



**Final Report**  
**Project #: 01-3-3-18**

**Title:** Evaluating the effects of prescribed fire and fuels treatment on water quality and aquatic habitat

**Location:** Umatilla National Forest, northeastern Oregon and southeastern Washington

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This final report summarizes project findings, and proposed and accomplished work including deliverables, and technology transfer. A variety of materials from the study, including the original grant proposal, annual reports, and links to publications and archived dataset is available on the Umatilla National Forest web site: [www.fs.fed.us/r6/uma/nr/hydro/](http://www.fs.fed.us/r6/uma/nr/hydro/)

## Summary of Findings

Measured effects of prescribed fire and fuels treatments are small and/or non-detectable under normal weather and standard operating conditions:

- Without large storm events in the first three years after prescribed fire, measured erosion rates were very low and there were no significant differences in hillslope erosion between burned and unburned plots. The significant relationship between bare ground and erosion rates, however, demonstrated the role of soil cover in controlling surface erosion.
- The hillslope area contributing sediment to the erosion fences was very small, extending no more than a few meters upslope of the fence apron. For the most part, erosion resulted from bioturbation by small mammals and elk.
- In general, current riparian buffer design criteria (no ignition within riparian, only allowing fires to “back into” riparian areas) appear effective in preventing hillslope sediment from entering riparian areas and delivering to streams.

Spatial and temporal variability of hillslope erosion rates is related to and dominated by local environmental conditions:

- Background hillslope erosion rates varied significantly by aspect and were generally higher on south-facing slopes.
- Estimates of background hillslope erosion rates suggested that low amounts of sediment are delivered to valley floors within each catchment, as measured with the silt fences located in toe-slope positions.

- The Disturbed WEPP model (<http://forest.moscowfsl.wsu.edu/fswepp/>) over-predicted soil erosion for small erosion rates on hillslopes subjected to low-severity prescribed fire and under-predicted erosion rates on undisturbed hillslopes with heavy vegetative cover. Although the Disturbed WEPP results generally varied from the measured sediment yield results by about an order of magnitude, the trend of small predicted erosion rates agreed with the small amounts of sediment yield measured in the field.
- WEPP modeling results offered a calibration check on the ability of the Disturbed WEPP model to predict sediment yield, particularly at low erosion rates.

Complex response including spatially variable and lagged response times at the watershed-scale influences detection of treatment effects beyond the site scale:

- The Skookum paired watersheds provide 13 years of “background” spanning a period of variable weather conditions and significant forest mortality. Data on streamflow, water quality, and channel morphology, demonstrate high spatial and inter-annual variability related to these factors. Water yield, suspended sediment, and bedload showed high inter-annual variability, tracking both climate conditions and the change in forest vegetation. Large differences in unit area yields between catchments shows the influence of catchment characteristics (geology, storage processes) on waters and sediment yields.
- At the watershed scale, annual sediment yields were highly variable. Watershed sediment budgets showed that episodic erosion events most likely control sediment delivery to streams but that sediment storage in valley floors and subsequent removal via bank erosion influences annual sediment yields over the long term.
- Because sediment may be stored on valley floors for long periods of time, continued erosion of stored sediment may maintain elevated sediment loads in streams, even when little erosion is occurring on upland sites.
- Hillslope and watershed-scale erosion patterns highlight the influence of episodic hillslope erosion events, sediment storage on floodplains, minor amounts channel erosion, and effects on watershed-scale sediment budgets.
- Prescribed fire and fuels treatments in uplands implemented under normal operating conditions are unlikely to be measurable, or detectable in tributaries because effects are small and well with the range of variability.

Implementing prescribed fire and fuels treatments in complex fuel types and controversial settings continues to be a challenge especially in landscapes which support TES and/or provide municipal water supply.

- The Mill Creek watershed, identified in our original study plan for intensive study, was dropped because treatments were not likely within the timeframe of our study. Active treatment within this municipal watershed continues to be highly controversial.

- Treatment of the Skookum project, planned for 2003, was deferred because of changed fuel conditions and overall Forest priorities: increased fuel load, outdated NEPA, complex treatment, increased cost and risk, and lower Forest priority (non WUI).
- Results validate the design of treatments for no effect to aquatics under “normal” weather conditions. Avoiding active treatment within riparian areas may, over the short term, prevent direct effects of sedimentation to streams but riparian conditions, including fuel loading, may or may not be meeting desired conditions at the project or landscape scale.
- Research based on Forest-level project plans faces continued uncertainty in terms of the likelihood of projects being implemented, yet remains dependent on Forest projects for opportunities to perform “live” experiments.

## Summary of Accomplishments

<b>Proposed</b>	<b>Accomplished/Status</b>
<b>Goals:</b>	
“to improve existing predictive models so that the impact of fuel treatments and prescribed fire on water quality can be evaluated”	Work was completed under partnership with RMRS consisting of WEPP analysis comparing measured and modeled data on study plots. Data collected by this project have been added to the RMRS dataset and will be used to calibrate the WEPP model for relevant applications for other users.
“to provide relevant data to guide management choices when making trade-offs between the short-term risks of active restoration strategies versus the potential, but poorly understood long-term risks to stream habitat posed by passive management strategies, especially where threatened or endangered fishes are present”	Results are being used in project-level analysis: measured data on hillslope erosion rates in the Blue Mountains adds significantly to the limited relevant data set on process rates and supports project-level analysis. Implementing treatments in complex fuel types continues to be a challenge especially in landscapes which support TES and/or municipal water supply.
<b>Deliverables:</b>	
<i>Pacific Northwest Research Station – General Technical Report: Changes in hillslope erosion rates, surface-sediment transport, sediment delivery to streams and net sediment yield from small watersheds in eastern Oregon following fuels treatments and prescribed burning.</i>	<i>manuscript in press:</i> Harris, R.M., Clifton, C.F., and Wondzell, S.M. In press. Hillslope erosion rates in areas with volcanic parent materials and the effects of prescribed fires in the Blue Mountains of eastern Oregon and Washington, USA. In: Furniss, M.J., Clifton, C.F., and Ronnenberg, K.L. (Eds.), <i>Advancing the Fundamental Sciences, Proceedings of a Conference for FS Earth Scientists</i> . 18-22 Oct. 2004. San Diego, CA. PNW-GTR-XXX, web link: <a href="http://www.fs.fed.us/pnw/publications/complete-list.shtml">http://www.fs.fed.us/pnw/publications/complete-list.shtml</a>

<p><i>Peer-Reviewed Publication:</i> Changes in erosion and stream sedimentation resulting from fuels treatments and prescribed burning in the Blue Mountains, Oregon.</p>	<p>Manuscript in preparation: Awaiting final data (to be collected fall 2006) before completing analysis and writing of final, peer-reviewed manuscript.</p>
<p><i>Peer-Reviewed Publication:</i> Influence of Fuel Treatments and Prescribed Burning on Channel Morphology and Fish Habitat</p>	<p>Incomplete: Project results are insufficient to directly address this topic with a peer-reviewed manuscript. Results described above in the PNW-GTR and the planned peer-reviewed manuscript, indicate that no effects to channel morphology or fish habitat resulted from the prescribed fire treatments examined in this study.</p>
<p><i>Administrative Reports:</i> Reports for Management summarizing effects of prescribed fire and fuels treatment on water quality and aquatic habitat.</p>	<p>Incomplete to date: planned fall-winter 2006, pending final samples from Lick study sites. Will incorporate results from WEPP validation work.</p>
<p><b><i>Technology transfer:</i></b></p>	
<p>presentations will be made at annual meetings of national and regional Scientific Associations with expected presentations at the following during the 3-yr duration of the study 1) American Geophysical Union; 2) Society for Ecological Restoration, Northwest Chapter; and 3) Oregon Chapter of the American Fisheries Association.</p>	<p>Incomplete to date: Awaiting final data (to be collected fall 2006) before completing analysis of final results. Once final results are available, they will be presented at scientific meetings, as planned.</p>
<p>presentations will be made at regional meetings and workshops held by the land management agencies, including the annual meeting of R6 Hydrologists and Fish Biologists</p>	<p>Harris, R.M., C. Clifton, and S.M. Wondzell. 2004. Evaluating the effects of prescribed fire and fuels treatment on water quality and aquatic habitat. Advancing the Fundamental Sciences Conference-A Conference for Forest Service Physical Scientists held October 18-22, 2004, in San Diego, CA.</p> <p>Wondzell, S. M., Clifton, C., and Harris, R. M. 2004. Preliminary results: Evaluating the effects of prescribed fire on hillslope erosion and sediment delivery to streams. Joint Fire Sciences Project, Principal Investigator Workshop, Phoenix, AZ.</p> <p>Harris, R.M., C. Clifton, and S.M. Wondzell. 2004. Evaluating the effects of prescribed fire on water quality and aquatic habitat. Poster presentation at the <i>Umatilla River Geology Workshop</i>, 14-15 October 2004, Pendleton, OR.</p>

	<p>Wondzell, S. M., Clifton, C., and Harris, R. M. 10 July 2003. Organized and led the <u>INLAS Annual Summer Field Trip</u> for a group of PNW Research Scientists, Oregon State Faculty, Umatilla NF Supervisor’s Office personnel, and Heppner Ranger District personnel. Topic: “<i>Fires, Fuels, Prescribed Fire Treatments, and Their Effects on Other Resources</i> “. Location: Skookum Experimental Watersheds and the Joint Fire Sciences Erosion Study</p> <p>Harris, R.M., C. Clifton, and S.M. Wondzell. 2003. Evaluating the effects of prescribed fire on water quality and aquatic habitat. Poster presentation at the <i>Walla Walla Watershed Science and Restoration Conference</i>. 12 February 2003. WallaWalla, WA.</p> <p>Harris, R.M., C. Clifton, and S.M. Wondzell. 2003. Evaluating the effects of prescribed fire on water quality and aquatic habitat. Oral presentation at the at the Region 6 Fish/Water program manager’s meeting Eugene, OR.</p> <p>Harris, R.M., C. Clifton, and S.M. Wondzell. 2002. Evaluating the effects of prescribed fire on water quality and aquatic habitat. Poster presentation at the <i>Watersheds Across Boundaries: Science, Sustainability, Security</i> conference. Bi-annual meeting of the Watershed Management Council, Stevenson, WA.</p>
<p>Results will be used to reparameterize existing sediment yield prediction models (e.g. R1/R4 sediment yield model) that is currently in use by the National Forests of central and eastern Oregon.</p>	<p>Collaboration with the RMRS to perform a WEPP validation provided a check on the ability of the Disturbed WEPP model to predict low severity fire erosion and sediment yield, particularly at very low erosion rates. Work is complete and results will be incorporated into future reports and publications (Robichaud, P. and Stayton, P. “Disturbed WEPP Hillslope Erosion and Prescribed Fire Project” May, 2006, administrative report on file, Umatilla National Forest).</p>

<p>Data will be available to researchers and managers upon request, and at the end of the project, data will be archived and freely available via the World Wide Web (2004)</p>	<p>Hillslope erosion data were provided to RMRS researchers for calibration and refinement of WEPP erosion model.</p> <p>Project data sets are being archived on the Forest Science Databank (FSDB) a long term data repository and information management system. The FSDB includes active and legacy data sets (metadata and databases) established in compliance with national data standards.</p> <p><a href="http://www.fsl.orst.edu/lter/data.cfm?topnav=8">http://www.fsl.orst.edu/lter/data.cfm?topnav=8</a></p>
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## Management Applications

- This study responded to a specific task “Filling Gaps in Local Knowledge”. Study results are being used in project-level design, NEPA effects analysis, and ongoing monitoring programs. For example, in a recent fire salvage EIS, study results supported WEPP modeling analysis of effects of salvage logging on hillslope erosion rates predicted after wildfire, in comparison with prescribed burning and fuels treatments. Measured data on hillslope erosion rates from JFSP-funded research plots allowed a direct check of observed and expected rates of erosion after wildfire disturbance in comparison to management activities.
- Fuels treatment plans will continue to rely on combinations of prescribed burning and mechanical methods to address complex fuel management needs. Data from the Lick project provides side by side comparison of various treatment combinations.
- Results validate local project design criteria for riparian protection and challenge assumptions about prescribed fire and fuels treatment objectives in these sensitive and high-value areas.

## Ongoing and future work

- Complete 2<sup>nd</sup> year of erosion plot measurement at Lick study sites (spring samples are being analyzed now), process samples, analyze data, update Forest Science databank, archive data (<http://www.fsl.orst.edu/lter/data.cfm?topnav=8>), and complete manuscripts reporting final results of the study.
- Present results from final Lick project sampling and WEPP calibration in poster paper at the Watershed Management Council Biannual Workshop, “*Community Action and Innovation for Watershed Sustainability*” Walla Walla, WA (October, 2006).

- Complete manager’s summary “technical note”, fall/winter 2006 (Umatilla National Forest).
- \$10,000 in FY2006 Station Director’s Office – Contingency Funds have been made available to S. M. Wondzell from the Pacific Northwest Research Station to conduct a  $^{137}\text{Cs}$  isotope study of longer-term erosion rates in the Blue Mountains. This will fund a pilot-scale study, and will help provide a longer-term estimate of hillslope erosion rates to supplement data collect under this JFSP-funded project.

### Project Location – Region 6 National Forests/Ranger Districts

