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1. <u>Title</u>
    A. Project Name
       Bear Creek/Cunha's Riparian Vegetation Enhancement; Monitoring Methods
    B. BPA Project # and Contract #
    C. Report Date
       11/30/2006
    D. Authors
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2. <u>Abstract</u>
    A. A summary; short version of the report

Survival and expansion were evaluated on greenhouse grown plugs of these two sedge species following transplanting within a reconstructed NE Oregon meadow stream. Sedge plugs were planted on fluvial surfaces along the stream: depositional (point bars) and erosional surface (straight).

Cirsium arvense (Canada thistle) is an invasive rhizomatous perennial that could compete with the sedge plugs thus lowering planting success. Canada thistle was removed from half the erosional surface plots and left on the other plots to observe if thistle density had an effect on sedge survival and shoot production. Preliminary observations show that survival of plugs is similar for both species and planting locations. Ground water depths and stream water level were measured twice a week and thistle density, shoot number, and soil moisture were measured at each planting location once a week from June through mid-September 2006. Graphs of sedge shoot numbers show that sedges growing in depositional areas produce more shoots than sedges growing on erosional surfaces.

3. <u>Introduction</u>
    A. Project Background

The Longley Meadows Restoration Project was initiated in 1999 by the CTUIR, ODFW, NRCS, and Alta Cunha Ranches to restore instream, riparian, and wetland habitat along Bear Creek, Jordan Creek, Moss Creek and the mainstem Grande Ronde River (Grande Ronde Model Watershed Program, Longley Meadows Report 2005). The overarching goal of the project was to restore the natural character and function of Longley Meadows including wetlands, floodplain, and stable channel morphology. Bear Creek is believed to have historically provided spawning and rearing habitat for summer steelhead. In-stream habitat was rated as fair to poor because of past disturbances, including channelization. About 5,500 feet of stream was reconstructed from 1999 to 2003. Vegetation plantings for channel stabilization followed in summer 2003. Willows, sedge plugs, and a standard wet meadow seed mix were planted in 2003 after stream reconstruction although information pertaining to the success of these plantings is limited.

Despite their importance to channel stability, little is known about the use of sedges in restoration projects, particularly in reconstructed streams. Sedges generally reproduce vegetatively, although they can reproduce by seed if the conditions are favorable (van der Valk et al. 1999). Seeding is less likely to be successful than transplanting when there is greater physical stress at the site, such as erosion (Steed and DeWald 2003). Planting sedge plugs has been more successful than seeding in many projects and is currently the most effective method for reestablishing sedge species (Hoag 2003). Groundwater depth has been identified as a key determinant of species placement within riparian meadows (Castelli et al. 2000), and its influence on sedge transplants has been documented in Minnesota by Yetka and Galatowitsch (1999). Much of the research has focused on restoration in meadows and not on issues surrounding revegetation after channel reconstruction. The appropriate location, season, and density of sedge plantings within a channel restoration project are important factors in the success of the projects and in bringing the channel closer to the original form and function.

Post-project monitoring is essential to record the success of the project. Despite the value of this information, monitoring is not often performed after restoration (Kondolf and Micheli 1995; Bash 2002). Information concerning the appropriate planting location would be useful for future restoration projects, and would eliminate repeating past mistakes and incorporate successful planting methods in restoration. Guidelines and methods for monitoring the success of the restoration should be included in all restoration projects.

B. Project Objective

Develop guidelines for re-vegetation of constructed meadow channels using environmental, physical, and biotic factors as determinates for appropriate species combinations, planting location and timing and frequency of planting sequences.

4. Methods and Materials

Experimental Design

The experimental design for the field planting is a three factor completely randomized split-plot design to test the effects of planting location, herbicide, and species on sedge plug survival after transplanting. The planting location has two levels (erosional and depositional), herbicide factor contains two levels (none and recommended application), and the species factor has two levels (*Carex nebrascensis* and *Carex utriculata*). Channel erosional and depositional surfaces were randomly selected, these locations served as the main plots (whole plot). Herbicide and species were randomly assigned in subplots. Herbicide was applied June of 2006 before planting with a backpack sprayer and the subplots were sprayed throughout the season when new thistles were found. Clipping was also used to maintain herbicide plots the remainder of the season. Plants growing in the herbicide plots were also removed using less invasive hand tools. The main plots are parallel to the stream flow and the sub-plots are oriented perpendicular to the stream so each treatment receives similar stream and ground water influence. Depositional main plots only contained herbicide treatment and no plots contained thistle throughout the season. This was due to the lack of thistle on these sites after field evaluation in May of 2006. These main plots only contain the herbicide treatment and two levels of species. The average plot size is 151 cm x 82 cm. Each plot has 9 replicates along the length of the stream, 9 erosional surfaces and 9 depsoitional surfaces.

Soil Moisture Measurements

Soil moisture was taken weekly with a soil tensiometer and gravimetric soil moisture method at depths of 15 cm. The initial soil moisture was taken at the time of planting. Throughout the summer tensiometer measurements were taken weekly and gravimetric soil moisture was taken every other week. This was done so tensiometer readings could be compared with gravimetric soil moisture measurements. Two tensiomter readings and two gravimetric soil moisture collections were taken at each planting location. The tensiometer gage stopped working in July and gravimetric soil moisture was taken weekly from mid-July through the first week in September 2006.

Groundwater Well Placement

Groundwater wells were placed above the main plots on the floodplain to protect the well from debris from the stream during times of high flow in the spring. The wells were constructed out of 3 inch perforated PVC pipe. The wells were capped with a 3 inch PVC cap. The well depth was variable depending on the soil material. Groundwater levels were measured twice a week from July 1 to September 1 of 2006. Ground water levels were measured using a metric metal tape. A flashlight was used to ensure accurate water depth readings. Once the bottom of the tape touched the water surface, the depth was recorded from the top of the well. All wells and ground level were surveyed using a level and stadia rod. The difference from the top of the well and ground level were subtracted from the ground water depth.

Vegetation Measurement

Canada thistle was counted weekly in each subplot. No sub-sampling was needed during the summer of 2006. Plants that were rooted directly under the top and left sides of the subplot were , but those rooted under the bottom and right of the subplot were not recorded to reduce overestimation of density. Because of the rhizomatous nature of both Canada thistle and the sedges, the number of above ground stems were counted instead of the number of individuals.

Sedge survival was measured weekly July through September 1 of 2006. The transplants were considered alive if one green shoot is present and green tissues is present at least at the center of the plant. A transplant was considered dead if green tissue is absent. Shoot emergence was measured weekly (shoot of Nebraska sedge will look like a tip of an awl at the earliest detectable stage). Each transplant was marked with coated wire around the sedge base so that new shoots and the transplanted plug could be distinguished.

Sedge Planting

The sedges were purchased from Wildlife Habitat Nursery in Princeton, Idaho. The sedge plugs were 10 cubic inches. This size was chosen because research has shown smaller plugs to be more susceptible to environmental condition than larger plugs (Hoag pers. comm.; Steed and DeWald 2003). Sedges were transplanted at the field site in June of 2006. Plots that were inudated with water 6 inched or more were not planted until the water levels dropped below 6 inches. All of the erosional surfaces were planted in one day and the depositional surface were planted over a period of three days because they had the most water covering the planting surface. The plugs were planted with a dibble that was made to fit the size of the sedge plug. Each plug was spaced 20 cm by 25 cm apart within each sub-plot.

A rule was created to plant the sedges at a certain water depth so the plants would not be completely submerged when planted. Hoag et al (2001) suggested cutting the plants to a height about 4 or 5 inches above the potential standing water height or to a height of 10 inches, which ever is taller. The average height of the plugs was about 6 or 7 inches, so no plants were cut. Plots that had a water depth of over 6 inches were not planted until the water depth dropped below that point, the reason for the different planting dates. Most of the high water was on point bars and some plants were submerged, but water dropped quickly and most of the sedges did not remain submerged through the first few weeks after transplanting.

Only one plot was irrigated, plot 9, but the soil was heavy clay and did not absorb the irrigated water and most of the water ran off into the stream. No other plots were irrigated and no plots will be irrigated the rest of the summer because all of the plots had water within the rooting depth of the sedge plugs. Plots 27, 26, 25, 22, 17, 16, 11, 5, 4, and 1 were planted June 24, 2006. Plots 14, 11, 7, and 2 were planted June 25, 2006. Plots 24 and 6 were planted June 27, 2006.

5. Project Description
    - 18 Ground water wells were placed at every planting location 6/20/2006-6/21/2006 (see figure 1).
    - 810 sedges planted: 405 *Carex nebrascensis* and 405 *Carex utriculata* 6/24/2006-6/27/2006.
    - Groundwater and stream water height were measured twice weekly 6/23/2006-9/7/2006.
    - Sedge vegetative reproduction monitored once a week 7/10/2006-9/4/2006.
    - Soil moisture measured once a week 6/24/2006-9/6/2006.
    - Thistle Density measured once a week 6/23/2006-9/4/2006.
    - Sedge and thistle foliar cover measured twice 7/18/2006 and 8/17/2006.
    - Stream cross-sections at every planting location measured once 6/29/2006, 7/5/2006, and 7/6/2006.

6. Project Participants

    Oregon State University Rangeland Ecology and Management Department
    Grande Ronde Model Watershed Program

7. Description of project area

    Bear Creek is located about 15 miles west of La Grande, Oregon in the Blue Mountains along Oregon Highway 244. The drainage area of Bear Creek is 7.8 square miles. The study reach is approximately mile in length and is along a low gradient meadow in the upper Grande Ronde River basin. Bear Creek is a tributary of the Grande Ronde River. Upper Grande Ronde River Subbasin (USGS HUC 17060104) T. 3 S., R. 36E., primarily in Section 15, Willamette Meridian (figure 1).

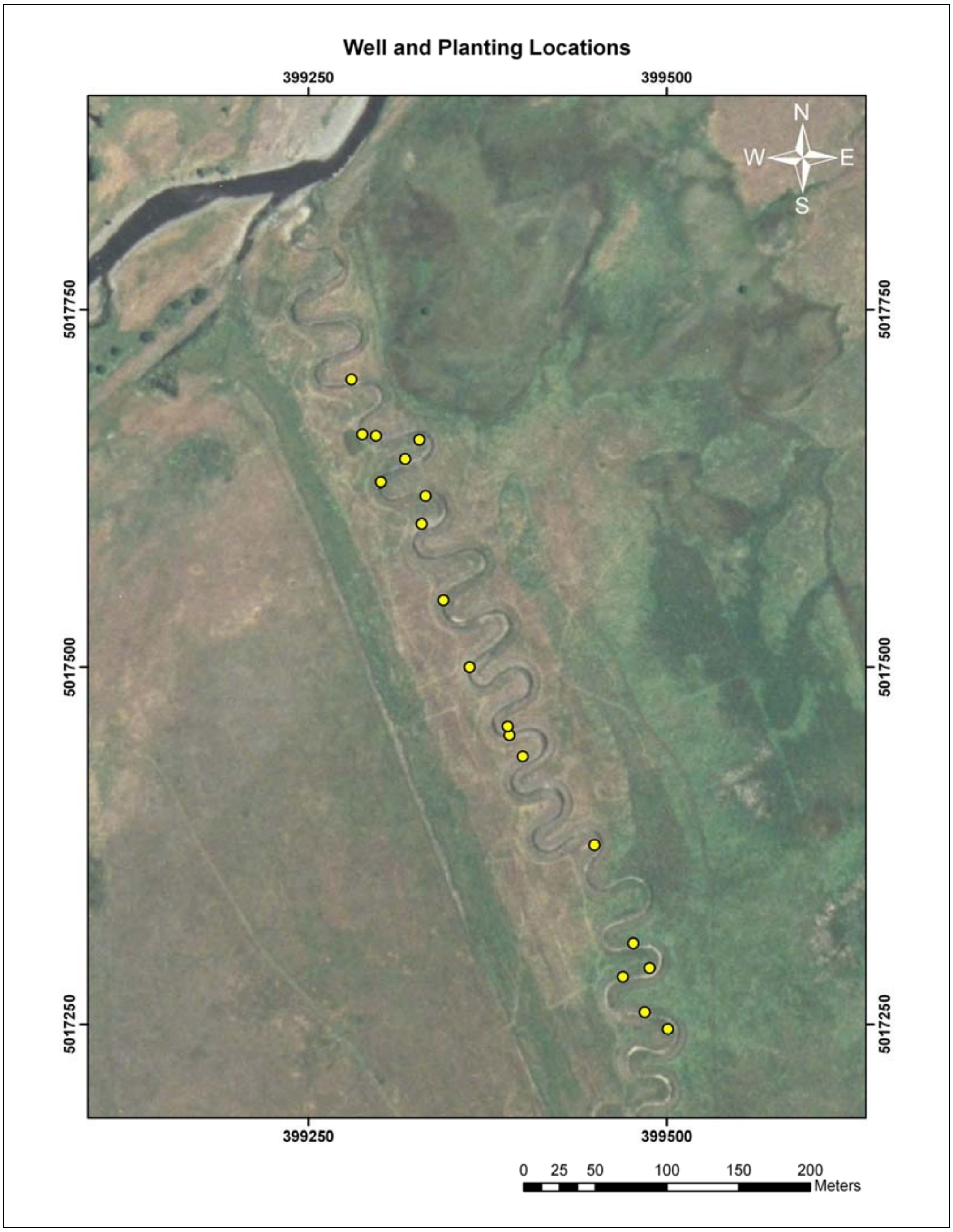

Figure 1: Ground water wells and planting locations

8. <u>Results and discussion of results obtained from the year's work.</u>

The transplanted sedges appeared to produce more shoots on point bar planting locations compared to straight reach planting locations (figure 2). Thistles also appear to decrease shoot production for both species (figure 3) although *Carex nebrascensis* (CANE) tends to produce more shoots than *Carex utriculata* (CAUT) when thistles are present in the subplots (figure 4). *C. nebrascensis* also appears to perform better than *C. utriculata* on the straight planting locations regardless of the presence of thistles (figure 5). The two sedge species appear to have no difference on the point bar planting location (figure 6).

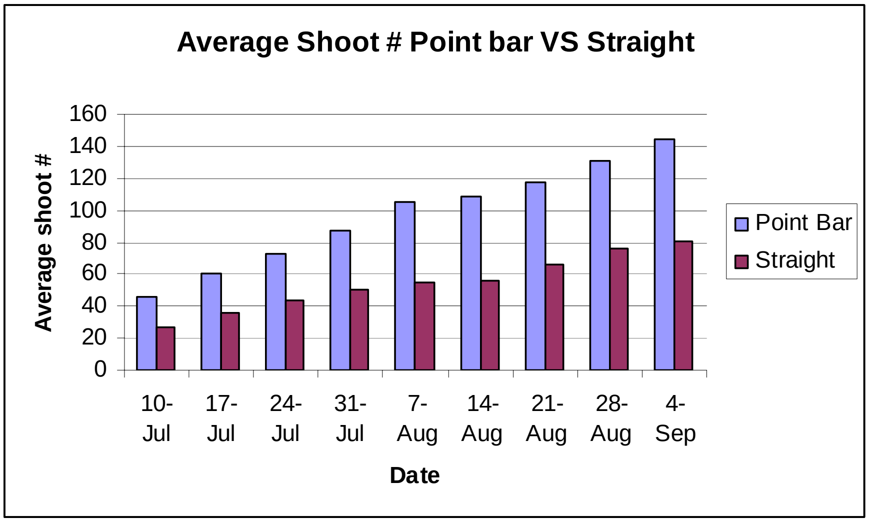

Figure 2: Average shoot number comparison between non thistle point bars and straight planting locations.

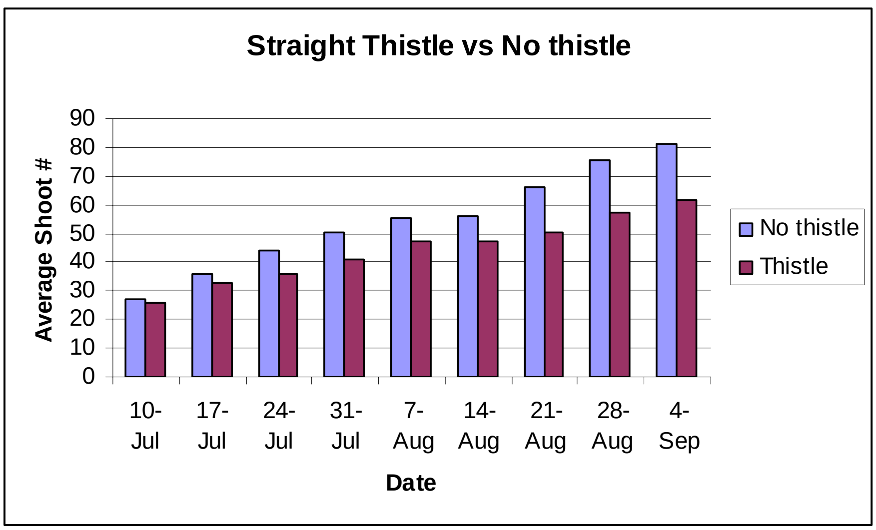

Figure 3: Average shoot number comparison between thistle and no thistle subplots on the straight planting locations.

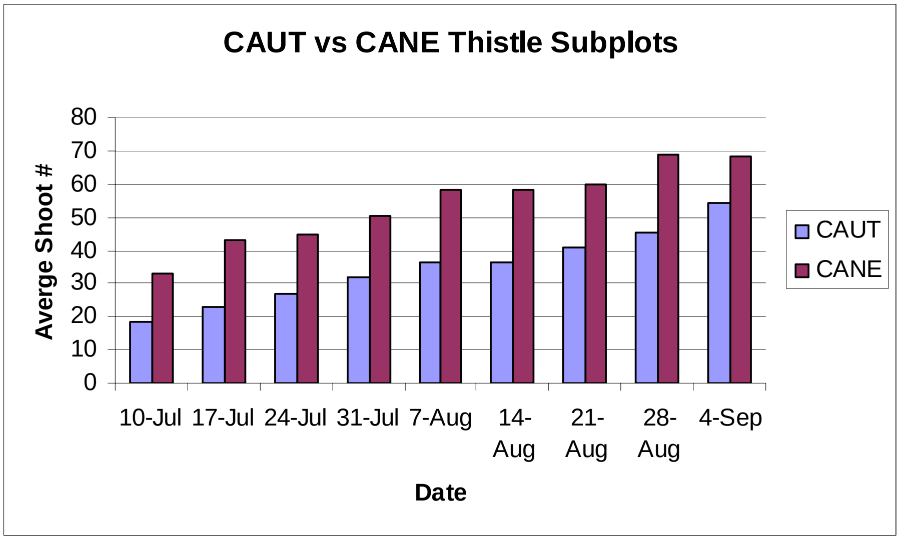

Figure 4: Average shoot number species comparison between thistle subplots on the straight planting locations.

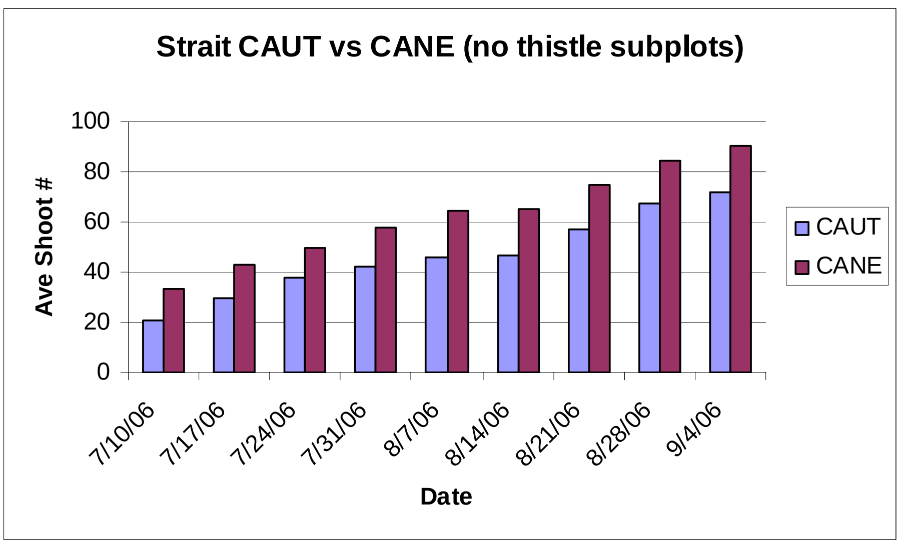

Figure 5: Average shoot number species comparison on the no thistle subplots on the straight planting location.

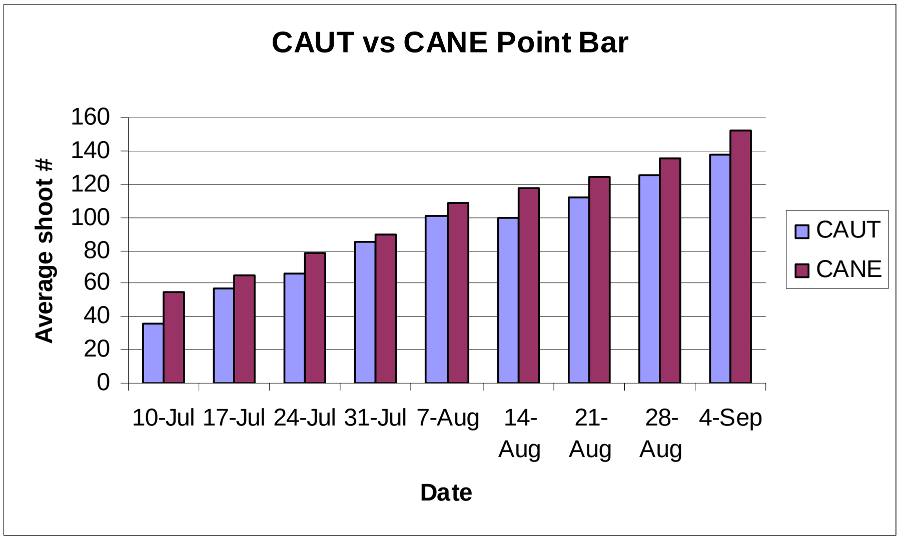

Figure 6: Average shoot number species comparison on the point bar planting locations.

9. Summary and conclusions.

   Carex nebrascensis and *Carex utriculata* are often used in riparian restoration projects. This project looked specifically at location of planting and how the sedges performed at each location. Sedges planted on point bars, or depositional landforms, appeared to produce more shoots than the sedges planted on straight reaches, or erosional landforms. This preliminary conclusion could increase the establishment of planted sedges in riparian restoration projects. Sedges are important components to meadow channels and the establishment of sedges after channel reconstruction could increase bank stability.

10. Summary of expenditures, including a list of major property purchased during the fiscal year.

   *See GRMWP accountant