EMC-2017-006 (1/2): Tradeoffs among riparian buffer zones, fire hazard, and species composition in the Sierra Nevada

October 2017

Background and justification

As the understanding of the ecological role that fire plays in sustaining Sierra Nevada forest structure and composition has grown through scientific investigation, new regulations have been developed to address the interaction of forest management and fire behavior on private lands. Examples include post-harvest slash mitigation requirements (e.g. 14 CCR 937.2, 957.2) and the development of fire hazard reduction exemptions (e.g. 14 CCR 1038(c)). These regulations, which include new operational restrictions but also new planning choices, presumably lead to an overall positive benefit of lower fire severity across the landscape. Because fires that are low in severity and result in small patch sizes are more in line with the natural disturbance regime (e.g. Stevens et al. 2016), the regulations that reduce high severity fire effects related to forest operations presumably bring along a host of other ecosystem values when fires do occur.

In Watercourse and Lake Protection Zones (WLPZ's) surrounding riparian forests of the Sierra Nevada, this same type of iterative improvement of regulations and choices leading to overall ecosystem health improvements on private lands has not occurred. Cumulative forest acreage within WLPZs can be significant. For example, 7% of Blodgett Forest Research Station is within Class I or II WLPZs. Because buffers extend to minimum distances from watercourse transition lines, WLPZs include both riparian vegetation as well as mixed conifer compositions that are representative of drier uphill sites. The protection of riparian forest values such as water quality, water yield, aquatic habitat, and riparian vegetation is a critical responsibility of the California Forest Practice Rules because these values are widely recognized as having high ecological importance at large, cumulative scales (Malanson 1993). Thus a cautious approach to forest management activity in WLPZ areas is justified. As with upland forests, however, adjustments in management that incorporate knowledge of the natural disturbance regime and that lowers risks of emerging stressors are eventually needed to improve long-term sustainability of public values.

It is known that pre-suppression disturbance regimes included frequent, albeit more variable, fires in and adjacent to riparian areas throughout dry forests in the western US (Agee 1998; Dwier and Kauffmann 2003; Everett et al. 2003; Pettit and Naiman 2007; Skinner 2003; Van De Water 2010). Despite the importance of fire from the top to bottom of watersheds, options for feasibly mimicking fire-maintained structures in Sierra Nevada riparian areas are extremely limited on both federal (e.g. USDA 2004) and private lands, where options for integrating the use of both fire (14 CCR 937.3, 957.3) and heavy equipment (14 CCR 916.4(d), 936.4(d), 956.4(d)) into operations are limited. Although active riparian restoration operations are possible via in lieu practices and explaining and justifying departures from standard rules, such actions are in practice very rare. On federal lands, some have suggested that riparian areas could be restored with net-cost, low-impact treatments paid with net-revenue timber harvests that occur in upland forests (North et al. 2009). But the persistently growing backlog of untreated forests (North et al. 2012) demonstrates the difficultly in

sustaining net-cost treatments. Relying on net-cost treatments is likely an even bigger challenge on private lands. The cumulative result of these factors is that riparian areas have become "no-touch" zones. In these zones, there is a continually widening departure from the natural disturbance regime and a depletion of the fire-associated structures and species compositions within the buffers intended to protect them. Thus, while a fundamental intent of the CA Forest Practice Regulations is to avoid significant adverse cumulative impacts to the beneficial functions of riparian zones (14 CCR 916,936,956), there is an unintended risk of adverse impacts from, as Berlik et al. (2002) put it, an "illusion of preservation" occurring at the watershed scale.

Objectives and scope

The objective of this project is to establish a network of locations that will be maintained as long-term study sites, periodically providing information relevant to policy and management for decades. This model, which requires outside funding but also significant landowner commitments, has worked on UC Center for Forestry forests to evaluate alternative management practices' impacts on various responses (e.g. fire hazard: Stephens and Moghaddas 2005; species diversity: Battles et al. 2001; timber productivity: York et al. 2015). Results from these various studies are integrated into ongoing outreach programs such as legislature tours, professional workshops, and NGO meetings. We want to expand this management-research-outreach model by evaluating the effectiveness of existing WLPZ regulations as well as other evidence-based alternatives that aim to sustain low fire severity and species diversity in and around riparian Sierra Nevada forests.

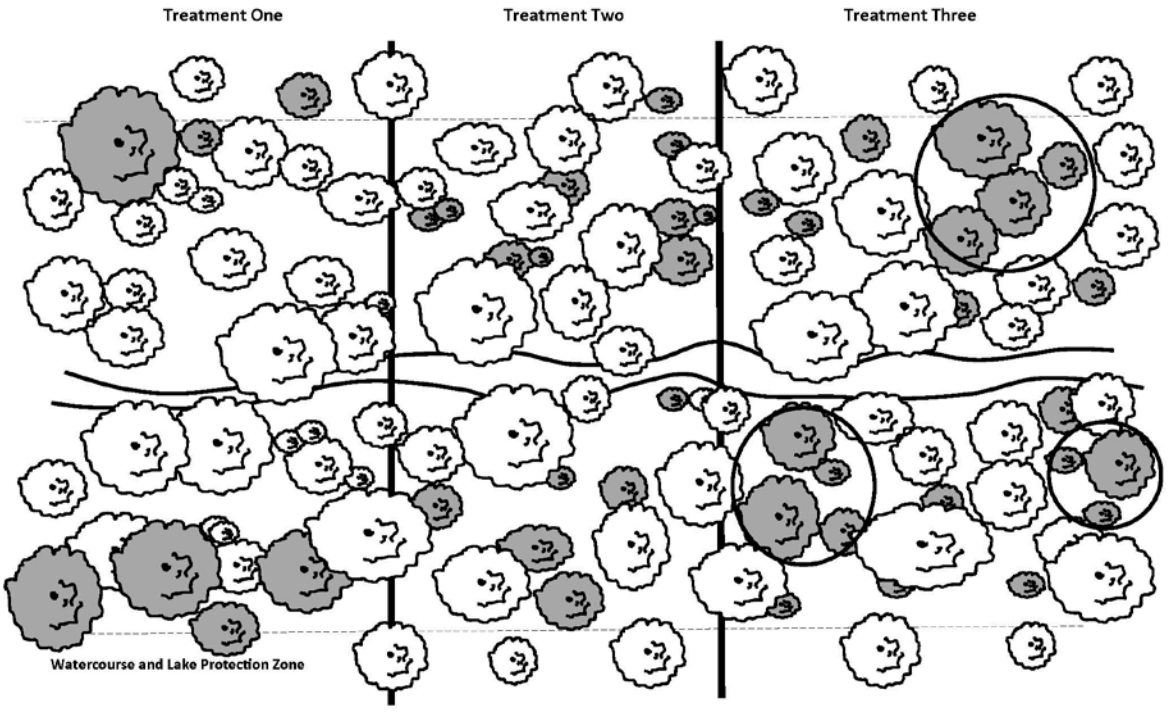
To reach this long-term goal, we are proposing a phased approach. In the short term (2 years), we propose to establish pilot sites at UC Blodgett Forest Research Station, with the mid-term (3 years) aim of expanding study locations to other research forests in Nevada County (UC Grouse Ridge Research Forest) and Shasta County (UC Marble Creek Research Forest). In the long-term (5 years), we aim to expand the study locations onto collaborators' lands at additional Sierra Nevada sites on private and state demonstration forest lands. Specifically, the treatments will be designed to reduce fire hazard and regenerate a diversity of species in Class I and Class II WLPZ areas. In order to evaluate the effectiveness of regulations experimentally, it will be necessary to have the capacity to conduct trials of treatments that are beyond the limitations of current regulations. **It will therefore be necessary to apply for the study sites to be designated as experimental forest land (PRC § 4526).** Specifically, the treatments (Figure 1) will be:

1. Control- no treatment will occur except for continued fire suppression. These will occur on sites that have been designated as reserves for over 40 years. Therefore there is no risk of compromising the integrity of the treatment (i.e. no harvests will occur).
2. Status quo- a selective removal of canopy trees, representing the status quo of no equipment entry and directional tree felling; during phase I, practicing foresters and CAL Fire forest practice inspectors will be interviewed to help define the typical nature of thinning that currently occurs in WLPZs (e.g. typical tree size selected for harvest, proximity to WLPZ edges, residual basal area, etc.).
3. Fire severity reduction- a thin from below to a target basal area or leaf area, followed by a fuel treatment that reduces surface fuel loading (pile and burn or mastication). Residual

stocking will be high enough to allow for density dependent mortality and hence input of coarse woody debris into riparian zones. **Heavy equipment will enter these treatment areas for both tree removal and to conduct fuel treatments.** Specific fuel treatment prescriptions will be guided by the most recent fire behavior models and treatment prioritization approaches developed by the UC Center for Fire Research and Outreach.

4. Fire severity reduction + small gap restoration- in addition to the fire severity reduction treatment described above, small canopy gaps ranging in size from 0.12 to 0.5 acres will be created. This will reflect the variable nature of fire effects on forest structure, and also new approaches to gap-based silviculture for regenerating pine species and reducing fire severity (York et al. 2011). **Heavy equipment will be allowed both in canopy gaps as well as in the matrix between canopy gaps.** Canopy gaps will be piled and burned, followed by experimental planting of all native conifer species. Hardwood species will be coppiced and monitored for survival and growth.

Figure 1. Visualization of three WLPZ treatments. Shaded trees represent those that will be removed. Circles in treatment three represent gap creations. Fuel treatments will occur in treatments two and three. Exact treatment sizes and locations will be developed during phase 1 to address spatial autocorrelations. Each treatment is expected to cover at least 4 acres and treatment locations will be randomized.



We plan to take advantage of the existing network of riparian monitoring plots that already exist on Class I watercourses at Blodgett. These have been maintained for the last 20 years and were most recently measured in 2014, thus providing a baseline measurement and saving the significant costs of acquiring baseline data. These plots, when augmented with additional plots on Class II

watercourses and other sampling efforts will be designed to measure the following response variables:

1. Light availability- measured with hemispherical photography at channels and within buffer zones of Class I and Class II streams
    a. Question addressed: Do thinning treatments designed to reduce fire severity and/or gap based silvicultural approaches (representing locally moderate severity effects) create enough resource availability for the regeneration of shade intolerant tree, shrub, and forb species?
2. Stream temperature- measured with direct temperature sensors and loggers in Class I streams
    a. Do fuel treatments and gap creations within WLPZs influence stream temperatures?
3. Understory vegetation and forest structure dynamics- measured with species surveys within existing permanent plots on class I streams
    a. How do mechanical disturbances in WLPZs influence understory vegetation composition?
    b. How do mechanical disturbances in WLPZs influence predicted fire behavior (i.e. Probability of torching).
4. Snag and Coarse Woody Debris dynamics- measured with in-stream transects that are already established in Class I WLPZs
    a. How do WLPZ mechanical treatments influence snag and CWD dynamics?
5. Planted seedling survival and recruitment- measured with systematic planting and tracking of seedlings in Class I and Class II WLPZs
    a. What is the effect of canopy opening size on the survival and growth of native conifer species?
6. Soil strength (and soil moisture as a co-variable), measured along transects perpendicular to Class I and Class II watercourses with cone penetrometers
    a. What is the effect of equipment use on soil compaction?

Treatment replication will occur at the stand level, with alternatives randomly applied to a minimum of 4 acre treatment areas. The pilot phase will include 16 acres of WLPZ areas, allowing for four replications of each treatment. Expansion to other WLPZ locations both at Blodgett and other forests will be informed by the initial results of the pilot phase (i.e. adjustments to treatment area, sampling design, etc.).

The scope of the project will initially be the central Sierra Nevada mixed conifer forests (i.e. forests representative of Blodgett Forest). Although we are referring to the first two years as the “pilot phase” because of the intention of expansion, there is enough replication and parsimonious design for the pilot phase to be relevant to a broad range of the mixed conifer forest. The existing outreach and demonstration program at Blodgett will be leveraged to extend results to professionals, stakeholders, and policy makers. As other study sites are incorporated, the entire mixed conifer forest should become represented. The network of UCB forest research stations alone represent significant latitudinal (from the Cascades to giant sequoia groves) and productivity (Site I to Site III) variability.

Critical questions and Relevant Forest Practice Regulations

The critical monitoring questions are those related to WLPZ function and wildfire hazard. The relevant regulations include Sections under Article 6 of the Forest Practice Rules, many of which are cited above.

Principal Investigator and Collaborators

The PI will be Robert York, RPF, Adjunct Associate Professor of Forestry and UCB Research Stations Manager.

Collaborators during the initial phase of the project will be:

Ariel Thomson, RPF, Assistant Resource Manager, Berkeley Forests

Scott Stephens, Professor of Fire Ecology, UC Berkeley

Bill Stewart, RPF, Forest Extension Specialist and Co-Director of UC Center for Forestry

Ken Somers, RPF, Manager, Grouse Ridge Research Forest

Ricky Satomi, MF, Forest Advisor, UC Extension

Kate Wilkin, PhD, Forest Advisor, UC Extension

Intern Forester, TBD

Seasonal Forest Resource Assistants (2), TBD

Other science and professional collaborators (i.e. scientists from other universities and foresters from host sites), to be identified as part of the objective of the pilot phase of the project

Anticipated Timeline

We are requesting funding to conduct the pilot phase at Blodgett Forest and to find partners for expansion. The pilot phase will require the installation of additional plots and the various pre-treatment measurements, followed by treatment installation and post-treatment measurements. This is anticipated to take 2 years. By the end of the 2-year pilot phase, we will be ready to expand the treatments to the other UCB research forests and will begin planning with other collaborators. Specifically, the timeline during the 2-year pilot phase is:

January 2018 – Certainty of funding by June 2018 is necessary to begin hiring procedures

June 2018 – Hire Intern Forester and Seasonal Assistants

June-July 2018 – Install plots and hemispherical photo stations in Class II WLPZs, flag treatment areas, install stream temperature sensors, measure pre-treatment soil strength.

July-September 2018 – Administer treatments with a contract operator, measure soil moisture immediately prior to operations

September 2018 – April 2019- Conduct post-harvest fuel treatments (pile and burn, mastication)

November 2018- Plant experimental gaps and measure light gradient

June 2019- Repeat the steps above for additional areas at Blodgett Forest

Summer/Fall 2019- Conduct post-treatment measurements of all response variables listed above

Winter 2019- Analyze data and interpret/report initial results

Winter 2019/2020- Plan for expansion of project to the southern, central, and northern Sierra Nevada sites. Seek additional funding and collaborators.

Funding

We are requesting funds to support a share of this project. Specifically, we are requesting funds for an Intern Forester (8 months) and two seasonal Forest Resource Assistants (3 months) for two years. All equipment and operator costs, project supervision, treatment installation, and write-ups of publications and reports will be in-kind. If invited to submit a final proposal, UCB sponsored projects will assist with detailed budget development and administration. The UCB indirect rate is 25%. Please note that guidelines for a final proposal submission that will include a final budget must be sent to the PI at least one month prior to its due date.

The anticipated amount of requested funds is $91,884 + $22,971 (indirect) = $114,855. The in-kind contribution is anticipated to be roughly equal to this amount. Specifically, the draft budget items are:

Item	Rate	Requested amount	In-kind contribution
Intern Forester (16 months)	$3450 / month	$55.200	
Forest Resource Assistants (12 months)	$2807 / month	$33,684	
Supplies (measuring equipment, film, and penetrometer shafts)		$3,000	
Baseline data, completed in 2014 (12 months)	$2807 / month		$33,684
Fuel treatments- 16 acres year 1; 32 acres year 2	$500 / acre		$24,000
Travel and housing (6 months of field season)	$1000 / month		$6,000
Project supervision and QAQC (2 months)	$8,300 / month		$16,600
Layout, contractor administration, and field supervision by RPF (3 months)	$7,000 / month		$21,000
Layout and planting of seedlings (2 acres)	$300 / acre		$600
Fire modeling, data analysis, report write-ups, outreach (2 months)	$8,300 / month		$16,600
Sub-total		$91,884	$118,484
Indirect cost	25%	$22,971	n/a
Total		$114,855	$118,484

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References

Agee, J.K., 1998. The landscape ecology of western forest fire regimes. Northwest Science 72: 24-34.

Battles, J.J., Shlisky, A.J., Barret, R.H., Heald, R.C., Allen-Diaz, B.H. 2001. The effects of forest management on plant species diversity in a Sierran conifer forest. Forest Ecology and Management 146: 211-222.

Berlik, M.M., Kittredge, D.B., Foster, D.R. 2002. The illusion of preservation: a global environmental argument for the local production of natural resources. Journal of Biogeography 29: 1557-1568.

Dwire, K.A., Kauffman, J.B., 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management 168: 71-74.

Everett, R., Schellhass, R., Ohlson, P., Spurbeck, D., Keenum, D., 2003. Continuity in fire disturbance between riparian and adjacent side slope Douglas-fir forests. Forest Ecology and Management 175: 31–47.

Malanson, G.P. 1993. Riparian landscapes. Cambridge University Press, Cambridge. 296 pp.

North, M., Stine, P., O'Hara, K., Zielinski, W., Stephens, S.L. 2009. An ecosystem management strategy for Sierra mixed-conifer forests. USDA For. Serv., PSW Gen. Tech. Rep. No. PSW-GTR-220, 49 pp.

North, M., Collins, B.M., Stephens, S.L. 2012. Using fire to increase the scale, benefits, and future maintenance of fuels treatments. Journal of Forestry 110: 392-401.

Pettit, N.E., Naiman, R.J., 2007. Fire in the riparian zone: characteristics and ecological consequences. Ecosystems 10: 673-687.

Stephens, S.L., Moghaddas, J.J. 2005. Silvicultural and reserve impacts on potential fire behavior and forest conservation: Twenty-five years of experience from Sierra Nevada mixed conifer forest. Biological Conservation: 125: 369-379.

USDA, 2004. Sierra Nevada Forest Plan Amendment Final Supplemental Environmental Impact Statement. US For. Serv., Pacific Southwest Region.

Van de Water, K., North, M. 2010. Fire history of coniferous riparian forests in the Sierra Nevada. Forest Ecology and Management 260: 384-395.

York et al. 2011. A gap-based approach for regenerating pine species and reducing surface fuel in multi-aged mixed conifer stands in the Sierra Nevada, California. Forestry 85: 203-213.

York, R.A. 2015. Large-tree removal in a mixed-conifer forest halves productivity and increases white fir. California Agriculture 69: 27-35.