June. Because one of the objectives of this study was to determine the relationship between willow planting growth and survival in relation to depth to groundwater, the wells were deepened to a depth of 150 cm in October of 2002. At that time, groundwater was visible in all wells, therefore it was determined that depth would be sufficient to monitor groundwater fluctuations over the course of the second field season. Because the initial wells were not installed to a deep enough depth, a complete seasonal water table record was not obtained and therefore not presented in this report.

Seasonal trends in soil moisture for the two planting locations for the control and early, and the control and late exclosures are illustrated in Figures 2 and 3. Results of two-sample t-tests comparing soil moisture averages across point bar and floodplain planting locations by date showed soil moisture content at the point bar locations were significantly higher than that at the floodplain locations from mid-June through mid-August.

CONTROL AND EARLY EXCLOSURES

The soil moisture content of the point bar and floodplain locations were not different early in the season; however the soil moisture at 30 cm on the point bar location was significantly higher by June 30 ($p=0.009$).

CONTROL AND LATE EXCLOSURES

The soil moisture content of the point bar and floodplain locations were significantly different by June 8 at a 30 cm depth ($p<0.0001$). Soil moisture decreased steadily in each planting position over the course of the growing season.

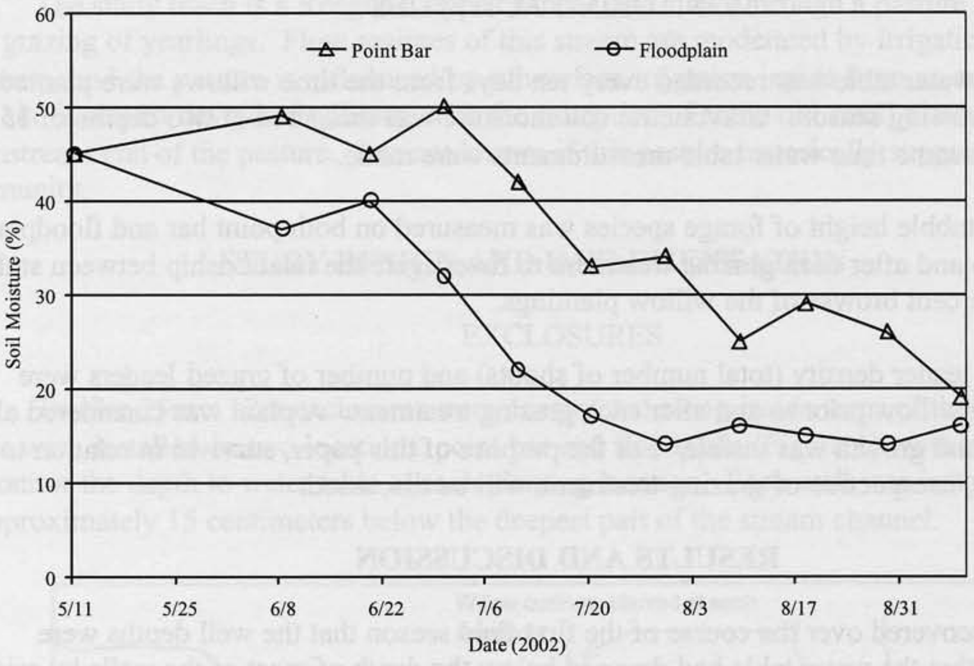

Figure 2. Average soil moisture at the point bar and floodplain locations of the early and control exclosures at 30 cm depth. Soil moisture at the point bar location was significantly higher than that of the floodplain from June 30.

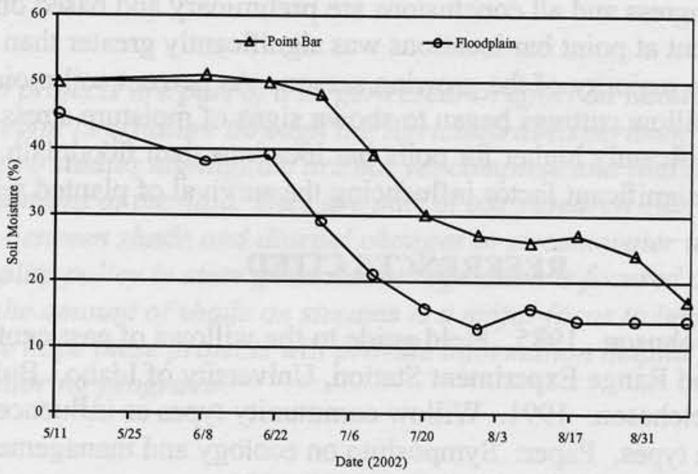

Figure 3. Average soil moisture at the point bar and floodplain locations of the late and control exclosures at 30 cm depth. Soil moisture at the point bar location was significantly higher than that of the floodplain by June 8.

WILLOW SURVIVAL

Almost all of the willows on both the point bar and floodplain survived the initial planting and six-week establishment period prior to the early grazing treatment. As the season progressed, the willows began to exhibit signs of stress, particularly on the floodplain location. Results from two-sample t-test comparing average willow survival prior to early grazing (mid-June) show 93% of the willows were still alive on point bar locations, whereas only 83% survival was observed on floodplain locations ($p=0.03$). Prior to late season grazing, willow survival at point bar locations averaged 84%, significantly greater than the 13% survival observed at floodplain locations ($p<0.0001$).

In May 2003, cuttings of Booth's willow were again planted on the site, following the previous year's protocol. At the time of the second planting, one year after the first set of willows were planted, 53 cuttings on the point bar locations exhibited signs of growth, compared to three on the floodplain. Though analysis is not complete at this time, it is anticipated that soil moisture is strongly related to willow survival, and the lower soil moisture values on the floodplain locations may partially explain high mortality rates.

FUTURE STUDY

A critical component of this study was to determine the relationship between willow planting growth and survival in relation to depth to groundwater. Because initial well depths were insufficient, the willow planting exercise was repeated in May of 2003 to determine that relationship. Water table levels and percent soil moisture will be monitored. The relationship between median stubble height and percent browse of willows will be investigated.

CONCLUSIONS

This study is in progress and all conclusions are preliminary and based on one season of study. Soil moistur e content at point bar locations was significantly greater than that of floodplain locations for the majority of the growing season. As percent soil moisture declined over the season, planted willow cuttings began to shown signs of moisture stress. Willow planting survival was significantly higher for point bar locations than floodplain locations. It appears soil moisture is a significant factor influencing the survival of planted willow cuttings.

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