Increasing Water Availability through Juniper Control

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Throughout the region where western juniper is now found, there has been a large amount of speculation regarding the amount of water an individual tree might use, and how that water use when extrapolated to a watershed or landscape level would impact things like stream flow, spring flow and soil moisture. Observations by individuals involved in juniper removal projects have included such things as, “we now have a near perennial stream when before it was at best, intermittent”, or, “the flow of the spring has increased since we cut the trees”. While these observations are important to land owners and land managers, without actual before and after data, it is difficult to use this observational information in designing or advocating for future projects. In fact, here in Oregon, several public land management agency watershed projects going through the environmental review process were withdrawn when individuals or organizations challenged them on this objective. The challenge, “prove it!”

Western juniper has been shown to have significant impacts on rangelands throughout Oregon, Nevada and California. In Oregon alone, since 1934, the U.S. Forest Service reports that juniper dominated rangelands have increased from 1.5 million acres to over 6 million acres. Studies conducted since the early 1980’s have shown that as juniper increased its dominance on the landscape impacts have included loss of forage production and wildlife habitat. With the loss of native shrubs, forbs and perennial grasses from these sites, increased soil erosion and lack of soil water infiltration have resulted. Until recently, research looking at the impacts on water has been limited to quantifying impacts on soil moisture, surface runoff (overland flow) and soil erosion.

In 1994, the Camp Creek Paired Watershed Study was initiated to provide long term, verifiable data which would be collected systematically to test the hypothesis, “does the removal of western juniper change the hydrologic function of a watershed”? Or stated differently, with the cutting of western juniper can we measure changes in soil moisture, ground water, channel flow and spring flow? As a brief introduction to how paired watershed studies work, you first need to identify two similar sites, spend some time studying them to see how similar and dissimilar they are, then apply your treatment to one of them and continue to monitor both to see if the relationships that were identified prior to the treatment change as a result of the treatment.

The Camp Creek Paired Watershed Study occurred in two watersheds which are located side by side (Figure 1). Mays and Jensen (names given to the watersheds based on the families that homesteaded the area) were selected. The study area is located about 60 miles southeast of Prineville, Oregon. Elevation of the study area ranges from 4000 to 4500 feet. Annual precipitation is 13 inches, and approximately 70 percent of each year’s precipitation comes in the form of snow or early spring rain (October through April). Each watershed is approximately 260 acres. Approximately 20 percent of the total study area is private ownership with the remainder under the management of the Prineville District, Bureau of Land Management.

In October, 2005, following 11 years of monitoring various parameters (vegetation, ground water, spring flow, soil moisture, etc.) all "post-European aged trees", those trees whose approximate age was less than 140 years old were cut in Mays watershed. The trees in Jensen were left uncut and thus Jensen became the "control" watershed. Old growth trees were not cut. Old growth trees were defined as rounded-top trees with deeply folded bark and moss and lichens growing on the limbs. These trees are commonly found on the rocky ridge tops and sites with shallow soils.

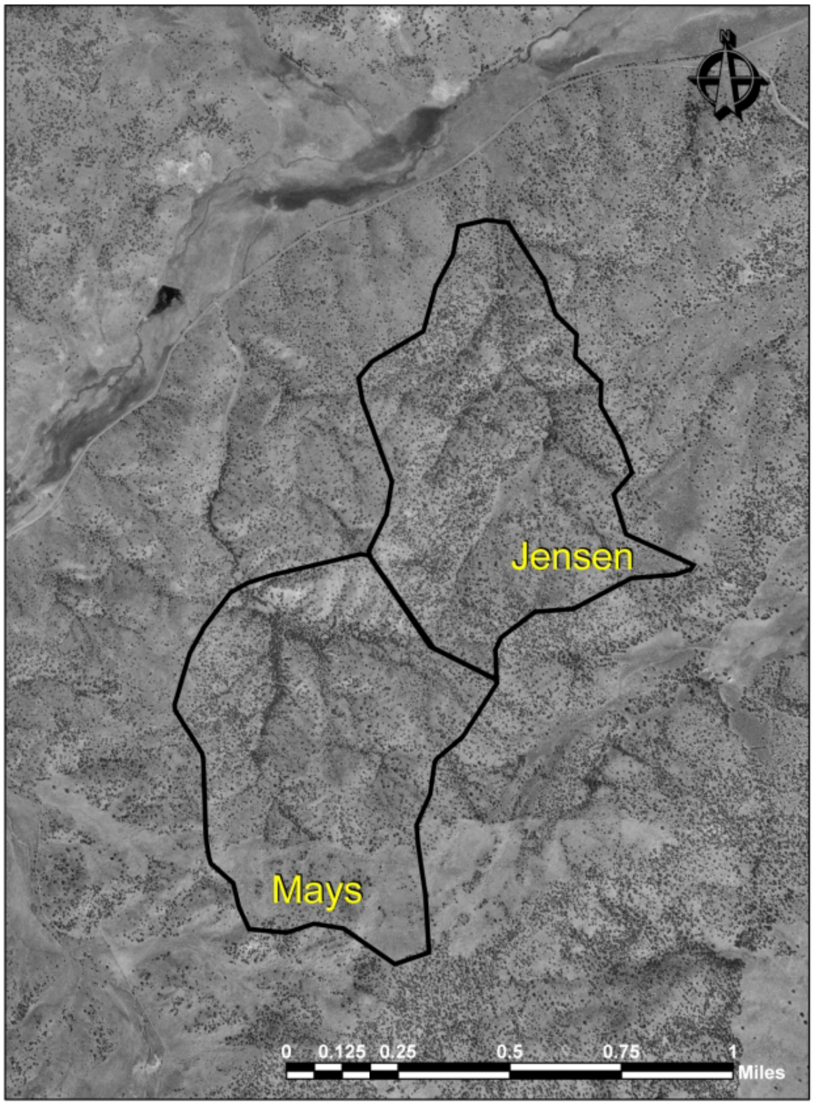
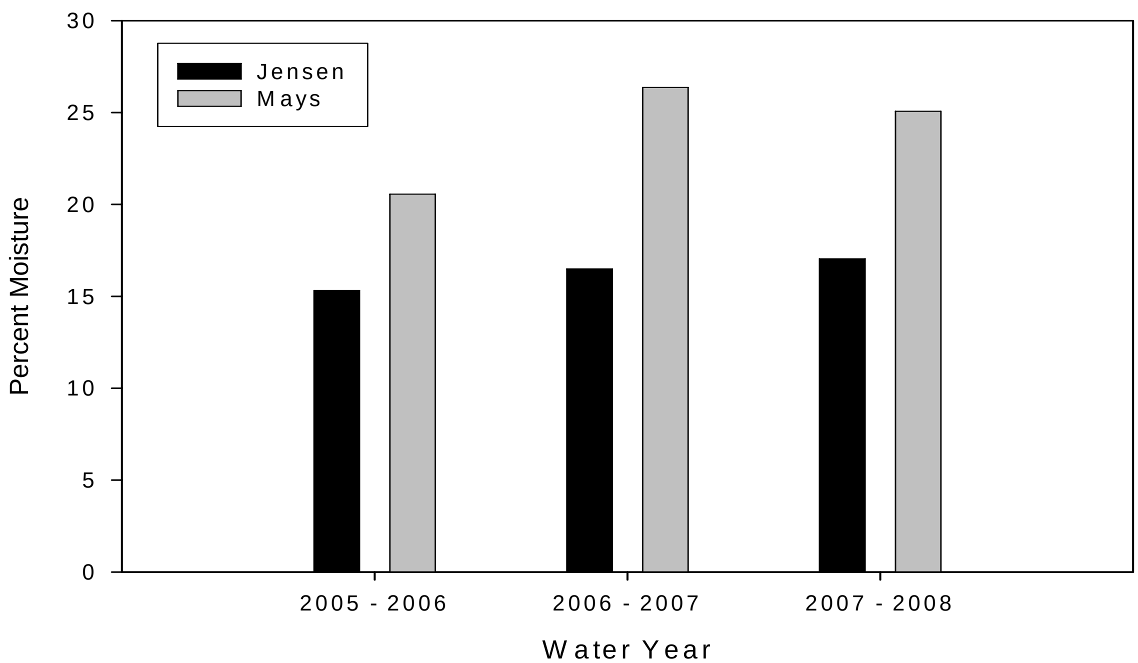


Figure 1. Camp Creek Paired Watershed Study Area
Mays and Jensen Watersheds.

So what have we learned? Analysis of the data two years after treatment shows a positive response in water yield as a result of juniper removal. Soil moisture was measured at 2 locations in each watershed. Moisture probes were placed at depths of 7, 18 and 27 inches. Figure 2 illustrates that stored soil moisture measured at 27 inches (bottom probe) increased at the end of the year (November and December) following treatment (years 2006-07 and 2007-08) when compared to the pretreatment year (2005-06). This increase in deep soil moisture is a result of the cutting of the juniper. Without many shrubs on this site, juniper would have been the only plant with a significant amount of roots in this zone. Without plants to use this soil moisture, it was allowed to accumulate with excess soil moisture moving through the soil profile and becoming ground water.

Figure 2. Average end of year soil moisture readings for Jensen (treated) and Mays (control) watersheds. Pre-treatment 2005-06 vs. treatment 2006-07 & 08. Bottom probe.



Changes in near surface ground water were measured through the use of shallow wells installed in November, 2003. Perforated PVC pipe was installed to allow the measuring of free standing water in the pipe. Measurements were taken every two to three weeks. Six shallow wells were placed across the valley bottom in each watershed. The depth of the wells varied from 19 feet to 27 feet.

Figure 3 shows the changes in recorded depth to water for Jensen watershed. It is important to note here that while the peak of each year is different, a reflection of that year's precipitation total and more importantly the timing of that precipitation, the shape of each year's curve are very similar. These bell shaped curves indicate that ground water is moving out of Jensen in a similar pattern each year. Well 4 in Jensen always had water at some depth until September of 2007 when all wells in Jensen were dry until

April, 2008. This is a result of 2006-2007 being a drought year. Precipitation for this period was only 75 percent of the long term average.

Figure 4 shows the changes in depth to water measure in Mays watershed both before and then after treatment (October, 2005). This figure shows a significant change in the shape of the curve from before (a sharp increase followed by a sharp decrease) to after treatment, a flatter curve. Well 6 in Mays watershed went dry each year prior to treatment but has not gone dry since treatment, even in the drought year. The number of days in which water was recorded in all wells for Mays increased an average of 41 days over Jensen after treatment. This is a significant change in how water is leaving the site. Instead of a sudden flush of water, water is now leaving the site over an extended period of time.

Figure 3. Depth to ground water in the untreated watershed: Jensen.

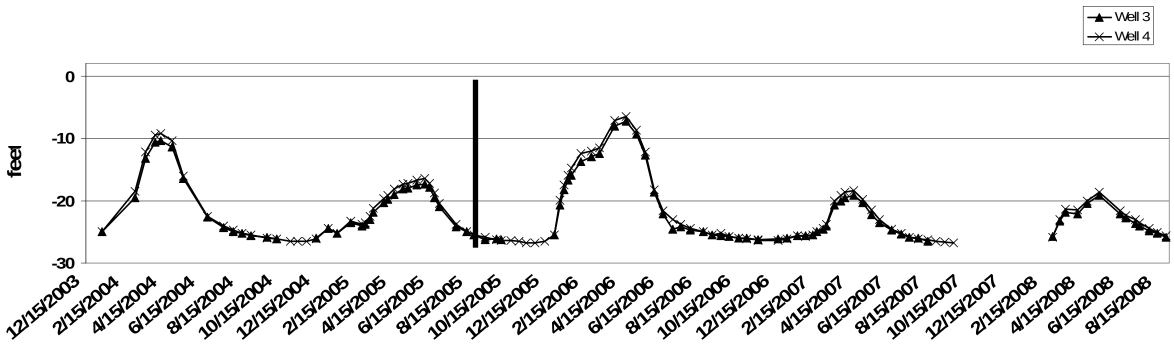
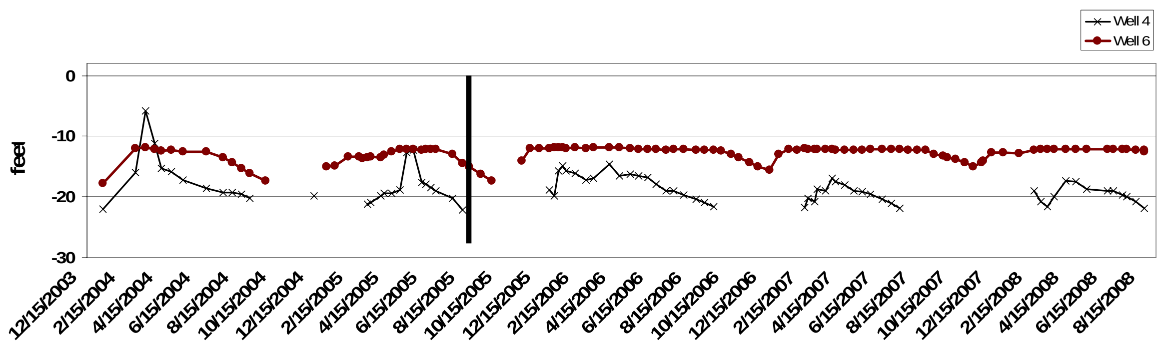


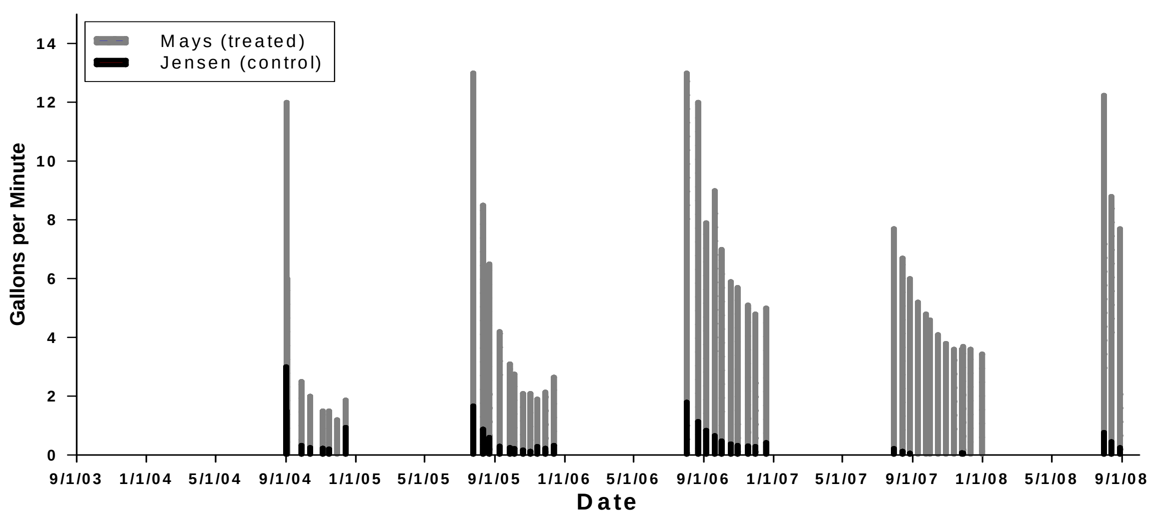
Figure 4. Depth to ground water in the treated watershed: Mays



Spring flow is the final measure that illustrates a response to juniper removal. Late season spring flow, that period from mid-July through September, is a reflection of how much precipitation is able to get into the ground water that year. This period of the year sees little precipitation and spring flow reflects this. Figure 5 shows the differences in spring output between Mays and Jensen both before and after tree removal. The first two groups of bars are the late season flows prior to treatment (9/2004 – 10/2005). The second two groups of bars show the changes in spring flows following treatment. It is the increase in the differences in flow between Mays and Jensen that shows a treatment effect.

Following the cutting of the trees in Mays, Mays spring output increased 3 – 5 gallons per minute during this late season period. In 2007 (the drought year), the spring in Jensen went dry for the first time since the springs were developed while the flow in Mays continued at a rate higher than pre-treatment levels. This increased late season flow benefits forage management by making water available in a pasture during a period of time it would not have been.

Figure 5. Late season spring flow.
Treatment applied to Mays watershed in October 2005.



In conclusion, this study has provided a valuable insight into how western juniper utilizes available moisture and how removal of stands of juniper may provide improved water availability for forage production, livestock and wildlife water and increased ground water for down slope uses. This study provides support to other research that has shown that through juniper removal and re-establishment of the historical native shrub/grass plant community, water (precipitation) delivered to these rangelands can be captured by improving soil/water infiltration, reducing overland flow and soil loss and making more water available for plant growth, groundwater recharge and sustained spring flow. As monitoring of these watersheds continue into the future, changes in channel flow are anticipated as gullies are healed and riparian areas are once again functioning.