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NORTH-CENTRAL OREGON DRYLAND CROP RIPARIAN CONSERVATION PROJECT

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ABSTRACT: Native riparian areas in the dryland crop region of the inter-mountain Pacific Northwest have been largely eliminated during the last 140 years. Native riparian grass, shrub, and tree species found on broad floodplains have been replaced by introduced species growing in narrow, incised channels. Owners of 2.2 km of Gerking Creek, located near Athena, Oregon, are working to reestablish a riparian community in former cropland. This effort requires an evaluation of present conditions and constraints imposed by existing vegetation, channel morphology, and management. We quantified valley bottom landform and channel development by establishing 22 channel cross-sections and developing a detailed contour map of the site. Reestablishment of a riparian community will depend upon changes in upland and channel management. Establishment of a buffer strip between cropland and channel will address excessive sediment delivery from the upland area within the project and the adjoining fields. However, Gerking Creek will continue to be a source of considerable sediment and energy associated with concentrated flow. Channel adjustment can be expected to continue in the form of deposition, headcut migration, channel migration, and bank sloughing. These processes can tear out newly planted material and alter soil-water relationships in the riparian area.

KEYWORDS: riparian; agriculture, Conservation Reservation Enhancement Program

INTRODUCTION

Native riparian areas in the dryland crop region of northcentral Oregon, eastern Washington, and western Idaho have largely been eliminated during the last 200 years. These areas are characterized by broad, shallow bottoms occurring on low-gradient second- and third-order streams. The degradation possibly began with the introduction of horses to the region and was exacerbated by the policy of fur traders associated with Great Britain in the early 1800s, when beaver were largely eliminated from much of the interior of current day Oregon and Washington. The resulting meadows were then used by the influx of U.S. immigrants as pasture for livestock, particularly draft horses, mules, and oxen. Judging by the native vegetation and namesake of some creeks flowing through these bottomlands, e.g., Greasewood Creek, the soils were naturally salt affected. With mechanization, a few of these pastures were retained for small herds of cattle and saddle horses, but most were cleared, plowed, and entered into the winter wheat (*Triticum aestivium,* L.)-summer fallow or annual cropping systems common in this region. These channels, often straightened, are regularly cleaned of vegetation to facilitate the efficient removal of water and soil from adjacent roads and fields. These practices, although unlikely to be applied today, remain in the USDA-NRCS Administrative Manual – Field Office Technical Guide (Sec. 4 Standards and Specifications, practices 326 and 580). Introduced vegetation now grows on narrow floodplains in incised channels where native riparian grass, shrub, and tree species on broad floodplains once thrived. Storm flow, concentrated in time and space, causes rapid soil loss through bank failure and down cutting. Increased channel slope resulting from channel straightening combined with entrenchment produce excess energy that exacerbates problems downstream during flood events.

In the 1960s, 44.5 ha of native prairie bottomland on Gerking Flat, near Athena, Oregon, were brought into production as a winter wheat-summer fallow rotation. Although the wheat-fallow system, which is prevalent in the inter-mountain Pacific

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Northwest (PNW) reduces the risk of crop failure resulting from inadequate soil moisture, it exposes soil to erosive forces (rainfall and wind) during late fallow and early crop establishment. Soil erodibility is increased further because of soil organic matter loss, which occurs during the non-productive part of the rotation (Rasmussen et al., 1993).

After the 1964 Christmas flood, Gerking Creek was straightened to ease use of farm machinery, to aid in early soil drainage for equipment access, and to reduce the impact of salt accumulation on crop production. Despite these efforts, an increase in soil pH and a decline in wheat yields were observed, and barley, a more salt tolerant crop, was planted. However, by 1998, the land was removed from production because barley yields were decreased to such an extent that it was no longer economical.

Due to environmental concerns regarding the impact of soil erosion on watershed fish and wildlife habitat, landowners' desire to enhance wildlife habitat, and continued crop production problems associated with salt affected soil, this portion of Gerking Flat was entered into the Conservation Reservation Enhancement Program (CREP) for 15 years, beginning in 1999. CREP's are managed and funded through the USDA-Farm Service Agency. This project is a cooperative effort amongst landowners, the USDA-Natural Resources Conservation Service (NRCS), the Umatilla Soil and Water Conservation Districts (SWCD), and Pheasants Forever. Concern that Gerking Creek, an intermittent stream, can produce excessive erosion rates during high flows resulted in a plan to plant native plants into three vegetation zones: 1) the active stream channel, which will be planted to cottonwoods, 2) the floodplain, which will be planted to willows, and 3) the upland area, planted to a mix of native grasses and forbs.

Our objectives for this paper are to introduce the Gerking Flat CREP project, it's goals, the initial stages of riparian community potential and channel analysis, and the unique research opportunities that will develop around this and other CREP projects on the Columbia Plateau. Our quantification of current channel conditions will be used to aid in developing a plan to ensure successful reestablishment of a riparian corridor and will aid in designing changes in channel plan form to create a more stable channel.

METHODS

Gerking Creek is a third-order stream and tributary of Wildhorse Creek, a tributary of the Umatilla River, which is a tributary of the Columbia River. The Gerking Flat CREP is located on Gerking Creek, approximately 6.4 km from the confluence of Wildhorse Creek, and 7.2 km west-northwest from Athena, Oregon (45° 50' 30" N, 118° 32' 30" W). The portion of Gerking Flat within the project area is owned by five landowners.

Meteorological records at USDA-ARS Columbia Plateau Research Conservation Center (CPCRC), located approximately 14.4 km southwest of the research site, show 39-yr minimum, maximum, and mean annual temperatures of -34° C, 46° C, and 11° C, respectively. Frost-free days range from 135 to 170. Approximately 70 percent of precipitation occurs between November and April, and results from maritime fronts that produce low intensity storms with a median duration of 3 h, 50 percent lasting 1 to 7 h. The annual average precipitation is 418 mm. Frozen soil, with or without snow cover, is transient and melts rapidly with the frequent arrival of warm maritime fronts. This area experiences from 0 to 7, (median = 3), freeze thaw events annually (Zuzel, 1994).

Soils are Hermiston silt loams (coarse-silty, mixed, mesic Cumulic Haploxeroll) formed in silty alluvium from loess and ash on flood plains and low terraces, with slopes ranging from 0 to 3 percent (Johnson and Makinson, 1988). These soils overlie the basalt layers of the Columbia Plateau, which formed in the Miocene age.

We surveyed the channel and associated bottomland with GPS survey grade equipment. The survey was conducted using a Trimble GPS TS 4400 and processed using Trimble and Autodesk software (the use of product names does not constitute endorsement by the USDA, Umatilla SWCD, or Oregon State University). Data used to construct a model of Gerking Flat, channel cross sections, and headcuts (vertical channel adjustments) were collected using real-time kinematic (RTK) data acquisition with a horizontal precision of 10 mm ± 2 ppm and a vertical precision of 20 mm ± 4 ppm.

The results presented below summarize the data collected for this project to date; the final analysis and interpretation of the full data set has yet to be performed. The current flood plain is interpreted from the survey data; there are no flow records for Gerking Creek.

RESULTS

The channel length through the CREP is 2,232 m, 2,072 m comprised of a single thread channel and 160 m in a multiple thread channel. The project area ranges in elevation from 571 to 587 m. Sinuosity is 1.1, and average channel slope is 0.8 percent, ranging from 0.16 to 4.00 percent within the project. Headcuts were found and measured at river stations 7.04, 7.41, and 7.56

km, and 22 channel cross sections were established, of which three w/d ratios are reported below. Valley form width to depth (w/d) ratios are ~ 11.5 into the valley bottom below the multiple thread section, whereas the w/d ratio above is ~ 6.1. Within the multiple thread section, the w/d ratio is 48.1. The remnant of an abandoned channel rejoins the current active channel at 6.95 km. This channel currently carries spring flow and appears to also carry water during extremely high flows that overtop the 1.5 m channel bank at river station 7.40 km. Bankfull w/d ratios are ~ 8.3 below and ~ 22.0 above the multiple thread section, and ~ 15.9 within the multiple thread section.

The incised reaches are populated with cattails (*Typha latifolia* L.), Russian thistle (*Salsola iberica* Sennen & Pau), Kochia (*Kochia scoparia* L.), downy brome (*Bromus tectorum* L.) and drop seed. The multiple thread section, farmed until 1998, contains both downy brome and Indian rice grass, and a mix of native grasses and forbs planted earlier in the project.

DISCUSSION

The opportunity to study riparian reestablishment and channel morphology in an intensively managed agricultural setting is unique. Riparian research has primarily focused in range and forest lands, which generally tend to have higher gradients with extensive land management practices, and predominately focus on channel morphology and riparian area ecology (Kauffman et al., 1995; Belsky et al., 1999). Alternatively, croplands generally have low valley gradients, are managed more intensively by reworking the channel, plowing, and other crop production activities. Previous riparian research in croplands has taken place in western Oregon, and the mid-western and southern United States. This research has focused on extraction of nutrients from shallow groundwater (e.g., Griffith et al., 1997).

Van Haveren and Jackson (1986) reviewed concepts of riparian structure and function in range and forest lands during the last 25 years that will serve as a useful guide to examine rehabilitation of riparian areas in croplands. In the Pacific Northwest, channel morphology research has focused on the impacts of logging in the Coast Range and Cascade Mountains of Washington and Oregon (Benda et al., 1997; Montgomery and Buffington, 1997), and the Sierra Nevada Mountains of California (Lisle, 1982). Unlike the mountain channels discussed in the research cited above, before crop production, these valleys were generally deposition areas for alluvial material. As a result, many channels on the Columbia Plateau have soft-bottomed silt-beds composed of deep alluvial and loess soils without shallow geologic control. Therefore, principles developed by Simon (1989) in larger, soft-bottomed channels in west Tennessee might be more applicable to our conditions.

Gerking Creek is typical of many 3rd order streams on the Columbia Plateau, the sinuosity of which was largely eliminated by channelization, and the active flood plain is narrow and confined. This stream form functions best for the efficient movement of water and soil from a site. It concentrates the stream energy, even after management objectives have changed and a channel is no longer mechanically cleaned. Anecdotally, some local producers consider occasional high flows important for cleaning and improving the efficiency of similarly incised channels, especially those channels thick with cattails or dead weeds.

The incised channel into the project area will continue to be a source of considerable sediment and energy due to concentrated flow. Channel adjustment as a result of these flows can be expected to continue in the form of elevation adjustment by upstream headcut migration, channel jumping to sites of pre-existing channels, and bank sloughing. These processes have the potential of physically removing newly planted material and altering soil-water relationships across Gerking Flat. Whether soil deposited on the active flood plain by channel forming flows with return periods of 1.2 ~ 1.5 years (Richards, 1982) can be washed away by flows with a return period of as little as 5 years is an open question in these streams.

Natural channels are dynamic; lateral movement, downcutting, and deposition are all natural processes. The goal of channel stabilization is not to create a channel wherein the channel never shifts in the floodplain or has a change in the channel slope. The purpose of channel stabilization in this project is to slow the movement of channel position to rates acceptable to the landowners and funding agencies. Channel stabilization should also result in absorbing stream energy so that channel banks and bottoms are not eroded downstream in a watershed.

Establishment of a healthy stand of riparian shrubs and trees in the incised channel will result in vegetation capable of damping the force of flood flows. The purpose of planting three types of vegetation, which consist of low profile grasses and forbs, mid stature shrubs, and trees, in addition to providing wildlife habitat, is to provide a foundation for structural enhancement of the stream channel. We expect the following scenario. Establishment of a grass community provides increased structural stability through root growth and increased roughness from stems. During high flows over the stabilized channel bottom: (1) energy transfers to stream banks, which begin to erode, and (2) sediment accumulates on the grassed terraces. As the high flows recede, the active channel will have a decreased w/d ratio to carry low flows. The flood plain builds with subsequent high flows, in which energy is distributed across wider, higher flood plain. On this aggraded flood plain, the establishment of shrubs and trees will lead to increased roughness, further absorbing flood energy and increasing soil deposition. At the same time, energy is no longer concentrated in the low flow channel, is not causing downcutting, but allows deposition in the streambed. This process contributes to a decreased channel slope and flow rate. As bank cutting occurs and the active channel develops, sinuosity increases (stream length increases), and further decreases slope. These processes lead to a channel in dynamic equilibrium, which should migrate slowly back and forth across the flood plain.

In addition to physical destruction by high-energy flows, establishment of shrubs and trees requires adequate soil/water relations. The bottom of much of the incised channel remains damp throughout the year. This near saturated condition prohibits establishment of most grass and shrub species. Alternatively, because the soils in the valley are well drained, but above the channel bottom, the ground water level is well below the rooting zone on the abandoned flood plain (abandoned due to channel downcutting). The soil in Gerking Flat is also known to be salt affected. It might be necessary to first raise the streambed by designing and reconstructing the channel and flood plain so that the water table is raised, low flows are carried in a narrow channel, but flood events will spread over the flood plain and flush the salts.

The presence of an abandoned channel, (confluence at 6.95 km), presents the potential of losing the current sinuosity. An active headcut is apparent approximately 100 m from the confluence. Above the head cut is a nearly linear channel that carries channel overflow from river station 7.40 km. If the headcut continues to migrate upstream, it will capture the current main channel. This event will further reduce the stream length through Gerking Flat, improving channel efficiency, and increasing the rate of energy transfer downstream.

Changes in stream elevation and slope must take into account two culverts, one at the bottom, or downstream, end of the project and a second located approximately at the 8.20 km. At minimum, the culverts should have debris guards place at the upstream entrances to prevent clogging by weeds and other debris. Incorporating these features into planned channel adjustments will complicate the design process, but will be necessary to preserve them. Alternatively, new culverts can be installed to accommodate the flow and expected stream changes. These changes might include culverts of a different design, elliptical rather than round, to fit within a shallower active channel, and with side culverts to accommodate high flows.

CONCLUSION

The Gerking Flat CREP project has the potential to reduce soil erosion and improve water quality and thus have a positive impact on aquatic habitat within the watershed and meet the landowners' desire to enhance wildlife habitat. As such, it is one of the first projects in a dryland-cropping region and will be closely watched by other landowners who will judge its successes and failures. The Gerking Flat project also provides a unique opportunity to help develop and test research hypotheses concerning riparian and channel development in the croplands on the Columbia Plateau.

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