Will the Creek Flow Again: The Camp Creek Paired Watershed Study

Tim L.Deboodt[1], John C. Buckhouse[2] and Michael P. Fisher[3]

[1]County Extension Agent/Associate Professor, Oregon State University, Extension Service, Crook County, Prineville, OR
[2]Extension Watershed Specialist, Oregon State University, Department of Rangeland Ecology and Management, Corvallis, OR
[3]Assistant Professor, Forestry Department, Central Oregon Community College, Bend, OR

Abstract

Western juniper's (*Juniperus occidentalis)* dominance on eastern Oregon's rangelands has increased 5 fold since 1934. The result of this significant vegetative change has been reduced forage production, increased soil erosion and reduced infiltration rates. Based on individual tree water use models and field observations it has been speculated that the expansion of western juniper has been, at least in part, responsible for the desertification of these landscapes. In 1994, a paired watershed study was implemented in the Camp Creek drainage, a tributary of the Crooked River (Deschutes River Basin). Two 300-acre watersheds were identified and calibrated. Baseline data for channel flow including duration and intensity of flow, along with channel morphology, hillslope soil movement and vegetative cover have been collected since 1994. GIS has been utilized to compare geomorphological characteristics of the two watersheds. Precipitation for each watershed has been continually recorded. In 2004, monitoring parameters were expanded to include weather, snow depth accumulation, spring flow, soil moisture and depth to ground water. Analysis of baseline data indicates similarities and differences between the two watersheds as it relates to their water cycles. In the fall of 2005, the juniper will be cut in one watershed and both watersheds will be monitored and data analyzed to determine changes in water.

Introduction

According to U.S. Forest Service publication PNW-GTR-464, *Western Juniper in Eastern Oregon*, western juniper's dominance in eastern Oregon has increased 5 fold since 1934 (420,000 acres to 2,200,000 acres). Based on water use models for individual trees, the U.S. Forest Service estimates that mature western juniper tree densities, ranging from 9 to 35 trees per acre, are capable of utilizing all of the available soil moisture on a given site. Research has shown that soil loss from sites with higher than the natural variation of western juniper cover is 10 to 100 times greater than similar sites that are still within their natural range of variation. Previous monitoring studies have been limited in their scope of monitoring to water quality impacts following western juniper control.

Water quantity and timing are the primary factors being monitored with this project. The project involves the use of a paired watershed study. The project consists of the treatment (cutting juniper) of one of the paired watersheds totaling approximately 300 acres with the other watershed serving as the untreated control. Scheduled for fall 2005, the Prineville BLM District will cut approximately 300 acres of western juniper in one of the watersheds and post-treatment monitoring will occur in both watersheds in order to compare responses and document impacts. The paired watershed project is located approximately 60 miles southeast of Prineville, Oregon. In 1993, two watersheds (Mays and Jensen) were identified in the Camp Creek Drainage, a tributary of the Crooked River. The average elevation of the site is 4,500 feet with an average

annual precipitation of 13 inches. The historic vegetation type was mountain big sagebrush - Idaho fescue. The site is currently dominated by western juniper with a sparse understory of shallow rooted perennial grasses and forbs.

The Prineville District Bureau of Land Management manages ninety percent of the treatment area while the remaining 10 percent is owned by the Hatfield High Desert Ranch. The BLM, in cooperation with Crook County Soil and Water Conservation District, the permittee (Hatfields) and OSU Department of Rangeland Ecology and Management identified the paired watersheds as areas of interest because of the opportunities they provided to monitor changes in water yields as a result of juniper control. Access to the site is from the Camp Creek/Bear Creek road.

Since 1994, the two watersheds have been monitored for similarities and differences. Precipitation, vegetation composition and cover, erosion rates, changes in streambed morphology and surface flows have been monitored annually. Stream flow is monitored continuously and changes in streambed morphology are measured twice a year.

Situation

Junipers are known to increase soil loss with runoff water; intercept rain and snow before it reaches the ground making it unavailable for plant growth, stream flow or groundwater recharge; and consume large amounts of soil moisture. Previous monitoring of juniper control projects have focused on changes in vegetative composition and production. With this project we are monitoring the effects – on a watershed scale – of juniper control on the availability of water (quantity and timing) for other beneficial uses. Water yield over time will be measured, demonstrating the relative ability of the paired watersheds to catch and release water.

This project is unique in that it involves a paired study approach to monitoring changes in a system's water budget following western juniper control. Monitoring water yield following juniper control has not been done in the western juniper vegetation type. The value of a paired watershed study is that the impacts of the treatment can be compared to the untreated watershed. This study is also unique in that it is the only long-term study of its type in the Northwest. Because of the time and expense in monitoring watershed level activities, such watershed comparison studies are rarely undertaken. Similar studies in different ecological and climatic zones have been conducted in Idaho, Utah, Colorado, Arizona, and now Montana but no paired watershed studies have been implemented in western juniper ecosystems.

As per an agreement between Oregon State University, Department of Rangeland Resources and the Prineville District BLM, the treatment phase will take place only after an adequate amount of baseline data has been collected. Baseline data has been collected in both watersheds since 1994 and has included the following parameters: 1) stream flow measurements including duration, intensity and volume recorded on a continual basis, 2) changes in stream channel morphology, 3) understory vegetative composition, 4) cover and juniper tree density, 5) soil comparisons and differences, 6) side hill erosion activity, and 7) precipitation. The value of this constant monitoring over the last 10 years is that annual variation in precipitation, vegetation expression, soil movement and storm activity has been documented. Initial data collected also included an ecological site description and analysis of the two watersheds based on vegetation, soils, topography, geology, channel morphology, streamflow, local climate and erosive processes. In 1996, six piezometer wells per watershed were established to monitor subsurface water in areas adjacent to the flumes. Average depth of these piezometer wells was 5 feet.

As a result of these initial monitoring activities, additional monitoring needs were identified and included soil moisture, sub-surface water, on-site weather data and timing of water use by juniper (timing). Grant monies from the Bureau of Land Management, Application of Science Program were secured in the spring of 2004 and are being used to: 1) instrument soil moisture measurements so that continuous soil moisture data can be collected, 2) install and instrument additional piezometer wells to capture water data below the soil surface, and 3) purchase and install on-site weather stations.

Ground Water Monitoring

During 2004, 12 piezometer wells were drilled with the assistance of the Ochoco National Forest. Each well is 2 inches in diameter and they vary in depth from 20 to 27 feet. Monitoring of depth to water has yielded very useful information. In Jensen, the channel is located at the far west edge of the valley bottom and all wells are located east of the channel (well 1 closest to the channel, well 6 farthest from the channel). In Mays, the channel is more centrally located and 4 of the wells (wells 1 – 4) are west of the channel and 2 (wells 5 – 6) are located east of the channel. In 2004, Mays' depth to water was at its lowest value (nearest to the surface) in mid-March, while in Jensen the lowest values did not occur until mid-April. Following each drainage's peak in ground water, depth to ground water continuously dropped throughout the remainder of the year. On average, this drop was approximately 6 inches per week.

Aerial Photography

Low level, aerial photographs, both color and color IR were taken in spring of 2004. Additional flights were flown in August 2004. Photographs will provide the basis for GIS analysis. Additional GIS layers will include soils, vegetation, slope, aspect, elevation and treatment locations.

Channel Profiles and Sediment

Continual monitoring of channel cross sections and sediment movement is occurring. Cross sectional data is measured twice a year, after spring run-off and after the summer thunderstorm activity. Data is being compiled using Reference Reach software provided by Dan Mecklenburg, Ecological Engineer Ohio Department of Natural Resources Division of Soil and Water Conservation. This software allows the data to be looked at in a graphical representation of a cross-section while providing numerical output of parameters such as total cross-section area, deposition, and scour. Additionally, this software provides an approach for comparing between the two study areas by comparing the differences from one season to the same parameter of the data collection period preceding it.

Analysis of current channel cross-sectional area did not appear to change dramatically between seasons except for the periods of 1994-1996 and 2000-2001. The largest difference occurred during the winter of 1996. This change in area is represented primarily by loss (scour) of channel material. Spring of 1997 and 2001 show a dramatic decrease of cross-sectional area in both watersheds (in 1997 in particular), whereas summer of 2001 shows a decrease of the cross-sectional area in Mays watershed and only a slight change in cross-sectional area in Jensen represented by a positive change (p-value < 0.10). A decrease in area is representative of channel deposition or aggregation whereas an increasing value in area is representative of scour or channel degradation.

Regression analysis (Figure 1) demonstrates a strong linear relationship between the two watersheds (r^2=0.9665). The variation in data can be adequately explained with a p-value of less than 0.05.

The resulting equation suggests that for every 1cm^2 change in Jensen cross-sectional area there would be an expected change of 1.852 cm2 in the Mays watershed channel cross-sectional area. It should be noted that the regression equation is strongly influenced by the outlier data of spring of 1997. When this data is removed the regression equation and associated correlation coefficient change substantially.

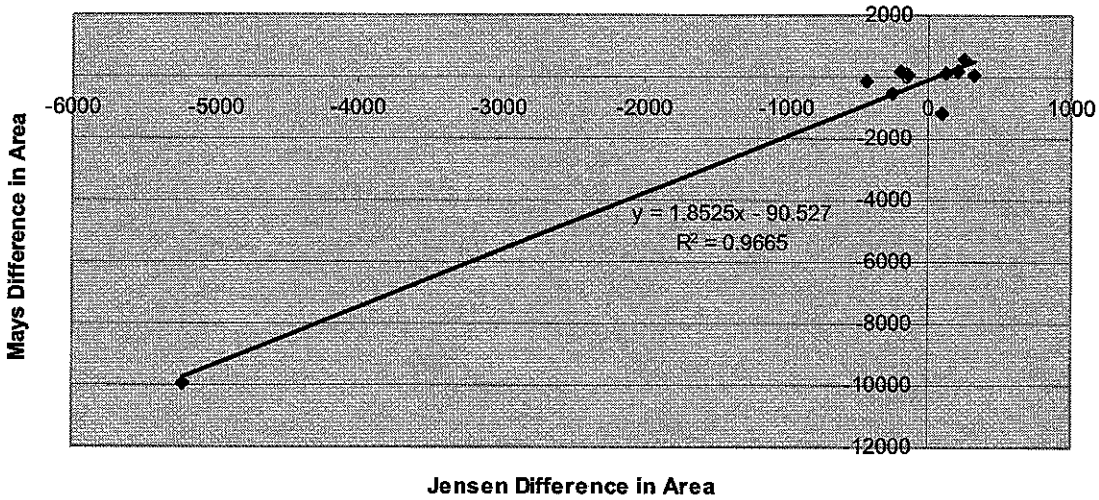

Figure 1. Regression graph of the difference in channel cross-sectional area with a correlation coefficient of 0.9665 and a best fit line equation of y=1.8525x-90.527 (p-value= 0.027464)

Weather Stations and Spring Developments

Installation of weather stations was completed in mid-November of 2004. Following completion, the sites received almost 2 inches of rain from mid-November through December. Early snow pack turned to ice (approximately 4 inches thick) and then was capped by another 10 – 14 inches of dense snow. Web site access to weather station information is: http://nopro.com/ifpnet. This web site is maintained by Automata Inc. and Wy'East RC&D. To view weather data, click on "change map" and highlight Crook County. Flags on map represent each weather station, Mays and Jensen.

Monitoring of spring flow began in September 2004 and is ongoing. Flow is read approximately every 2 to 3 weeks. Flow in Mays was lowest in November at 1.2 gpm, Jensen with .2 gpm. Spring output in mid-March 2005 was 20 gpm for Mays and 10 gpm for Jensen.

Depth to ground water is also measured every 2 to 3 weeks. Ground water in 2005 is not following a similar pattern to the winter of 2004. Ground water accumulation in Jensen and Mays wells in 2005 are approximately one-half of the accumulation in 2004.

Partnerships in Project

As this project progresses, the number of organizations, agencies, and individuals involved continues to grow. The current list of partners includes:

Prineville District, BLM	Deschutes Resource Conservancy	OSU Extension Service
Ochoco National Forest	Crook Co. Natural Resources Ad. Comm.	Doc and Connie Hatfield
OSU Rangeland Resources	Crooked River Watershed Council	COCC Forestry Dept.
Crook Co. Cattlemen's Assoc.	Crook/Wheeler Co. Farm Bureau	Crook County SWCD
Oregon Dept. DEQ	Western Juniper Work Group	McCormack and Sons
Malheur Co. Experiment Station	Congressman Walden, Senator Wyden	Larry Swan, U.S.F.S.
Ochoco Irrigation District	Oregon Watershed Enhancement Board	Wy'East RC & D

The Prineville District of the BLM has been a major cooperator and continues to support this project. Their cooperation and active participation in this project will assure that the results of this study are applied appropriately throughout the western juniper range. Special thanks to them for their support.