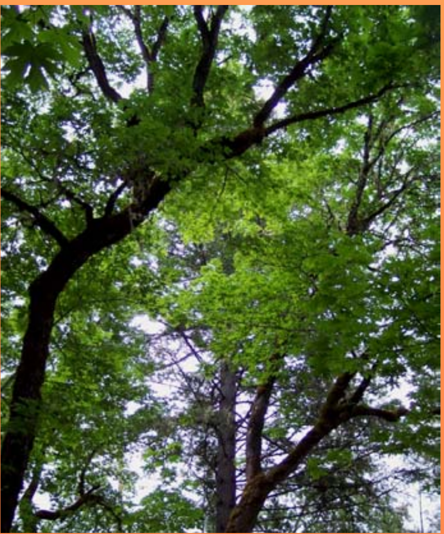


Riparian Fuel Treatments in Intermittent & Perennial Streams: Effectiveness and Ecological Effects


A **Decision Support Tool** that presents findings and management implications of a study in the Klamath Mountains Province of southwestern Oregon.



Version 1.2

Background

Riparian areas constitute a small portion of the landscape, yet they support the greatest diversity of both plant and animal species. As the interface between aquatic and terrestrial systems, riparian areas maintain ecological integrity at both landscape and local scales.

Klamath Mountains Province: The study context

This study was conducted in the Applegate and Middle Rogue River subbasins of the Rogue River watershed in southwestern Oregon. The Rogue River originates in the Oregon Cascades and drains through the Siskiyou Mountains of the Klamath Mountains Geologic Province.

The area is characterized by mild, wet winters and hot, dry summers. Precipitation, ranging from 66 to 118 cm, largely falls as rain from October to April, while shallow snowpacks can accumulate above 1,000 m from December to March. Historically, the region had a frequent, but low intensity fire regime; however, decades of fire suppression, logging and re-seeding have led to high fuel loadings and subsequent increased fire intensity.

The Applegate and Middle Rogue subbasins include a high percentage of federal land where there are ongoing and planned fuel treatment projects, and a high abundance of 'replicate' drainage basins suitable for studying the effects of fuel treatments.

Fire: Historically and now

Fire was historically an important, natural component of western riparian environments, and there is evidence that certain riparian corridors in the Klamath Mountains Province of southwestern Oregon burned with comparable frequencies to their associated upland areas. In spite of this evidence, fuel treatments are not implemented in most riparian areas of southwestern Oregon. Conventional management prescriptions maintain a buffer along streams to exclude riparian areas from fuel treatments because land managers have been reluctant to treat riparian areas, lacking knowledge of how fuel treatments may impact these important ecological areas.

Fire in the riparian areas

Relative to fire in upland forest, the relationship of fire to riparian areas remains largely understudied. Past studies in southwestern Oregon suggest that many mixed-conifer forest riparian areas associated with perennial and intermittent streams historically burned with similar frequencies and intensities as associated upland areas, and that fire played an important role in maintaining these areas.

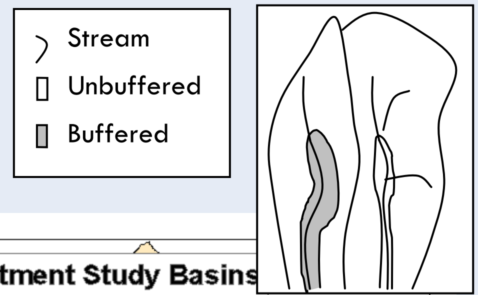
Riparian areas are typically characterized by cooler temperatures, higher soil moisture, higher humidity, and variation in vegetation. This riparian microclimate may also support greater biomass production and fuel loading. Under certain conditions humidity in the riparian microclimate may result in patchy burns of low intensity. While under very dry conditions, typical of summer in southwestern Oregon, these areas may now experience more intense fires than would have historically occurred.

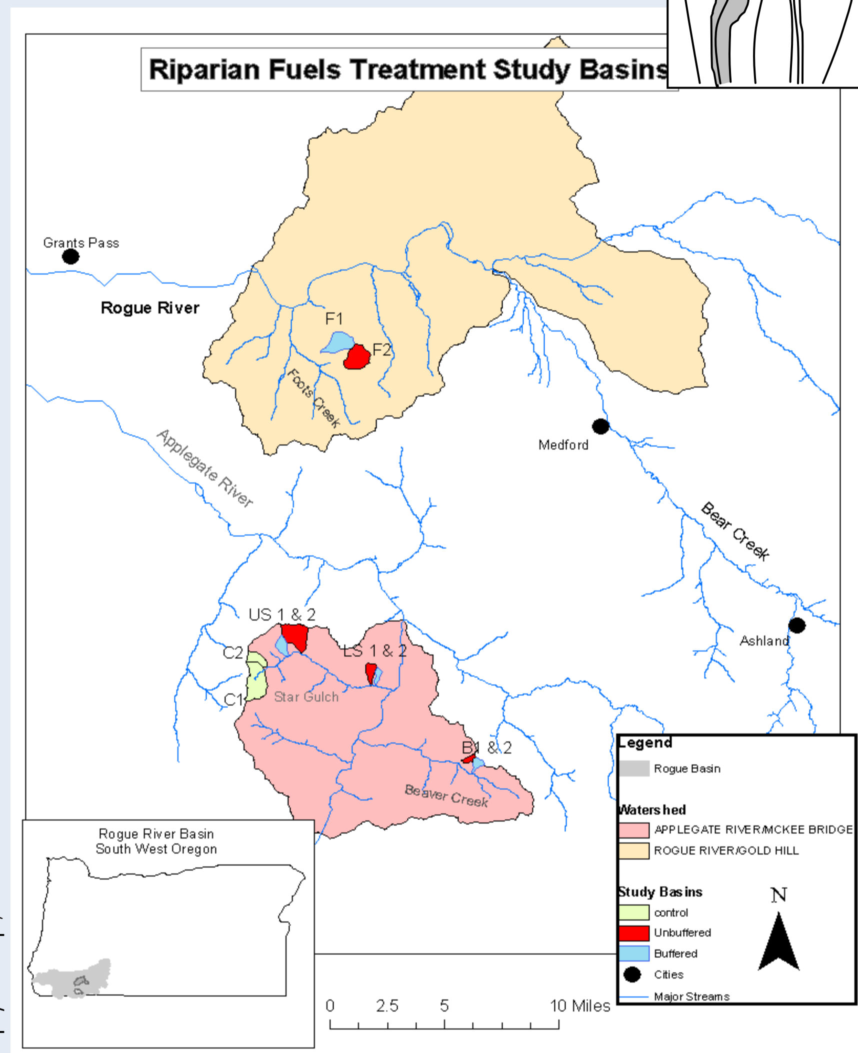
Fuel management in riparian areas

Extensive fuel treatments implemented by the Bureau of Land Management (BLM) have maintained no-cut buffer strips along riparian areas, due to the perception that these areas are sensitive to any type of anthropogenic disturbance. Conventional fuel treatments near natural water ways typically leave vegetative buffers (50' buffer, either side of perennial streams, and 25' buffer around intermittent streams) to reduce impacts to water quality and aquatic organisms. In some cases, fuels have accumulated to unnaturally high levels in buffered areas. These buffered corridors may act as "fuel wicks," reducing effectiveness of landscape scale fuel treatments. **Land managers lack needed data to inform decisions regarding inclusion of riparian areas in fuel reduction projects.**

Study design

Using a paired watershed approach, this study followed a basic Before and After Control Impact study design (BACI) to compare standard fuel treatments applied only to the uplands (buffered) with a treatment applied to both upland and riparian areas (unbuffered). In the case of two of the ecological effects studies, two additional control areas where not treatments occurred were also selected.





Map by Chris Volpe, BLM

Four paired watersheds were selected. Each paired watershed included two streams: one where streams were buffered and fuel treatments were applied to upland areas only (buffered treatments) and a second where fuel treatments were applied to both the riparian and upland areas (unbuffered treatments).

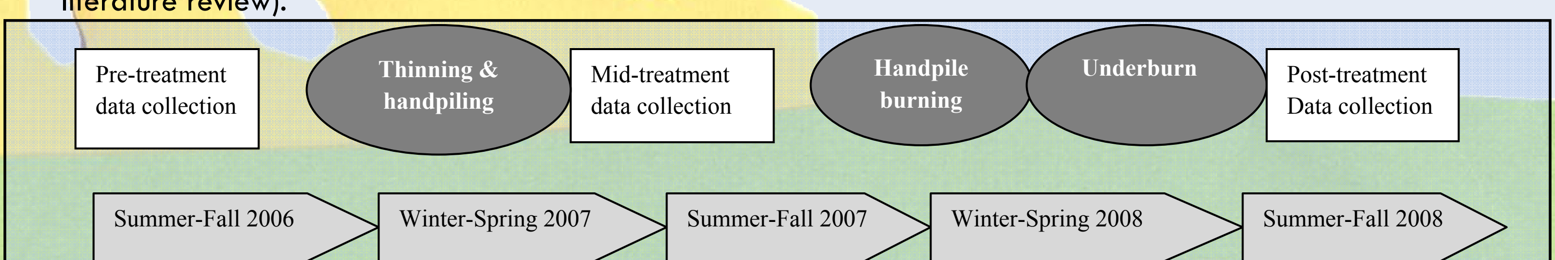
Fuel treatments

Fuel treatments included non-commercial thinning, handpiling and pile burning, followed by underburning. Thinning treatments targeted brushy species and small (<8 inch diameter) conifers and hardwoods. Overstory shade producing vegetation and riparian species (e.g. maple, alder, dogwood) were not directly targeted for thinning. Treatments were applied in two configurations. In buffered basins only uplands were treated and standard vegetative buffers were left untreated. Fire was not applied on the ground within the buffers, but was allowed to back down into the buffers from upland areas. In the unbuffered basins, all treatments were applied throughout the basin, including in riparian areas.

Measuring treatment effects

We used the following indicators to compare the effects of treatments in buffered and unbuffered basins:

- Fire behavior (composite burn index, crown fire potential)
- Vegetation (richness and cover),
- Hydrologic indicators (water quality and watershed yield),
- Aquatic macroinvertebrates (diversity and abundance),
- Birds (species richness and nesting success), and
- Amphibians (predicted effect based on a literature review).



This study occurred over a three year time frame. Pre-treatment data collection occurred during the summer of 2006. Thinning and handpiling treatments followed in fall and winter with mid-treatment data collected during the summer of 2007. During the subsequent fall, winter, and into spring 2008, the handpile burning and underburning treatments were completed. Post-treatment data were collected during the summer of 2008.

An adaptive management study

Decision Support Tools

Decision support tools present relevant and accurate information from the best available science in a useable format to aid land managers in making natural resource management decisions.

Our framework

Our DST links management challenges, science-based results, and wildlife and habitat conservation objectives.

Research questions

This three year study investigated the effectiveness of non-commercial fuel treatments (i.e., thin, handpile and burn, and underburn) inside riparian buffers. We present results that determine the effectiveness and ecological effects of the fuel treatments. Such fuel treatments are intended to reduce the threat of severe wildfire across the landscape and the impacts of severe fire on riparian ecosystem function and integrity. Our results inform decisions about the implementation of fuel prescriptions in southwestern Oregon riparian areas associated with perennial and intermittent streams.

Through an interdisciplinary approach to monitoring short-term effects of fuel treatments implemented in riparian areas we sought to answer the following three overarching questions within an adaptive management framework:

(1) Will reducing the fuel load in these riparian corridors significantly reduce the threat of wildfire across the landscape as measured through predictive fire behavior modeling?

(2) Can streams be treated without compromising riparian function as measured through the effects of treatments on vegetation and hydrologic indicators?

(3) Will biological diversity of riparian areas be maintained, lessened, or improved through fuel treatments as measured through effects on vegetation, macroinvertebrates, birds, and predicted effects on Amphibians?

Study partners

Through an on-going partnership between the Bureau of Land Management (BLM; www.blm.gov/or/districts/medford/index.php) and Klamath Bird Observatory (www.KlamathBird.org), research and monitoring efforts were implemented to measure the effectiveness and ecological effects of fuel reduction and prescribed fire in riparian areas associated with perennial and intermittent streams.

This research represents an interdisciplinary collaboration between the BLM's fire management team and a Joint Fire Science Program research team and serves as a model for designing, implementing, and monitoring the effects of fuel reduction projects within the adaptive management framework.

Summary of findings

Within these three over-arching questions, we found the following:


photo by Jena DeJuilio, BLM

Did the fuel treatments reduce the threat of wildfire? *(See pages 6-7)*
Unbuffered fuel treatments reintroduced low intensity fires, altered fuel models and crown characteristics and diminished predicted late season fire behavior within uplands and unbuffered riparian areas.


photo by Jena DeJuilio, BLM

What are the first order fire effects of the fuel treatments? *(See pages 8-9)*
Buffered areas remained mostly unburned. Unbuffered areas showed evidence of low to moderate severity fire within the riparian zone after underburns. Treatments resulted in a reduction of subcanopy and understory cover, as well as plant species richness, in the unbuffered areas as compared to the buffered areas. The negative affect to species richness that followed thinning treatments was no longer apparent after underburning.


photo by Dakota Otto, BLM

What are the effects of the fuel treatments on summer stream flow, water quality, stream side shade, summer water temperature, and substrate composition? *(See pages 10-11)*
Stream side shade and water temperature may potentially be affected by application of fuel treatments. These effects appear to be site specific. All other measured riparian and hydrological parameters remained relatively unchanged by both buffered and unbuffered treatments.


photo by Scott Miller, BLM/USU

What are the effects of the fuel treatments on macroinvertebrate communities relative to control basins? *(See pages 12-13)*
Macroinvertebrate assemblages did not vary between buffered and unbuffered areas. In fact, the treatments had no adverse impacts on macroinvertebrate assemblages on buffered and ubnbuffered basins.


photo by Jim Livaudais

What are the effects of the fuel treatments on bird species richness and nesting success?
(See pages 14-15)
Overall, we found no difference in bird richness and limited differences in nesting success between buffered and unbuffered basins. Reproductive success of ground and shrub nesting birds did differ, however, with lower nest success in unbuffered areas after handpile treatments and higher success in these areas after underburn treatments.


photo by Chris Brown, USGS

What are the effects of the fuel treatments on amphibians as predicted by a literature review?
(See pages 16-17)
Fuel treatments within riparian areas can negatively affect microclimate and habitat characteristics that are important for amphibians, however, in our study these affects were site specific and can be avoided in future riparian fuel reduction treatments by maintaining large coarse woody debris, shade, and existing sedimentation levels.

Fire Behavior

Why study fire behavior?

There are considerable differences in the effects of a fire contained to the surface (those that burn on the forest floor), versus those that transition to a passive (torching) or active (running) crown fire. Fuel management activities are intended to reduce the hazard of crown fires, increase the likelihood that a wildfire stays on the surface, and promote ecological resiliency in fire prone habitats. Monitoring the effectiveness of these treatments is an essential element of adaptive management.

Studying fire behavior

Using fire behavior models we compared the predicted fire behavior before and after fuel treatments in buffered and unbuffered basins. Fire behavior predictions were modeled under mid to late summer and early fall conditions when herbaceous species, low foliar moistures, and hot, dry and windy weather enhance the likelihood of intense fire behavior.

Predictive models consider weather conditions and topography along with:

Standardized fire behavior fuel model – characterized aspects of live and dead woody surface fuels and their associated fire behavior

Crown characteristics – amount and spatial arrangement of fuel (i.e., needles and small branches) within the forest canopy

Crown bulk density – cubic weight of needles and small branches making up a tree crown

Critical canopy base height – height where there is sufficient crown bulk density for a certain level of surface fire intensity to transition into the tree crowns

photo by Jena Dejuilio, BLM

Prescribed underburn moving through an unbuffered basin.

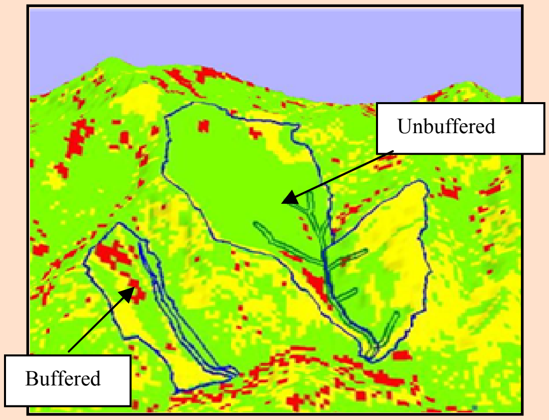
Findings

Passive crown fire was predicted for pretreatment conditions in both buffered and unbuffered basins. Treating fuels in the uplands provided protection to riparian areas from simulated wildfire advance. Once unencumbered fires entered riparian areas there was a marked difference in the modeled post treatment predicted fire type in buffered versus unbuffered areas. After fuel treatments in the unbuffered basins, predicted fire behavior diminished, resulting in a greater probability of surface fire. Critical crown base heights were raised as a result of thinning treatments, and fuel models were altered during prescribed burning. These changes to fuel models and crown characteristics did not occur in buffered riparian areas and, therefore, did not alter the predicted fire behavior.

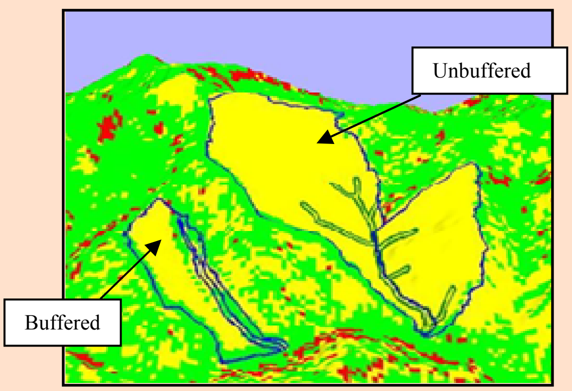
Management implications

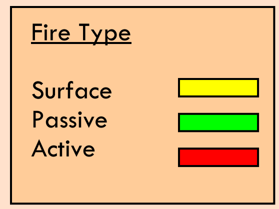
Riparian fuel treatments (unbuffered) appear to decrease the predicted intensity of wildland fires occurring in riparian areas. This reduction in fire intensity will likely translate to low burn severity and reduced potential negative impacts of wildfire on riparian areas. Further, we expect that a wildland fire in an unbuffered treatment area would be less likely to "wick" into uplands, or create other less manageable fire behavior.

Before treatments



After treatments





An example of the FlamMap fire behavior spatial output for the Upper Star Basins. *All fire behavior was modeled with FlamMap, FARSITE (www.fire.org) and Fuels Management Analyst Plus (www.fireps.com/fmanalyst3/)*

Repeat photos of an unbuffered riparian area during three years of the study.

Pre-treatment

After thinning

After handpile burning

Vegetation

Why study vegetation?

Complexity in vegetative diversity and structure is integral for maintaining and supporting the rich productivity associated with riparian ecosystems. While live and dead vegetation supply fuel for wildfires, they also provide habitat for aquatic and terrestrial wildlife.

Role of vegetation in riparian habitat

Riparian areas support high plant species richness and structural diversity. Vegetation performs many critical roles in riparian function including low stream temperatures, shade, nutrient inputs, habitat structure, water filtration and stream bank stabilization.

Role of fire in vegetation

Post-fire effects on riparian areas may include removal of vegetation, consumption of litter and duff, and tree mortality, potentially affecting several riparian functions. Many native plant species of the region are fire adapted and depend on periodic episodes of fire occurrence for nutrient cycling, regeneration and other ecological processes.

Studying vegetation and fire

Species richness and composition – the number and arrangement of species present

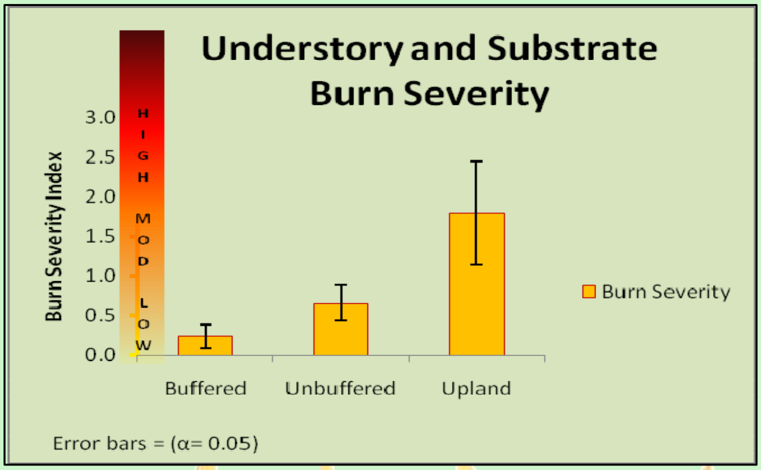
Vegetative life form cover – percent cover of herbs, shrubs, and trees

Surface fuels – amount of dead woody fuel on the forest floor

Environmental prescription window – the range of weather conditions (i.e., temperature, winds, relative humidity) which determine optimum and implementable prescribed fire operations. Low (moist) end of the window is likely to result in less intense fire behavior than the high (dry) end

Composite burn index – the severity and influence from post-fire effects to ecological communities and organisms, particularly soil, forest litter consumption, and vegetation scorch

Consumption and scorch – total or partial burning of litter, dead woody fuel, and vegetation



Mean burn severity of forest substrate and vegetation <16 ft (5m) in height. Error bars represent 95% confidence in the sample mean.

Findings

Riparian areas that carried fire during the underburn, including buffered areas that supported a backing fire, burned with low to moderate severity. Approximately 50% of unbuffered basins showed evidence of low to moderate intensity fire, resulting in a 43% reduction in total dead woody fuels. The majority of buffered streams (80%) remained unburned. Despite buffering from direct ignition, the backing fire carried into one buffered area and burned similarly to unbuffered areas, as a result of drier conditions during the underburn.

The reduction of species richness and subcanopy and understory cover was more pronounced in unbuffered areas. Species richness in unbuffered areas rebounded following prescribed burning, while there was a continual decline in buffered areas. In unbuffered areas changes in vegetative characteristics applied to all lifeforms (small trees, shrubs, herbs, grasses), whereas the effects were more concentrated in buffered areas, resulting in a greater reduction in herbaceous cover. This accounted for the continued reduction in species richness observed in buffered areas and may have resulted from intensified competition for water among herbaceous species in these un-thinned areas due to low water years in repeat sampling.

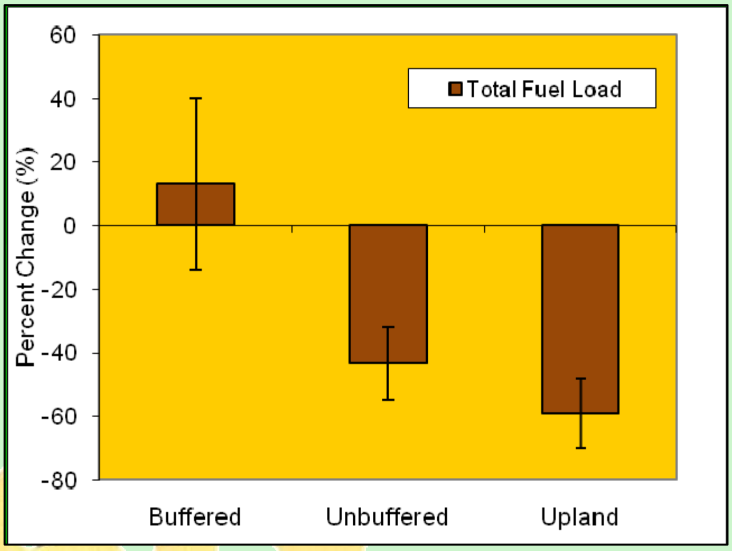
Management implications

Riparian and upland areas reach optimal environmental prescription windows at different times (seasonally), resulting in a narrow prescription window (dry) when fuels can be reduced in uplands and buffered riparian areas without direct treatments (thinning and ignition). Burning only under the high end of the prescription window poses higher political, resource, and operational risks and would also limit opportunities to implement prescribed fire in larger upland areas. Treating riparian areas appears to be an effective solution for reducing riparian and adjacent upland surface fuels even when applied during moist prescription windows.

Though fuel treatments also reduced live fuels in unbuffered areas, structurally varied vegetative cover was retained. Species richness was only negatively affected in the short-term. The variable effects to species composition and vegetative lifeform cover within unbuffered areas may promote future diversity in structure and composition, relative to buffered areas that did not experience the same range in structural and compositional effects.

photo by Jena DeJuilio, BLM

Herbaceous vegetation and lightly burned litter.



Average percent change in total dead woody fuel load among all treatment types. Error bars indicate sample standard error.

Significant reductions occurred in the abundance and frequency of mesic shrubs such as beaked hazelnut, Lewis' mock orange, and oceanspray in unbuffered areas. Prescriptions called for the retention of these species that are more commonly associated with moist habitats. In the winter and early spring, when thinning treatments occurred, these deciduous shrubs lack leaves to aid in identification. Future treatment prescriptions for fuel treatments intending to include riparian areas might need to pay closer attention to the unintended removal of mesic shrubs during thinning.

Hydrologic indicators

Why study hydrologic indicators?

The riparian and hydrologic indicators studied reflect the health of aquatic ecosystems. These indicators respond to disturbances of many types, including wildfire. The effects to these indicators by fuel treatments is lesser known, as few studies of this nature have been attempted previously.

Role of hydrologic indicators in riparian habitat

Riparian areas are critical transition zones between upland and aquatic habitats and support high species diversity of both terrestrial and aquatic organisms. Riparian vegetation is an essential component for maintaining healthy aquatic and riparian ecosystems.

Role of fire in hydrologic indicators

Reintroduction of prescribed fire under controlled conditions may increase the resiliency of riparian areas to wildfire, but it must not compromise certain riparian and hydrologic goals mandated by laws, policies and regulations. Specifically, federal land management activities are required to maintain/improve channel shade and to not increase sediment or temperature in stream channels that are critical to the health of aquatic habitats.

Studying hydrologic indicators and fire

Summer stream flow – volume of water discharged by the basins during the summer

Water quality – condition of the water as measured by the pH, Dissolved Oxygen, and Electrical Conductivity

Stream shade – amount of effective shade provided by riparian vegetation

Temperature – stream temperature during the summer warm period

Substrate – stream bed material, in particular the amount of fine sediment in the channel

Precipitation – amount of precipitation recorded during the water year preceding the study seasons

Air temperature – daily mean and maximum air temperatures recorded near the basins

photo by Chris Volpe, BLM

A field biologist uses a "check dam" to aid in measuring stream flow at a hydrology study site.

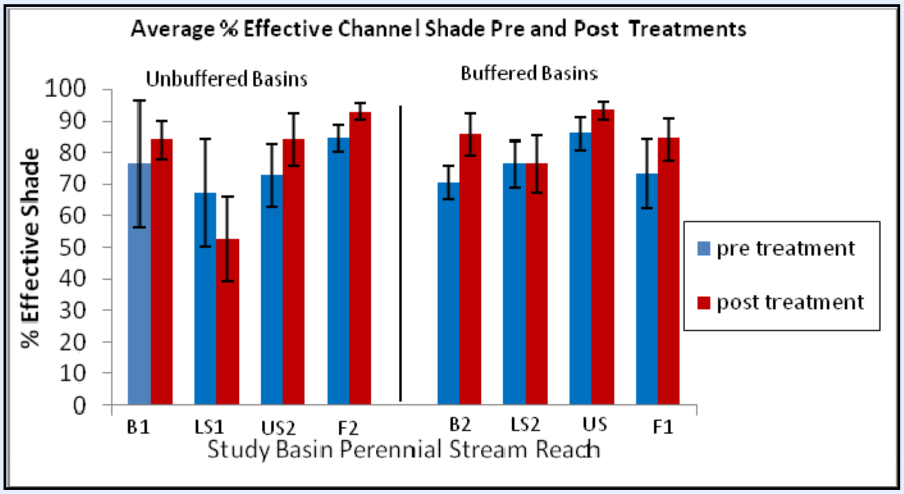
Findings

Summer stream flow, water quality, and substrate were unaffected by treatments as applied in both buffered and unbuffered basins. Some channel shade (14%) was lost in one of the unbuffered basins, as much of the shade producing vegetation consisted of young brushy species which were lost to cutting. Repeated post treatment shade surveys documented either static or modest increases in shade levels in all other study basins. The effects to stream temperature from the fuel treatments were somewhat inconclusive and likely were confounded by the variability of hydrological years during the study. However, there was some evidence that treatments in general may have increased warming rates and maximum temperatures, which were higher post treatment in most of the buffered and unbuffered basins as compared to the control basins. There was some evidence that stream temperature increases were less extreme in buffered basins.

Management implications

Overall results indicate that, with caution, fuel treatments can be incorporated into riparian areas without measurably affecting summer stream flow or water quality. Shade and stream temperature should be considered before applying fuel treatments in riparian areas. In riparian areas lacking a mature canopy in the overstory, treatment of riparian vegetation will likely reduce the amount of effective channel shade, resulting in increased water temperatures. Though not conclusive, there is some evidence that leaving riparian buffers lessened the apparent warming affect fuel treatments had on water temperature.

Substrate remained largely unchanged in most basins following treatments, though there was a modest increase in sand in one of the unbuffered basins, not conclusively related to the treatment itself. Management should consider the soils and topography in a basin, as there may be potential in highly erodible soils to increase sediment levels through removal of streamside vegetation, construction of fire lines, and other disturbance.



Average shade provided to each stream reach in the study basins pre and post fuel treatments. Notice shade was reduced only in LS1, an unbuffered basin.

Air temperature was similar, but the differences in precipitation pre and post treatment must be considered in this study. The pretreatment season (2006) was subject to 1.5 times the 10 year average amount of precipitation, while before the post treatment season (2008) less than 60% of the 2006 total was recorded. This resulted in many study streams going dry during the post treatment study season, reducing the number of data points and the confidence in interpretation of results. This particularly impacted the flow, water quality, and temperature components of this study.

Macroinvertebrates

Why study macroinvertebrates?

Aquatic macroinvertebrates are ubiquitous and exhibit graded responses to increasing stress levels. Thus, they integrate the cumulative direct (increased temperature, ash, nutrient loadings) and indirect (increased fine sediment loading, altered hydrologic regimes, reduced organic matter inputs) effects of fire on aquatic systems. For these reasons, we chose aquatic macroinvertebrates as the primary instream biologic response variable.

Role of macroinvertebrates in riparian habitat

We defined macroinvertebrates as aquatic invertebrates big enough to be seen with the naked eye. Presence of macroinvertebrate species provides information about water quality and stream productivity. They are a critical part of the freshwater food web, breaking down organic matter (leaves, detritus, algae) and, in turn, becoming food for fish and birds. Macroinvertebrates are important indicators of watershed condition. Activities that alter the type and cover of riparian vegetation (prescribed fire) can affect the structure and function of aquatic systems, which may be reflected by changes in macroinvertebrate communities.

Role of fire in macroinvertebrate ecology

Fire can adversely impact macroinvertebrate assemblages through either direct or indirect pathways. Direct effects include increased temperature, nutrients, and ash, and occur during or immediately post-fire. These impacts typically have little to no effect on macroinvertebrates except during high intensity fires. Indirect effects such as increased turbidity, fine sediment loading, and channel alteration have been shown to elicit the greatest macroinvertebrate responses.

Studying macros and fire

Macroinvertabrate samples were collected at true control sites, where no fuel treatment was undertaken, in addition to the paired buffered and unbuffered basins resulting in 12 sampling basins.

Species composition – species that are present

Assemblage – group of organisms collected at one site

Species richness – number of different species in a particular area

Species diversity – a measure of community structure defined by the relationship between the number of distinct taxa and their relative abundance

Relative abundance – number of organisms of one species relative to the total number of organisms of all species

photo by Scott Miller, BLM, USU

Mayfly
Ameletus

Findings

Fuel treatments in both buffered and unbuffered areas had little to no short-term effects on macroinvertebrate communities relative to control sites. Further, there was no difference between the buffered or unbuffered streams themselves. This result was consistent among measures of macroinvertebrate richness and relative abundance, in addition to assemblage composition. Low fire severity likely interacted with unseasonably dry conditions (see pg. 11) to minimize the occurrence of direct and indirect effects on macroinvertebrate assemblages. Within riparian treatments, burn severity ranged from low to moderate and burned areas were discontinuous, with large patches of unburned vegetation and minimal mortality of mature trees. In contrast, burn severity was greater in the adjacent upland, with burned areas being larger and more contiguous than in riparian areas. However, no significant runoff events occurred post-treatment as it might in a wetter year, minimizing the opportunity for hillslope erosion and instream fine sediment loading.

Management implications

Results from this study support a small but growing body of literature suggesting low to moderate intensity fires, both natural and prescribed, have little to no adverse impacts on macroinvertebrate assemblages. Thus, in this study, results did not differ between buffered or unbuffered treatments. However, given the unique responses of many systems and the myriad of factors influencing post-fire outcomes, the extrapolation of results from one geographic region to another is tenuous. Consequently, the use of fire in riparian areas as a management tool will need to be implemented with caution and evaluated on a case-by-case basis.

photo by Scott Miller, BLM, USU

Mayfly
Epeorus longimanus xerces

photo by Scott Miller, BLM, USU

Collecting samples from stream with surber net.

photo by Scott Miller, BLM, USU

Stonefly
Claassenia sabulosa xerces

photo by Scott Miller, BLM, USU

Salmonfly
Pteronarcys californica

Birds

Why study birds?

Birds provide an effective measure of ecosystem health. By studying a suite of species with varying habitat associations we can evaluate overall change in an ecosystem.

Role of birds in riparian habitat

Riparian areas support diverse bird communities and provide important habitats for both nesting and migrating birds. In southwestern Oregon mid-elevation riparian systems and the associated birds differ from other areas in western Oregon. Riparian and the adjacent upland habitats in this area can have similar vegetation composition and structure, and thus, similar bird communities.

Role of fire in bird ecology

Historically fire was an important component in maintaining richness and diversity of bird communities in this ecosystem. Specifically, fire maintains mixed-age class forests important for diverse bird communities and creates snags for nesting and foraging.

Studying birds and fire

Species richness – number of species present

Abundance – number of individuals of a species present

Nesting success – whether individuals successfully fledge young

Vegetation structure – amount of cover in the overstory, understory, herb, and ground strata

Predator abundance – number of avian predators present

Insect biomass – weight of available insects from sweep net surveys

photo by Jaime Stephens, KBO

Studying nesting success in addition to bird richness and abundance provides more information about how birds are responding to fuel reduction treatment.

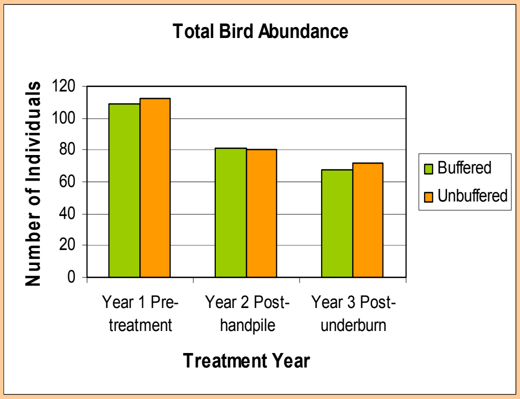
Findings

Overall, we found limited difference in bird richness and nesting success between buffered and unbuffered basins. Specifically, we found no variation in species richness. Of the five birds for which we studied nesting success, we found a difference between buffered and unbuffered treatments for the shrub nesting Black-headed Grosbeak and the ground nesting Oregon Junco. For both species, nesting success was lower in unbuffered basins after handpile treatments, compared with typical upland treatments with buffers. However, in the third year post-underburn, nesting success was greater in unbuffered compared with buffered basins. For both the Black-headed Grosbeak and the Oregon Junco, there was a trend of stable to increasing nesting success in both buffered and unbuffered basins after completion of all treatments. However, nesting success is annually variable, and trends are not necessarily evidence of a direct treatment effect. In an examination of how cover and food availability in the habitat might have related to these changes, we found the differences in vegetation cover between buffered and unbuffered streams changed over the course of the study for only the herb strata, which had greater cover on unbuffered basins in both years after treatment. Differences in insect biomass and predator abundance did not vary between buffered and unbuffered basins.

Management implications

Overall, results suggest that fuels reduction and prescribed burning in riparian areas as compared with typical upland treatments with buffers has a negligible effect on bird richness and nesting success. The opposite response of ground and shrub nesting birds post-handpile and post-underburn indicates that these two treatments have different, but minimal, near-term effects. Further, the results post-underburn suggest that nesting success was influenced by the variability of fire severity across treatments. The results for nesting success of the five species studied can be used as indicators for likely response of other birds that share their habitat preferences. Difference in nesting success was not apparent for tree nesting species, likely because the fuels reduction treatment as prescribed would not cause a change in overstory vegetation. The response of Black-headed Grosbeak nesting success is likely an indicator of the response of shrub nesting species in this system, which include Lazuli Bunting, Spotted Towhee, Chipping Sparrow and Hutton's Vireo. Similarly, the response of the Oregon Junco is indicative of ground nesting species, which include Spotted Towhee, Nashville Warbler, and Winter Wren. Near-term effects were likely related to changes in the shrub and herb vegetation strata. We suspect that the effect of treatment in upland areas in these unique systems where the riparian bird species composition mirrors that in upland areas might have washed out an effect of buffers on species abundance and richness.

The perennial and intermittent stream riparian systems within the mixed-conifer/broadleaf forest of the southwestern Oregon do not support riparian obligate (species that only inhabit riparian systems) bird species. Thus, the bird community will be affected by fuels reduction and prescribed burning in the upland areas, and an effect from a buffer may be slight in comparison. Bird abundance in the study area decreased after handpile, and underburn, irrespective of buffer.



Birds studied

Western Tanager

photo by Jim Livaudais

Tree nester

Cassin's Vireo

photo by Jaime Stephens, KBO

Tree nester

Oregon Junco

photo by Jim Livaudais

Ground nester

Pacific-slope Flycatcher

photo by Jim Livaudais

Tree nester

Black-headed Grosbeak

photo by Jim Livaudais

Shrub nester

Amphibians

Why study amphibians?

Amphibians associated with microclimates and habitats that also characterize streams and adjacent terrestrial habitats may be particularly vulnerable to fuel reduction. Treatment related disturbance is often accompanied by loss of woody debris, litter and shade, changes in suitable surface and stream bed substrates, and stream characteristics such as flow, temperature, and sedimentation.

Role of amphibians in riparian habitat

Perennial and intermittent stream riparian areas create unique microclimates of cool temperatures and moist conditions that are important for amphibians found in the Klamath Mountains Province.

Role of fire in amphibian ecology

Fuel build up in these riparian habitats may lead to unnaturally severe fires that result in loss of habitat, also resulting in increased stream and air temperatures, and increased sedimentation in streams. In the Klamath Mountains Province mixed severity fire regimes likely maintained habitat characteristics that are important for riparian and forest associated amphibians.

Studying amphibians and fire

Based on a literature review, we consider the possible impacts of unbuffered fuel treatments in riparian habitats on Siskiyou Mountain Salamander, Ensatina and Pacific Giant Salamander, and other associated amphibian species as measured by variables that are associated with these species. These variables, which were collected as part of the Fire Behavior, Vegetation and Hydrologic aspects of this study include:

Surface Fuels – amount of dead woody fuel on the forest floor

Woody Debris Cover – percent ground cover of dead woody debris

Stream Shade – amount of effective shade provided by riparian vegetation

Temperature – stream temperature during the summer warm period

Substrate – stream bed material, in particular the amount of fine sediment in the channel

Composite Burn Index – the severity and influence from post-fire effects

Findings

Preliminary survey work conducted in the study basins confirmed the occurrence of Siskiyou Mountain Salamander, Ensatina, and Pacific Giant Salamander. The literature suggests that, along with other amphibians, these species are associated with cool microclimates, vegetation shade, and dead woody debris, with Siskiyou Mountain Salamanders associated with talus slopes and Pacific Giant Salamander and other stream obligates benefitting from clean cool water and stream nutrient related productivity. In the Klamath Mountains Province, the habitat conditions that are important for these amphibian species generally occur on north-facing slopes at lower slope position, were the conditions were historically maintained by regularly occurring low to mixed severity wildfires.

Findings continued

Based on these amphibian species' associations with these habitat conditions we predict the short and long-term effects of unbuffered fuel treatments on Siskiyou Mountain Salamander, Ensatina, and Pacific Giant Salamander. Results from the botany and hydrologic aspects of this study suggest possible short-term negative impacts of fuel treatments on amphibians. Differences of such impacts between buffered and unbuffered treatments are limited and impacts that were greater in treated riparian areas appear to be site specific.

Burn severity in unbuffered areas was variable, with only 40% of the areas burned, most of which at low to moderate severity. In the unbuffered riparian areas greater than 10% cover of woody debris remained post treatment with 1.6 to 2.1 tons of large diameter dead fuel (>3 inchers) per hectare retained. This patchiness of burn and retained downed wood provided potential refugia for amphibians within the treatment area. Decreased shade and increased sedimentation was limited to one study basin and was associated with lack of canopy shade and fragile soil conditions measured before the treatments. The negative impacts predicted for amphibians based on these results, are therefore site specific.

A reduced probability of passive crown fire within the unbuffered treatments, and greater likelihood that a late summer fire would stay on the ground is consistent with long-term conservation objectives for amphibians. These include maintaining natural fire regimes and reducing the probability of uncharacteristically severe wildfires in riparian habitats that are critical for these species.

photo by Chris Brown, USGS

Ensatina

photo by James Bettaso, USFWS

Pacific Giant Salamander

Management implications

Unbuffered fuels treatments were effective in restoring the fire regime associated with these habitats by increasing the likelihood that surface fires will occur in the treatment areas, as opposed to crown fires, contributing to the long-term survival of amphibians in these areas. Treatments should be designed to maintain large coarse woody debris, shade, and existing sedimentation levels. Specifically, maintaining buffers in areas where tree canopy cover is low and fine substrates are exposed would benefit amphibians.

Conclusions

Study limitations

This study explored fuel treatments in perennial and intermittent riparian areas on a very short term basis. Climatic variations during the study were varied and likely influenced the results. The study was implemented in a limited set of watershed basins located in a diverse bioregion. In this study, as will be the case when implementing management in a replicated fashion across diverse landscapes, land ownership and treatment objectives influenced site selection. Given the unique responses of many systems and the myriad of factors influencing post-fire outcomes, the extrapolation of results from one geographic region to another is tenuous. Consequently, the use of fuel treatments in riparian areas as a management tool will need to be implemented with caution and evaluated on a case-by-case basis.

Aerial photo after typical fuel treatments that buffer riparian areas.

Answers to research questions

Results from this study, regarding the effectiveness and ecological effects of noncommercial fuel treatments (i.e., thin, handpile and burn, and underburn) inside riparian buffers are intended to inform management decision about fuel treatment prescriptions in and around perennial and intermittent riparian habitats.

Will reducing the fuel load in these riparian corridors significantly reduce the threat of wildfire across the landscape as measured through predictive fire modeling?

Unbuffered fuel treatments within small stream riparian habitats effectively reintroduced low severity fires to these areas, altered fuel models and crown characteristics, and diminished predicted late season fire behavior within riparian and adjacent upland areas. The unbuffered riparian fuel treatment reduced the probability that late summer wildfires would be carried through the forest crown and increased the likelihood that such fires would be contained to the forest floor. Unbuffered fuel treatments effectively reduced the hazard of uncharacteristically severe large scale wildfires in these areas, relative to the effects and scale associated with the historic fire regime.

Can streams be treated without compromising riparian function as measured through the effects of treatments on vegetation and hydrology?

Treatments resulted in a reduction of subcanopy and understory cover in the unbuffered riparian areas. Most hydrologic indicators remained relatively unchanged by both buffered and unbuffered treatments; however, our results suggest that stream side shade and water temperature may potentially be affected by application of fuel treatments, with some negative effects associated with treatments in specific riparian areas.

Will biological diversity of riparian areas be maintained, lessened, or improved through fuel treatments as measured through effects on vegetation, macroinvertebrates, amphibians, and birds?

Plant species richness appeared to be more negatively affected in unbuffered areas following the thinning treatments only, and after the underburn species richness was similar in buffered and unbuffered treatment areas. Macroinvertebrate assemblages did not vary between buffered and unbuffered areas. We also found no evidence that the effects of buffered and unbuffered treatments on bird species richness differed. Reproductive success of ground and shrub nesting birds differed, but with opposite response after handpile and underburn treatments; nest success was lower in unbuffered areas after handpile treatments and higher in unbuffered areas after the underburn. There was a trend of stable to increasing nesting success in both buffered and unbuffered basins for these species after completion of all treatments. Predicted negative affects of unbuffered treatments on amphibians were limited to site specific changes in microclimate and important habitat characteristics.

Summary of implications

Unbuffered riparian fuel treatments decreased the potential of severe wildfires and increased the likelihood that wildfire will be limited to the ground in treatment areas. Post treatment lower severity fire behavior predictions for unbuffered treatment areas suggest reduced operational complexity of wildland fire suppression activities and prescribed fire operations in these areas, relative to areas where riparian buffers remain untreated.

Temperature data suggests that riparian fuel treatments should not follow a "one-size-fits-all" prescription approach. Fuel treatment planning should consider potential short term increases in stream temperature as a result of the treatments. Though substrate remained largely unchanged by these riparian treatments management prescriptions should also consider soils and topography of a basin because removal of streamside vegetation, construction of fire lines, and other disturbance may cause stream sediment increases in erosion prone areas. Fuel treatment prescriptions might, therefore, consider limiting riparian treatments to areas with more overstory shade development and areas where soils are more stable. Such precautions would likely mitigate the site specific potential negative effects of unbuffered treatments on amphibians.

The vegetation data suggest that riparian fuel treatments might promote future diversity in riparian vegetation structure and composition. Difference in nesting success was not apparent for tree nesting species, likely because the fuels reduction treatments did not cause a change in overstory vegetation. An opposite response of ground and shrub nesting birds post-handpile and post-underburn indicates that these two treatments have different, but minimal, near-term effects, with nesting success influenced by the variability of fire severity across treatments. There was a trend of stable to increasing nesting success in both buffered and unbuffered treatments for the ground and shrub nesting species.

Our results suggest that riparian fuel treatments can provide for ecological integrity while meeting overall fuel reduction objectives. Results from this study, along with results from additional studies regarding the ecological effects of fuel treatments in this region, suggest that treatments should be designed to maintain heterogeneity in habitat structure at a landscape scale. The overall negative ecological effects of these treatments were limited based on our plant, hydrologic, bird and amphibian results, and some vegetation results suggest possible benefits.

The continued experimental implementation of riparian fuel treatments may be warranted, with sufficient attention to maintenance of landscape level heterogeneity, habitat structure, and site specific prescription considerations. When considering these management implications, it is important to recognize that this was a very short-term study and continued implementation of riparian fuel treatments should only occur in a replicated fashion, within an adaptive management framework that includes continued monitoring at these study sites as well as additional monitoring in association with new treatment implementation.

Adaptive Management

This study represents a model interdisciplinary approach to informing management decisions within an adaptive management framework. This project was completed with an exceptional level of cooperation between the BLM fuels work group, an interdisciplinary study team, BLM management, and interested public. Our research questions were developed through a collaborative process involving a high level of communication with land managers, assuring this project addressed a relevant, priority land management issue. As a result, the design of this project, implementation of treatments, and delivery of findings occurred through close cooperation among researchers and managers from start to end. Impressive coordination efforts were made to accommodate the study design needs within the context of fuel program objectives and public interest. Only through such a process can management be implemented in a replicated fashion, to allow for effectiveness and ecological monitoring to be integrated in a way that meets the true intent of adaptive management. This approach to adaptive management has resulted in part from a long-term partnership between a federal land management unit (Medford District BLM) and a non-government science-based organization (Klamath Bird Observatory) that is based on a mutual commitment to the implementation of short and long-term applied research and monitoring efforts. These efforts inform management practices that are in the interest of the public.

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This Decision Support Tool is based on the following reports and publications.

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