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COMING EVENTS:

23-25 June 2009. Energy and Sustainability 2009. Second International Conference on Energy and Sustainability. Bologna, Italy. Contact: imoreno@wessex.ac.uk

24 June 2009. OSU/EOARC Range Field Day. Department of Rangeland Ecology, OSU, and Eastern Oregon Agriculture Research Center, Burns, annual field day. Great Basin Research Station, Burns, OR. Contact: michael.borman@oregonstate.edu

25-27 June 2009. Pacific Northwest Section/Society for Range Management summer meeting and tour. Dayville, OR. Contact: jlbreese@crestviewcable.com

11-15 July 2009. Soil and Water Conservation Society Annual Meeting. Dearborn, MI. Contact: www.swcs.org/09ac

7-9 September 2009. River Basin Management. Fifth International Conference on River Basin Management including all aspects of Hydrology, Ecology, Environmental Management, Flood Plains and Wetlands. Malta. Contact: imoreno@wessex.ac.uk

9-11 September 2009. Water Resources Management 2009. Fifth International Conference on Sustainable Water Resources Management. Malta. Contact: <http://www.wessex.ac.uk/wrm2009rem3.html>

14-16 September 2009. Sediment, Conservation Measures, and the Future of Reservoirs. Soil and Water Conservation Society. Kansas City, Missouri. Contact: <http://www.swcs.org/sedimentation>

16-18 September 2009. PNW Annual Meeting and Workshop. Clarkston, WA.
Contact: jlbreese@crestviewcable.com

30 September-1 October 2009. Living on the Land educators' training. Albuquerque, NM. Contact: Susan Donaldson at donaldsons@unce.unr.edu

28-29 October 2009. Big Sky Carbon Sequestration Partnership. Annual Energy Forum. Spokane, WA.
Contact: Kimi Nygaard at kimi.nygaard@montana.edu.

15-17 December 2009. Ravage of the Planet II. Second International Conference on Management of Natural Resources, Sustainable Development and Ecological Hazards. Western Cape, South Africa.
Contact: <http://www.wessex.ac.uk/ravage2009rem2.html>

7-11 February 2010. Society for Range Management Annual Meeting. Denver, CO.
Contact: www.rangelands.org

Search Status

Due to budgetary constraints at Oregon State University, the Department of Rangeland Ecology and Management's search for a faculty member to fill the vacant rangeland ecologist position has been terminated. It is uncertain when, or if, this restriction will be lifted. In the meanwhile the existing faculty are attempting to cover the bases as completely as possible given our short staffing.

Wolves in Oregon

John Williams, Wallowa County Extension

With the recent confirmation of wolf depredation that has occurred in Oregon it is time to make sure that ranchers and other livestock producers understand what they can legally do, what they cannot do and what procedures they may need to follow if they encounter a wolf in or around their operation.

Wolf Status

The wolf is listed as endangered under the federal Endangered Species Act (ESA). It is also listed as Endangered under the Oregon ESA. The U.S. Fish and Wildlife Service has proposed that they be removed from the federal ESA listing and has published that rule in the federal register. That delisting will occur on May 4, 2009 barring any court action that would delay or suspend it. There has been several notices of intent to file a lawsuit to stop the delisting, however, at this writing it has not occurred.

Following a delisting from the federal ESA, wolves in the eastern portion of Oregon will continue to be listed endangered under the Oregon ESA. This delisting will affect all wolves in that portion of Oregon that lies east of Hwy 395 from the Washington line to Burns, then south along Hwy 78 to Burns Junction, and south along Hwy 95 to the Nevada border. For those producers west of the above described boundary, wolves will still be listed as endangered under the federal Endangered Species Act.

Actions While Federally Listed

Actions producers can take while wolves are listed under both federal and state ESA: (this includes producers east of above described line through May 4, 2009 and the rest of producers west of line until future delisting occurs)

Livestock producers may scare a wolf off (by making loud noises for example) but may not harm a wolf in any way, even one seen in the act of attacking livestock. Producers need to report any wolf **sightings or incidents** to:

- U.S Fish and Wildlife Service (USFWS) John Stephenson 541-962-8584 or 541-786-3282
- OR Department of Fish & Wildlife (ODFW) Russ Morgan 541-963-2138 or 541-786-5126

If you believe a wolf has killed your livestock (depredation): Do not move or disturb the carcass or the area surrounding it that might offer clues to cause. Preserve tracks, hair or scat by covering it with plywood, cans or buckets or anything that will not destroy the evidence. Cover the carcass or any remains with a tarp or other material that you might have. Weight it down so wind or other disturbances such as predators will not have access. When you have **depredation** contact the following:

- USFWS John Stephenson 541-962-8584 or 541-786-3282
- Wildlife Services (WS) Mike Slater 541-963-7947 or 541-805-9492) or Dave Williams 503-326-2346.
- ODFW Russ Morgan 541-963-2138 or 541-786-5126

Actions while listed only under Oregon ESA

After federal delisting occurs in the eastern part of the state, since wolves in this portion of Oregon will not be listed under the federal ESA, but are still listed under the Oregon Endangered Species Act, the Oregon Wolf Plan rules apply. The Oregon Wolf Plan establishes rules by Phases. Phase I rules apply until four breeding pair of wolves produce pups for a minimum of three years. At that time wolves will be delisted in Oregon and a new set of rules will apply during Phase II.

The rules regulating the actions a livestock producer can use when encountering a wolf around his operation are as follows during Phase I:

No permit required

If a livestock producer sees a wolf testing or chasing livestock or in close proximity, they may scare a wolf off by firing shots in the air, making loud noises or otherwise confronting the wolf provided no bodily harm is done to the wolf. Such incidents must be reported to ODFW (541-963-2138) within 48 hours and the rancher cannot be intentionally looking for a wolf.

ODFW permit required

If persistent wolf activity around livestock occurs, producers may engage in additional harassment by permit: Harassment of wolves in ways that may cause bodily harm but not death (e.g., rubber bullets or bean bag projectiles)

Intentional pursuit of problem wolves would be allowed under this permit to keep wolves away from livestock. If a wolf is captured, ODFW may relocate it to the nearest wilderness area.

(Before a permit is issued, ODFW will consider the location of den sites and any attractants that may be luring wolves to the area. Wolf harassment under the permit must be reported to ODFW within 48 hours.)

Permits for lethal control

Permits for lethal control will be issued if non-lethal methods are deemed ineffective. This permit allows a livestock producer to kill a wolf “caught in the act” of attacking (but not testing or scavenging) livestock.

Lethal control for chronic damage situations

ODFW and authorized agents may also conduct lethal removal of wolves after chronic depredations and ineffective non-lethal efforts.

Livestock producers can work with their local wildlife biologist on these issues or they may want to work with Russ Morgan, ODFW wolf coordinator 541-963-2138.

Remember to keep from attracting wolves to your operation bury or remove dead animals immediately. Prepared by: John Williams, OSU Extension Service, Wallowa County in cooperation with OCA wolf task force. Significant information was taken from *the Federal/State Coordination Strategy for Implementation of Oregon's Wolf Plan, April 2007* and ODFW's document titled: *How to Respond to Wolf Depredation under the State's Management Plan*.

Long Term Watershed Studies---the Paired Watersheds of Central Oregon; a Short History and Preamble

John C. Buckhouse

In the early 1990's the groundwork was being laid for a tri-state research project, funded by EPA, to look at several regional issues germane to natural resource management. Drs. Mel George and Royce Larsen, University California-Davis, and Sherm Swanson, University Nevada-Reno, and John Buckhouse, Oregon State University joined together to write and eventually be awarded this grant. The Oregon portion of the project was to establish a paired watershed experiment looking at the hydrologic effects of juniper encroachment.

The real work of the project began with the choosing of graduate students and their assuming on-the-ground leadership for establishing monitoring equipment and collecting & analyzing data.

Michael Fisher began his Master of Science program on the paired watersheds in 1993 and finished his MS thesis in 1996. Following graduation, Michael maintained his interest in the project, however, and on weekends, evenings, and holidays was on the watersheds maintaining equipment, gathering data, and keeping the project alive. Michael simultaneously attended classes at OSU (both in Corvallis and "distance" (on-line) through the OSU Cascades Campus). In 2004, he defended his PhD dissertation and was awarded his PhD degree from the Department of Rangeland Ecology and Management. To this day, Michael remains an active and critical component and team member of the Paired Watershed experience and research project!

Tim Deboodt, OSU Crook County Agent, cooperated with Michael and me from the beginning--- and in 2003 he assumed the role of official PhD candidate. Tim and Michael worked together on the continuing and new aspects of the project. Finally in 2005, Twelve years after Michael collected his first set of reference data, the encroached trees in May's Canyon were cut. [Twelve years were required to establish a baseline of data appropriate to a paired watershed study in the semi-arid rangelands of the west. Rainfall is sporadic and highly variable, forcing long periods of data collection time in order to get a handle on the range of variability within the watersheds. This data is necessary so that one can statistically predict the response of one of the pair relative to the other]. By 2005, Michael, Tim, and I felt that we finally had enough pre-treatment information to initiate tree removal. And the results were almost instantaneous in some instances and are slow to manifest themselves in others. In a nutshell, thanks to Michael's long term understanding of the hydrology of both watersheds and Tim's monitoring of results post-treatment we have established the following restoration sequence:

- With the scattering of limbs we immediately increased the retention and detention storage on the site with the result being increased infiltration of precipitation and therefore increased soil moisture.
- As the moisture entered the soil rather than running off the surface, we saw, within months, a change in below ground water and in resulting spring flow....the catchment basin was filling from the bottom up!
- As the catchment filled, soil moisture, ground water regimen, and spring flow increased. Mays Creek, an ephemeral stream is beginning to assume the features of an intermittent stream.

- As the soil moisture regimen improved, herbaceous vegetation responded, resulting in further enhancement of infiltration, creating a more positive water cycle.
- Geomorphic features, particularly the historic gullies which exist on the site, show signs of healing; there is increased vegetation in the bottoms. Michael's long term data showing cross sections of these gullies suggest that this will not be a quick fix. Now that the hydrologic regimen has been improved, one can hypothesize that the gullies will heal...but we anticipate that that will be a long-haul proposition (perhaps decades)...and is one that we are poised to document.

Tim completed the requisite coursework and data collection to write his dissertation and graduate with his PhD in 2008. Both Michael and Tim are continuing with the project and are looking forward to what this effort will continue to show!

Cooperation has been the key to this project from the get-go. I initially worked with private land owners, Doc and Connie Hatfield and BLM's officials, Dan Tippy and later John Swanson to gain access to this mixed ownership land in the Crooked River Basin. In the years since, the Hatfields, to include second generation family members, Travis and Cynthia Hatfield, and John Swanson have remained constant and consistent cooperators. In addition, neighboring landowners, specifically the McCormack and Breese Families, have offered constant moral and physical support. Larry Thomas (BLM) and Carrie Gordon, (USFS), Earl McKinney and Butch Heilmeyer, (private contractors) all played a huge role in providing specific, technical advice and help. Following the initial EPA grant, the Bureau of Land Management (BLM) with leadership from Michelle McSwain, the Oregon Watershed Enhancement Board (OWEB), Crook County Taylor Grazing Board, Crook County Extension Service District and Secure Rural Schools and Community Self-Determination act of 2000: Title II all supported the project financially. Finally, it is appropriate to note that the colleagues and families of the graduate students who worked on this project became integral to the success of the mission. If there had not been the interest and support, both on the ground and at home, which these marvelous individuals provided, this project would not have come to be!

I am fortunate to have been associated with this project, with the many wonderful people who participated, and especially with Michael and Tim. This project was painstakingly crafted and conducted. It is yielding interesting and useful information. When I retired in 2008, I did so with a clear understanding of how important this project is to Oregon and Her citizens. Michael and Tim are dedicated to maintaining the project and are excited about the next logical issues which they might research and explore. I am confident that under the leadership and guidance of Dr. Fisher and Dr. Deboodt, it will indeed continue to provide valuable information well into the future.

With that preamble and historic background, I asked Michael and Tim to provide the specifics. They follow:

Monitoring Hydrological Changes Related to Western Juniper Removal, a Paired Watershed Approach.

Deboodt, T.L., M. P. Fisher, J. C. Buckhouse, John Swanson

Abstract

Since 1934, western juniper has increased its hold on eastern Oregon rangelands. U.S. Forest Service reports that juniper acreage has increased from 1.5 million acres to over 6 million acres in 1999. Previous studies have shown that water use by juniper can exceed 30 gallons per day when adequate soil moisture is present. Increased juniper dominance has been implicated in the desertification of Oregon's rangelands. Ground water mitigation, reintroduction of steelhead into the upper Deschutes River basin and changes in laws affecting surface water right allocations have driven public policy to look at how water is currently being used and how changes in water use (water law) could affect water availability. Vegetative modeling has shown that 9 to 35

trees per acre are enough to utilize all the precipitation delivered to a site in a 13 inch precipitation zone. Earlier studies suggest that a minimum of 17 inches of annual precipitation is required to measure a water yield response associated with vegetative manipulation. In 1993, the Camp Creek Watershed study area was established to monitor the effects of juniper removal on hydrologic processes. In 2005, following 12 years of pretreatment monitoring in the 2 watersheds (Mays and Jensen) all post-European aged juniper (juniper < 140 years of age) were cut from the treatment watershed (Mays). Analysis indicated that juniper reduction significantly increased late season spring flow by 225 percent ($\alpha > .05$), increased days of recorded ground water by an average of 41 days ($\alpha > .05$) and increased the relative availability of late season soil moisture at soil depths of .76 m (27 inches) ($\alpha > 0.1$). Ephemeral channel flow did not show a predictable trend following 2 years of post treatment measurements. The Camp Creek project illustrated that for this system, managing vegetation for water yield may be obtainable at a much lower precipitation threshold than what was previously understood.

Keywords: Paired Watershed, water yield, western juniper, range restoration

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) (Gedney et al 1999). The result of this significant shift in plant community dominance 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. 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 an order of magnitude greater than similar sites that are still within their natural range of variation (Buckhouse and Gaither, 1982).

Established in 1993, the Camp Creek Watershed Study Area was created to monitor water quantity and timing associated with juniper control. Channel morphology, hill slope erosion and changes in vegetation were also monitored. The project involved the use of a paired watershed study format. The paired watershed project is located approximately 60 miles southeast of Prineville, Oregon.

Two watersheds (Mays and Jensen) were identified in the Camp Creek Drainage, a tributary of the Crooked River. The project consisted of the treatment (cutting juniper) of one of the paired watersheds totaling approximately 250 acres with the other watershed serving as the untreated control. The Prineville BLM District cut approximately 200 acres of western juniper in Mays watershed. The cutting was initiated in October, 2005 and was completed in April, 2006.

The elevation of the project area ranged from 4,500 - 5000 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. Since 1993, the two watersheds have been monitored for similarities and differences.

Project Objectives

- Evaluate hydrologic changes following the cutting of post-European aged juniper (trees established since mid-1800s).
- Evaluate changes in hill slope erosion and channel morphology following the cutting of post-European aged juniper.
- Evaluate changes in plant community composition following the cutting of post-European aged juniper.

The majority of the two watersheds were comprised of public land, administered by the Prineville District, BLM (75% Mays, 86% Jensen). The remaining portions of each watershed were owned by the Hatfield High Desert Ranch. The BLM, in cooperation with Crook County SWCD, the permittee (Hatfields), and OSU Department of Rangeland Ecology and Management identified the paired watersheds as an area of interest because of the opportunities the study provided to monitor changes in water yields relative to juniper control. Access to the site is from the Camp Creek/Bear Creek road.

Methods

Establishment of the study and initiation of monitoring began in 1993. Each watershed was delineated by the location of a continuous recording flume placed in the channel at the lowest point of each watershed. Flow was measured and recorded with the aid of a data logger. Precipitation inputs were first measured with the use of Belfort Universal Rain Gauge and in 2004, a weather station was added to each watershed to record air temperature, precipitation, wind speed and direction, solar radiation, leaf wetness, relative humidity and snow accumulation. Changes in channel morphology was determined using channel cross-sections located in the main channels of each drainage.

In 2004, additional monitoring was added to the watersheds (Figure 1). Within each watershed, a spring was improved and flow measured. Six shallow wells were placed across the valley bottoms of each watershed near the flume location for the purpose of measuring depth of groundwater. Soil moisture and soil temperature probes were installed at 2 locations within each watershed and placed at multiple soil depths.

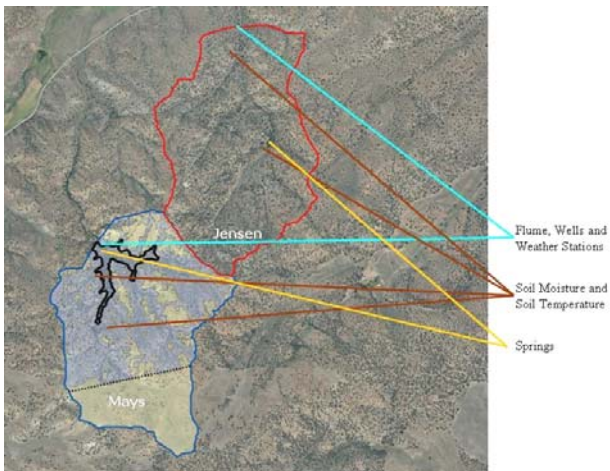


Figure 1. Location of Monitoring Stations

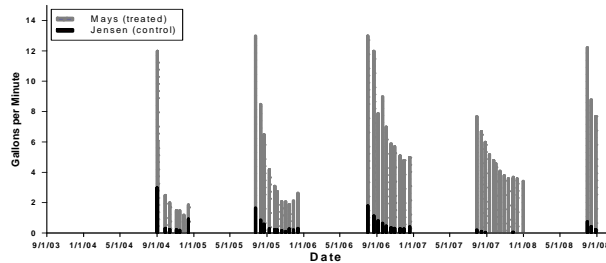


Figure 2. Differences in late season spring flow before and after treatment.

All monitoring of weather, spring flow, channel flow, soil moisture and depth to water was done through satellite uplinks and data is available for viewing on the web site: <http://ifpnet.com>.

Results

Spring flow

Figure 2 illustrates the differences in output between the two springs and the differences between years. Spring flow is dependent on timing, type and amount of precipitation. Base flow, that flow which is least likely to be influenced by a recent precipitation event or snow melt period, is the late season flow. Late season flow is defined as the period between July and November. The first two sets of bars represent the pretreatment years (2004 – 2005) and the last 3 sets of bars show the changes in flow after treatment (October, 2005).

Table 1 shows the t-test results for comparisons of late season flow (lowest flow recorded) between the two watersheds and the pre (2004-05) and post (2006-07) treatment years. The one tailed P-value is significant at alpha = .05**.

Table 1. T-Test for Spring Flow Data, lowest flow recorded (GPM)

Year	Watershed	Diff.	Mean	Variance		
	Mays	Jensen				
2004	1.87	0.20	1.67			
2005	1.90	0.13	1.77	1.720	0.00500	
2006	4.80	0.23	4.57			
2007	3.6	0.00	3.60	4.085	0.47045	
		Difference	2.365			
		Standard error	0.487			
					t-test	4.8505805
		One tailed P-value	0.019 **			

Wells

Well data, in addition to depth measured, provides insight to the timing or availability of subsurface water. The length of ground water availability could be an indicator of watershed function (Table 2). Increases in length would indicate an improved hydrologic condition. A review of the data (t-test) indicates that changes in the average number of days in which water was recorded in the wells increased in Mays as a result of cutting the trees (p-value = .0152). Using a Wilcoxon rank test the wells in Mays post-treatment, recorded a greater increase in the number of days that water was recorded when compared to the control watershed – Jensen (p-value 0.013).

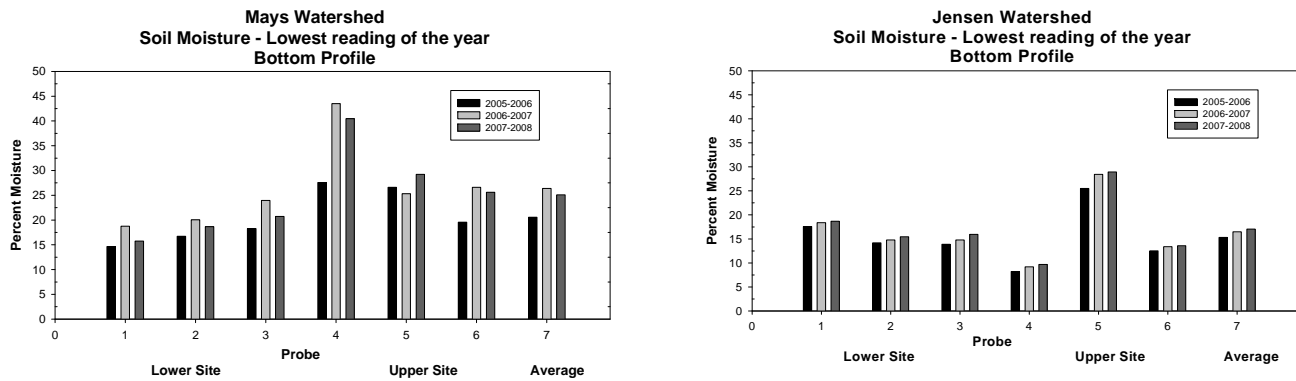
Table 2. Comparison of Average number of days of well water for the watersheds. Pre and post treatment years consist of 2 years each.

Watershed	Well	Pretreat	Posttreat	Diff.
Mays	1	112.5	128.5	16
	2	119.5	135	15.5
	3	195.5	285	89.5
	4	195.5	209	13.5
	5	156	197	41
	6	269.5	342.5	73
Jensen	1	70	82	12
	2	78.5	89	10.5
	3	283.5	296	12.5
	4	314.5	361.5	47
	5	283.5	296	12.5
	6	167.5	141	-26.5

Soil moisture

Observing the lowest readings of the year within each watershed illustrated the amount of “water savings” that was carried over from one year to the next. Evaluating the change in “water savings” over years helps to see if that change was associated only with precipitation, or if increases might have been due to the lack of deep

rooted vegetation (the cutting of the juniper). If it was due to the removal of deep rooted vegetation, then excess soil moisture could move through the soil profile and into sub-surface water storage and flow.



Individual probe readings were averaged by location within the soil profile and by site for each watershed. ANOVA showed that the observed increase was significant (Alpha = .1*) for the difference between 2006 and 2005 and for the average increase difference of 2006-07 combined and 2005 when comparing Mays with Jensen. Table 3 shows the results of this test for the combined years 2006-07 compared to 2005.

Table 3. Significance of end of year soil moisture accumulation post vs. pre treatment.

Year	Probe Location	P-value
2006-07 vs. 05	Bottom (0.27 in)	.1002*
2006-07 vs. 05	Middle (0.18 in)	.1796
2006-07 vs. 05	Top (0.7 in)	.6132

Channel Flow

Channel flow in the two watersheds is ephemeral. These channels only have flow during periods of snow melt and extreme summer thunderstorm activity. Ephemeral channels tend to be more influent in relation to the ground water then perennial flows contributing to ground water rather than ground water contributing to channel flow.

Comparisons of ephemeral channel flows or days of flow did not show a relationship to the treatment. In most years, recorded channel flow occurs during the spring and early summer months. In 1996 and 2004 total annual days of flow were greater than days of springtime channel flow, a result of late summer thunderstorms and early fall rain. In all years but one, Mays flowed longer than Jensen. Only in 1998 did Jensen flow longer when compared to Mays. In 2007, while length of flow was greater in Mays, Jensen's flow as measured in accumulated cubic feet per second (cfs.) was greater than Mays' flow.

Of special note in the observation of these systems was the winter of 2006, following the cutting of juniper in Mays. The snow pack, which began its accumulation in December, 2005 was static at approximately 16 inches. December and early January rain events saturated the snow pack. While no water content measurements were taken, field notes indicate that the snow was saturated and frozen on top. Field notes also indicated that the snow pack was solid enough for researchers to be able to walk on top of the snow without breaking through. As mentioned earlier, soil temperatures during this period did not drop below 32 degrees F for either watershed. Channel flow in Mays began on January 7, 2006. Flow was recorded through mid-June, 2006. In contrast, flow in Jensen did not begin until April 1, 2006 and ceased to flow by early May. During this period, all observations for both watersheds indicated that flow was generated exclusively from bank seepage and that no evidence of overland flow was observed for either watershed.

In contrast, during the winter of 2007, very little snow pack was accumulated. Bare ground was observed in both watersheds (50 – 70 percent of the landscape) with snow accumulation areas measuring less than 6 inches. Soil temperatures in early February were approximately 22 degrees F. An early February storm produced a rain on snow event. Flow was recorded in both watersheds and evidence was observed which indicated the majority of channel flow originated as overland flow. Sediment movement was observed on the hill slopes and in the channels. Sediment deposits had to be removed from both flumes. These two different observations help to illustrate the high variability within these systems and the difficulty in connecting channel flow data to treatment effects, especially during the first two years following treatment.

Channel morphology

In order to access changes in channel morphology over time, 25 permanent channel cross-sections were established in each watershed. Figure 3 shows a stylized diagram of how each cross-section looked. Depth measurements were taken at 10 cm intervals across the channel.

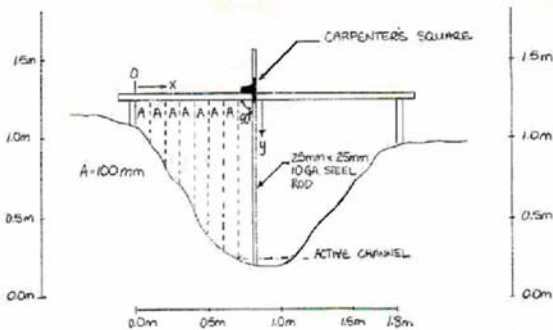


Figure 3. Diagram of channel cross-section layout.

Measurements were taken twice a year, first following the end of the snow melt period and spring flows, and then at the end of the summer thunderstorm period. Data was plotted using reference reach software© developed by Dan Mecklenburg, Ecological Engineer Ohio Department of Natural Resources, Division of Soil and Water Conservation. This software allowed graphical representation of cross-section data while providing numerical output of parameters such as total cross-section area, deposition, and scour. Figure 4 shows the depositional and scouring changes of Mays channel cross number 21.

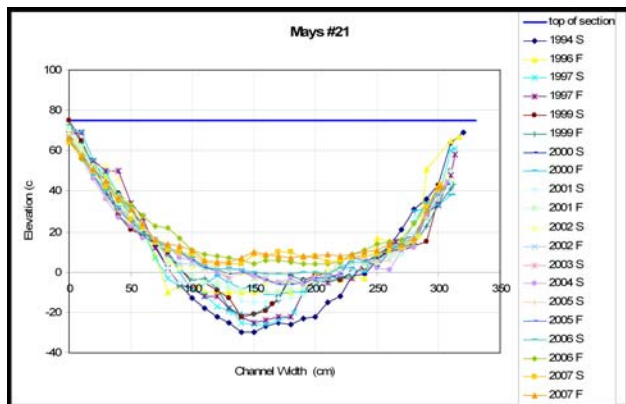


Figure 4. Diagram of channel morphological changes over time (1994-2007) using a single

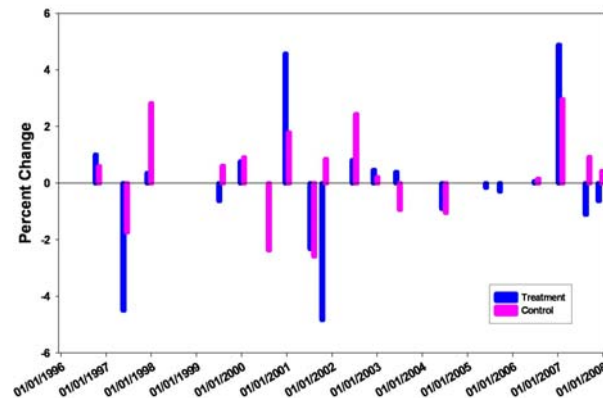


Figure 5. The comparative change in cross sectional area (1994-2007) by percent.

Analysis of the cross-sectional data sets showed no significant difference (p-value = 0.5755) in changes of channel morphology. However, there does appear to be some interesting trends in the data as displayed by the diagram in Figure 5.

The time series analysis demonstrates greater variation of change in cross-sectional areas in the treatment versus the control watershed. The treatment data tends to depict periodic, extreme soil movement events with intermixed periods of little to no soil movement. Alternatively, the control data shows more consistent soil movement with less extremes. This variation may be a product of the two channels being at different evolutionary or successional stages relative to each other.

The control channel (Jensen Watershed) can be described as being generally shallow, with less steep sides and a wider channel bottom. The treatment channel (Mays Watershed) can be characterized as being deeper and v-shaped with multiple headcuts found along its length. The treatment channel also tends to support longer periods of flow throughout a greater expanse of its length than the control. The control channel also appears to be influenced more by side-hill erosion processes as demonstrated by channel cross-sections being completely silted in due to side-hill sediment movement.

By acknowledging these inherent differences we may expect potentially different channel forming processes within each drainage. Long term monitoring questions yet to be answered include how ephemeral channel processes work following vegetation treatments, and how recovery periods associated with vegetative treatments may differ based on channel morphology, associated vegetative conditions and hydrologic processes.

Management Implications

A healthy, functioning watershed is one that captures, stores and safely releases the precipitation that is delivered to the site. Land management decisions should include looking for ways to increase opportunities for precipitation to infiltrate into the soil profile (vegetation management), moving excess moisture into sub-surface storage and ground water, slowly releasing that water to minimize the risk of soil loss and channel bank and bed instability (Fisher et al. 2008). Hibbert (1983) and others have suggested that there would be no water yield increase as a result of vegetation manipulation (juniper cutting) in precipitation zones where annual precipitation was less than 4300 mm (17 inches). Any change to the water budget would only yield an increase in soil moisture, improving herbaceous vegetative production.

The 30-year average annual precipitation at Barnes Station (USGS weather station) located approximately 10 miles east of the study site is 3492 mm (13.75 inches). Precipitation over the last 4 years on the study site has ranged from 2781 mm (10.95 in., 80 percent of average) to 4491 mm (17.68 in., 129 percent of normal). Both the high and low precipitation years occurred during the post-treatment phase of the study.

A review of the data collected over the course of the last 13 years indicated that the cutting of post-European aged juniper has changed the water balance equation. Analysis of the first two years following treatment has shown that spring flow, ground water and soil moisture have all increased when compared to pre-treatment levels. Comparisons of ephemeral channel flows did not show as clear a trend (data not presented here). Ephemeral channels tend to be more influent in relation to the ground water, contributing to ground water rather than ground water contributing to channel flow.

In the uplands, management implications suggest that with juniper removal, herbaceous vegetation can create a more uniform ground cover across the hillslope. Reduced bare ground results in increased infiltration opportunity and decreased soil erosion. Improved hydrologic function of the uplands can maintain site stability and fertility.

Within the riparian area, management implications point to the opportunity to increase spring flow for livestock, wildlife and domestic use along with some mitigation of water diversion. Late season low flows limit land management alternatives. Increasing flows by cutting juniper could partially offset this limitation. Changes in ground water may have downstream impacts, delaying the time water is moved through the system and by adding to channel or perennial stream flow downslope.

By combining the upland and riparian benefits of juniper removal, the system will begin to move toward a watershed that is functional in its ability to capture, store and safely release water while providing a site that is productive and capable of being managed for sustainable use.

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A Positive Spin-Off of the Paired Study:

Tim Deboodt, PhD

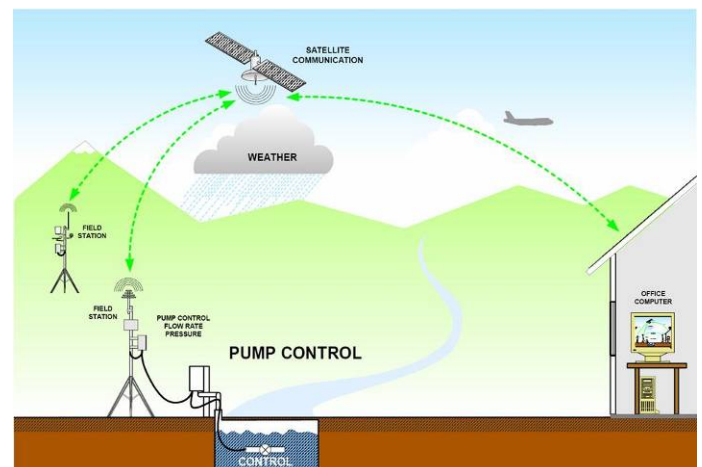
Why the need for remote monitoring systems?

- Water developments in the intermountain west provide one of the most effective means of managing livestock distribution and forage utilization.
- Ranches are often large, covering many square miles, involving multiple herds.
- Ranchers are challenged with assuring water is available to livestock while trying to manage multiple activities each day.
- Water checks can involve driving 20 to 100 miles per trip.
- Labor resources, cost of fuel, vehicle maintenance and time require the rancher to make choices about daily workloads and priorities.

Challenge

How to reliably monitor stock water at a reasonable cost

Remote sensing provides a way to monitor stock water supplies. Remote sensing involves the collection of information using sensors and data loggers. Once the information is collected, the information has to be transferred in a manner which is usable to the rancher. Communication technology available today includes cell phones, spread spectrum radio (ground based radio) and satellite. Once the information is transferred, it must be displayed so that the rancher can use it. Internet services, spreadsheets and graphing opportunities are methods to display data.



System Choices and Features

Ground-based radio

- Large number of stations (monitoring sites)
- Radio communications require line of sight
- Repeater stations can be used as field station
- Base station can access up to 150 field stations
- Large variety of sensors
- Real time access and sensor control
- Customizable email and telephone alarms for low water level
- No annual charges Satellite
- Field station is stand alone—doesn't need a base station
- Large variety of sensors
- Doesn't need line of sight – install anywhere
- Customizable email and telephone alarms for low water level
- Delayed access and sensor control
- Annual satellite and web server fees system tested¹ included:

In the summer and fall of 2008 a demonstration of this technology was conducted at two locations. The system tested¹ included:



- Solar panel/solar controller
- MINI-SAT™ with satellite communication
- Level-watch water level sensor
- Cost—\$1800.00 plus shipping¹
- Estimated annual subscription = \$80.00
- Supplies for installation = \$50.00

Cost savings reported by one user in the first year = \$756.00 in fuel, \$2016.00 in labor and \$800.00 in maintenance of the water system for a total savings of \$3572.00. ¹Cost reflects 2008 purchase price.

Remote livestock water monitoring systems are:

- Reliable
- Portable
- Expandable
- Cost Effective
- Accurate
- Easy to install

Partners in this project were:

Agsys Northwest, Mike Omeg/Mike Land, 912 E 10th St., The Dalles, OR., 97058, 541-288-7253, mjland@gorge.net
Automata Inc., Lenny Feuer, 104 New Mohawk Rd. Ste A, Nevada City, CA 95959-3261, 800-994-0380,
automata@automata-inc.com

¹To simplify terminology, trade names of products are listed here. However, no endorsement is intended nor criticism implied of products not mentioned. Elements of this system are available from a variety of manufacturers.

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(Editor's note: The obvious benefit of research such as the Paired Watersheds is clear. What is less often recognized is that technologies and concepts developed in the course of one project might have rational value elsewhere. In this short note, Dr. Deboodt shares how some of the satellite based data collection developed on the paired watersheds made a useful and economically valuable contribution to a different aspect of management.)

Theses generated from the Paired Watershed Study:

Fisher, Michael. 1996. Paired Watershed Ecological Analysis. MS Thesis. Department of Rangeland Resources. Oregon State University. Corvallis, OR. 180 numbered leaves.

Fisher, Michael P. 2004. Analysis of Hydrology and Ecology in Small, Paired Watersheds in a Juniper-Sagebrush Area of Central Oregon. Department of Rangeland Resources. Oregon State University. Corvallis, OR. 220 numbered leaves.

Deboodt, Timothy L. 2008. Watershed Response to Juniper Control. Department of Rangeland Ecology and Management. Oregon State University, Corvallis, OR. 140 numbered leaves.

Copies of theses are housed in Valley Library, Oregon State University, Corvallis, OR. 97331. Copies can be made available by contacting the library.

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