WORKSHOP ON THE MULTIPLE INFLUENCES OF RIPARIAN/STREAM ECOSYSTEMS ON FIRES IN WESTERN FOREST LANDSCAPES

SUMMARY REPORT

By

J. Boone Kauffman
Department of Fisheries and Wildlife
Oregon State University
Corvallis, OR 97331

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Stream Systems Technology Center
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INTRODUCTION

Riparian zones are among the most diverse, dynamic, and complex ecosystems on Earth. They are an interface between terrestrial and aquatic ecosystems. Their biotic composition, geomorphology, hydrology, microclimate, and fuel load, arrangement and chemistry are often much different than the surrounding uplands. As a result their fire regime (frequency, behavior, and biotic response) will differ. Riparian zones are often sites of increased natural disturbances (floods) while simultaneously functioning as buffers or barriers to other natural disturbances (i.e., natural fire breaks on the landscape).

Riparian zones are frequently used in fire control and use activities. This includes their use as sources of water for suppression, as safety zones, and as control points and fuel/fire breaks. It could be hypothesized that land use activities that diminish pools in streams would indirectly increase the probability of deleterious wildfires in the surrounding landscape. In spite of the biotic, resource, and human values, few studies have investigated the role that riparian areas play in affecting the behavior and spread of fire on western forest landscapes.

This report summarizes discussions from **The Workshop On Multiples Influences Of Riparian/Stream Ecosystems On Fires In Western Forest Landscapes** held at the Center for the Management of Information, University of Arizona, Tucson AZ, March 13-15, 2001. A diverse group of 30 federal scientists, fire and natural resource mangers, and university professors convened to discuss the functional role of riparian/stream zones as they affect fire on western forest landscapes (see appendix). Specific objectives of the workshop were to:

(1) Discuss the status of knowledge on the relationships between fire and riparian zones at spatial scales from the riparian area to the entire landscape;
(2) Discuss the role and values that riparian areas have for fire suppression and use;
(3) Discuss the effects of land and water management on fire regimes (fire frequency, behavior and severity within riparian zones;
(4) Discuss the effects of land and water management on the efficiency and capability of wildland fire control and use; and
(5) Identify knowledge gaps and needed research on these subjects.

To accomplish these objectives, the group participated in a series of verbal and electronic discussions over three days. The electronic discussions occurred using the GroupSystems® software. The technical facilitator for the discussions was Ana Lopez (CMI) and the workshop coordinator was J. Boone Kauffman (Oregon State University). Prior to the 2 days of discussions at the CMI, workshop participants spent a half-day of initial discussions and presentations (see workshop outline). Each afternoon/evening was spent in illuminating discussions amongst informal groups hiking through the magnificent Sonoran desert.

This report includes an executive summary and a summary of all discussions from the workshop. This is followed by the actual responses from the electronic portion of the workshop followed by appendices containing relevant documents generated from this workshop project. As the author of the report, I take full responsibility for the interpretations presented in the Executive Summary

and Summary of Responses. In these sections I endeavored to capture the sentiment of the workshop participants with as little bias as possible. All 30 participants statements are included in the section of actual responses to questions.

EXECUTIVE SUMMARY

A diverse group of 30 specialists in the fields of fire science, fire management, riparian ecology, hydrology and geomorphology met together for this workshop in Tucson, AZ on March 13-15, 2001.

The goals of the workshop were: (1) discuss the status of knowledge on the relationships between fire and riparian zones at spatial scales from the riparian area to the entire landscape; (2) discuss the role and values that riparian areas have for fire suppression and use; (3) discuss the effects of land and water management on fire regimes (fire frequency, behavior and severity within riparian zones; (4) discuss the effects of land and water management on the efficiency and capability of wildland fire control and use; and (5) identify knowledge gaps and needed research on these subjects.

A relevant summary is to present the final discussion of the Workshop where we derived the following 7 conclusions and polled the respondents for their level of agreement.

Final Truths
In this section, 7 conclusions that arose out of the discussions of the workshop were revisited to gage the degree of scientific agreement. Participants were asked to respond to the statements along a scale from strongly agree (5.00) to strongly disagree (1.00). If all respondents strongly agreed, the score would be a 5, and if all strongly disagreed, the score would be 1. Statements below are ordered based upon the degree of agreement (highest to lowest). The numbers before each statement are the means of the degree of agreement or disagreement of each statement.

4.58 Statement 1. While observations and intuitive knowledge would suggest that riparian zones are valuable for fire management and safety, we lack much quantification to address many needed resource management needs.

There was strong agreement that we need more quantitative information on the functional role of riparian zones as they affect fire patterns on the landscape.

4.38 Statement 2. Riparian areas influence fire behavior/fire properties. However, we also recognize that fire is one of the natural disturbances shaping riparian stream ecosystems. This suggests a total fire exclusion policy in these areas (riparian zones) is unwise and unnecessary.

It was recognized that the unique vegetation, microclimate, and topographic features of riparian zones function to affect fire behavior and spread. In many cases riparian zones have been effectively used in fire control and use.

In addition, it was recognized that fire is a natural disturbance process in riparian zones. As such, fire has a role in riparian zones and a total exclusion policy of fire is discouraged. It was recognized that other natural disturbances shape the composition and structure of riparian/stream ecosystems. In particular, floods or high flows are significant disturbances. Diversions which influence these processes also affect riparian structure and function. Alterations in structure and function could also affect the fire properties of the riparian zone.

4.23 Statement 3. Riparian zones and streams have some influence on the fire properties of forested landscapes

It was recognized that riparian zones play an important role affecting fire on the landscape. Under some conditions, riparian/stream ecosystems act as fire breaks halting the spread of wildland fires on the landscape. In other cases riparian zones have been used by fire suppression forces as safety zones, burn out points, and water sources. These uses likely have resulted in fires of smaller area.

4.15 Statement 4. Riparian areas influence fire in the landscape where fuel moisture, loadings, composition and topography are different. This is true where fuels and microclimate may be strong controlling factors during fires. Under extreme weather events, fire behavior is largely influenced by weather variables.

*Comparing riparian zones to uplands, the unique presence of surface water, composition, fuel moisture, fuel chemistry, microclimate, and topography combine to affect fire behavior. There is a limit to the degree in which riparian zones affect fire behavior. Under conditions where fuel moisture is low (near or below the moisture of extinction) and under severe fire weather conditions (high winds, low relative humidity and high temperatures) riparian zones may burn with similar behavior as the uplands***.**

4.08 Statement 5. The long-term effect of land and water management (exclusion, water diversions, etc) can affect the function of riparian zones on the landscape. Fuel loads, vegetation composition, geomorphology and hydrology can be affected such that fire intensity/behavior is much greater than historically occurred under a similar weather scenario ("The Perry model", Figure 1, Page 8).

Water diversions can alter riparian/stream ecosystems such that the fuels, species composition, and microclimate become similar to uplands. Under these scenarios the differences in fire behavior between riparian zones and uplands are diminished. This would diminish their value in fire control as firefighter safety zones, and control lines.

4.00 Statement 6. Access to water sources is important in fire management activities (prescribed and wildland fires). However, it is difficult to describe or generally state the value except that they are important for safety, containment, and mop up activities.

There are a number of cases where riparian zones have saved lives when used as a safety zone. Riparian zones are used as foundations of control lines and the starting point where backfires are lit to halt fire spread. Streams are frequently used as sources of water in fire suppression efforts. Quantification of these values is quite difficult because it is impossible to ascertain how fire behavior, severity and size would have differed with more (or less) water available. In addition the natural variation in riparian zones, landscapes, and in wildland fires limits formulation of universal generalizations.

3.58 Statement 7. Riparian zones/streams in steep first order high elevation streams have little, if any influence on fire behavior because of few differences in the upland vs. riparian environment.

There was less agreement in this statement than the others. In headwater streams, the species composition may not differ from that of the uplands. These are small areas that are limited in their effectiveness as a fire break (i.e. the fire can easily spot over the small riparian zone). However, some disagreement was expressed with this statement because of the unique position of headwaters on the landscape. In headwater streams topographic shade and microclimate are often different enough to slow the rate of fuel moisture loss relative to rates in more exposed uplands (especially south slopes and ridgelines). Differences in microclimate, fuel moisture content, and presence of surface water, could influence fire behavior even in small headwater streams under certain seasonal and weather conditions.

Finally, we conclude this Executive Summary with a conceptual model of the effects of land and water use on fire behavior in western forest landscapes. This conceptual model was derived during the Interdisciplinary Group discussions on March 14, 2001. This is called the "Perry model" in discussions referring to Dave Perry who first presented and described the model. The model describes how land and water use may affect fire behavior and severity on western landscapes. Each curve represents a different degree of departure from the historical range of variability for a given wildland landscape or watershed. The lowermost curve represents the response in fire behavior that an intact landscape may experience along a gradient of increasingly severe fire weather conditions (i.e. high temperature, high wind speeds, low relative humidity, extremely low levels of fuel moisture content, etc). Basically, under all fire weather conditions it is predicted that fire behavior extremes will be lower in intact ecosystems than perturbed landscapes. The greater the degree of departure from intact conditions as a result of land and water use activities, the greater the probability of extreme fire events. Perturbations that would result in curves such as this include fire exclusion in low severity regimes, logging, and the long-term effects of livestock grazing. In addition, water diversions and channel incision would increase fire severity on the landscape through a loss or decrease of the riparian zone width, alterations in microclimate, and the loss of surface water for suppression activities.

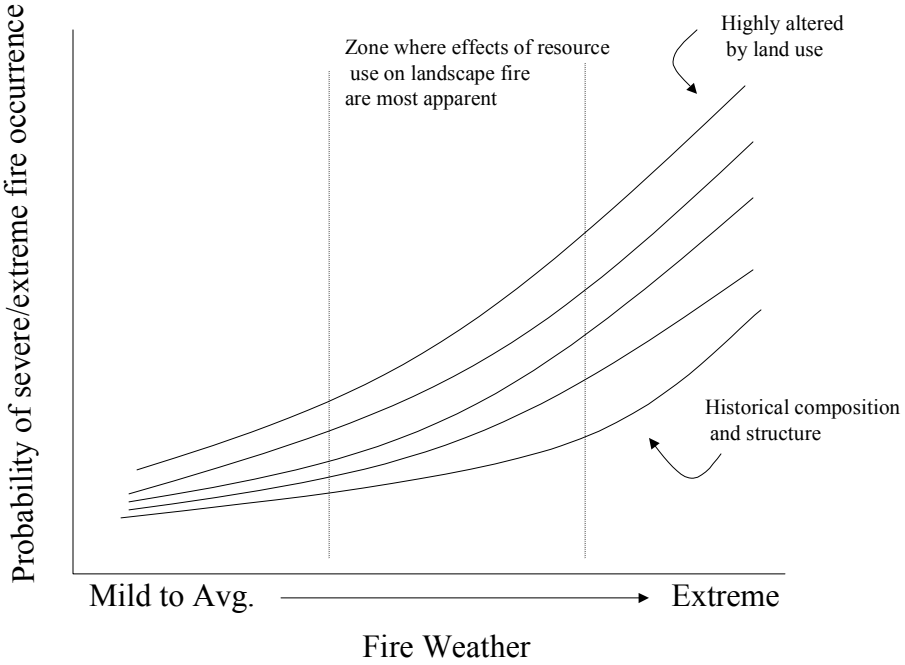

Figure 1. Conceptual relationships of how land and water affects fire behavior and severity along a gradient of increasing fire weather conditions (temperature, relative humidity, wind speed, fuel moisture content).

RIPARIAN ZONES DEFINED

For the Workshop the following definition of riparian zones was used:

Riparian zones are the three-dimensional zones of direct physical and biotic interactions between terrestrial and aquatic ecosystems; boundaries of the riparian zone extend outward to the limits of flooding and upward into the canopy of streamside vegetation (Gregory et al. 1991).

Limits of the riparian zones can be defined by

- The high lines of flooding
- Where microclimatic differences no longer exist
- Distinct breaks in topography (valley bottoms vs. upslope)—Soils of alluvial and colluvial origin
- Areas where vegetation composition includes species requiring more water that that of the surrounding uplands
- The outer limits where shade, litter fall inputs, and direct inputs of large wood debris into the aquatic ecosystem (stream) are no longer probable.

An important objective of this workshop is to define the functional role(s) of riparian zones in landscapes (i.e., how they may affect the fire properties of the landscape).

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41: 540B550.

SUMMARY OF DISCUSSIONS AND RESPONSES TO QUESTIONS

This section is a summary of all questions and discussions addressed during the 2 days of discussion at the Center for the Management of Information, University of Arizona. This section is broken down by days and the specific topics covered.

March 14, 2001

These questions encompass all that we will be discussing for the next two days. Do you Agree/Disagree with each of these premises?

1. Riparian zones have a strong influence on fire properties (size, intensity, frequency, and severity of fires) in western forest landscapes.

There was a general agreement that this premise was true but the statement may be an overgeneralization. This premise was met with a number of qualifications. The size of the stream and riparian zones were mentioned as being important variables. In other words small streams may be of limited effectiveness as a fuel/fire break. In addition, riparian/stream ecosystems likely have variable effects on fire properties. For example, many suggested that climate and fuels have greater effects on fire frequency. Yet if some fires are slowed and/or halted at riparian zone edges, then size of the fire will be diminished. If fire size is diminished then it is likely the frequency would be also diminished.

In general it was agreed that large riparian/stream ecosystems fit this premise, but there exists little documentation for this premise. It was suggested that the adjective "strong" should have been replaced with "important".

2. Land and water use alters the role of how riparian stream/ecosystems affect the fire regimes of western forest landscapes.

There was a high degree of agreement with this premise. Again, the variation of the western forest landscape makes this generalization difficult to apply everywhere.

Land use correlates with physiography, relief, valley size, and other physical landscape characteristics that also influence fire, so effects may be intertwined. Many types of land use were suggested as exacerbating the intensity and severity of fire—grazing, timber harvest, roading, water diversions, introduction of exotics, etc.

3. Riparian zones/streams are key areas for many aspects of fire suppression operations (fire lines, back fires, safety and escape, water sources, etc).

There was general agreement with the premise (but not unanimous). As was the case with the first two premises, broad wet meadows may be more important in suppression strategies than narrow canyon bottom streams. Under severe fire behavior situations, riparian zones

(particularly small ones will have few effects on landscape fire spread. Ridgelines and other natural fuel breaks were also cited as being important.

Riparian areas have always been looked upon as critical areas of refuge. Depending on fuels, wind conditions, and the size and wetness of the zone, they have a functional potential as a natural fire break. Clearly, in scenarios where surface waters only exist in streams, their values as a sources of water for suppression and mop-up are very important.

4. Land and water use can affect the efficacy of fire suppression efforts.

There was unenthusiastic agreement with this premise. If the natural width of riparian vegetation and its naturally higher fuel moisture content is decreased via land use, then the potential to halt wildland fire within the riparian zone would be diminished.

It was stated that "…in the greater scheme of things, the ecological effects of land and water use on riparian areas (e.g., as they affect vegetation species composition and greenness, water tables, stand structure and coarse woody debris) have a much larger influence on fire behavior and effects than does the provision of water for direct suppression activity."

In addition some suggested that water use could be viewed as a competitor for water that could be used for fire fighting. And, conversely, some water uses may actually make water more available for suppression actions. Dams, ponds, diversions, etc., create places where water could be pumped or drafted**.**

5. Restoration of riparian zones has benefits to wildland fire management of the landscape.

Restoration of a wider "green area" and surface water was generally agreed to likely benefit wildland fire management. However, there was some discussion and skepticism on the likelihood that this would be high on the list of reasons for ecological restoration. Some suggested that ecosystem restoration as it benefits wildland fire management is an "intuitively appealing" hypothesis.

Many believed that ecological restoration should take a landscape viewpoint. In areas where fire regimes include frequent fire return intervals, fire events in riparian zones would be expected to increase.

In addition, much of the discussion centered on the objectives of restoration (which was off the subject). They suggested that restored riparian systems (i.e., those that exhibit improved ecological functioning from current conditions) have much greater benefits to wildlife, fisheries, water quality, and favorable conditions of flow, than fire management.

II. How do riparian zones affect the fire properties of western forested landscapes?
By **fire properties** we are referring to the size, return interval, fire behavior, and fire severity in western forests (**Behavior** = intensity, rate of spread, resistance to control, etc.; **Severity** = the ecological effects of fire).

There was a general consensus that because riparian zones have higher relative humidity, and are composed of facultative and/or obligate wetland plants, they act as fire breaks. However, this is dependent on the intensity of the fire in the surrounding uplands and the size of the riparian zone. Season of burn as it affects fuel moisture contents would also affect the spread of fire across a riparian zone.

Some general ways in which riparian zones affect fire properties of western forest landscapes include:

- Higher relative humidity in the riparian zone
- Riparian vegetation that may stay greener longer into the season
- Higher productivity of grasses in meadows that can carry late season fires
- Cooler temperatures, lower daily maximum temperatures
- Increases in fire severity due to a chimney effect in steep canyons
- The stream channel and unvegetated bars function as natural fuel /fire breaks

These riparian zone attributes can affect fire size, fire severity, and return intervals. Riparian zones likely have no effects on ignition (except where they may draw tourists --- human ignitions). All of the ways in which riparian zones can affect fire properties depends upon the linkages between topography, weather conditions, season of burn, riparian vegetation conditions, and stream size. Large unconstrained riparian zones dominated by wetland vegetation with high fuel moisture contents are most effective in serving a fire breaks.

*Fire Properties or Riparian Zones Compared to Uplands

111. Are fire properties and fire regimes in riparian zones different from their surrounding uplands (Fire regimes are manifested in their frequency, magnitude, and extent)? In what forest types and how do they vary?

The degree to which fire properties vary from riparian zones to uplands depends upon the degree of difference between the two ecosystems. Where there are few differences in vegetation, fuels, topography, and microclimate, few differences in fire properties are expected. This would be the case in conifer dominated headwater systems. Also riparian ecosystems that have been degraded by land and water use was suggested to assume fire properties more similar to the drier uplands. This would be the case with overgrazed riparian zones in semiarid ecosystems. Conversely, in unconstrained reaches where riparian vegetation is quite different (a dominance of shrubs, meadows deciduous trees, etc.,) the fire regimes would be expected to differ. In riparian areas where fuel moisture, microclimate and temperature are moderated, fire properties will be different.

Fire properties are affected by: valley width and soil depth, the degree of development (age, height) of the riparian vegetation, the amount of soil moisture or proximity to the water table, aspect, soil moisture, rates of decomposition (higher in riparian zones so fuel loads may be lower), physical properties – (elevation, gradients, aspect), and land management- degree in which the floodplain is decoupled from the water column.

2. Where might fire occurrences be more and less common compared to their surrounding uplands?

See above comments for the correlations of fire properties and the physical, climatic and biotic components of landscapes.

Fire occurrence in riparian zones may be more common than surrounding uplands:

- In steep, 1st order channels, fire occurrence may be the same as uplands, but severity may be greater because of concentration of heat and fuel in the draws.
- In degraded or dewatered stream reaches
- Areas that receive a great deal of recreation
- Areas where the NPP (and hence fuel loads) of riparian zones exceeds that of the surrounding uplands. This might be wetlands in desert environments where late season dry conditions with lightning could facilitate frequent fires (e.g., Malheur National Wildlife Refuge).
- Incised streams (due to disconnected floodplains and conversion of those areas to xeric vegetation) are likely to be much less effective at stopping or retarding an existing fire.
- Where pinon/juniper uplands are adjacent to ponderosa pine in the riparian zone (Southwest USA). Pine stringers in the bottom have highly flammable dead needle beds while the PJ often has little ground vegetation to carry fire (due to desertification/overgrazing). The typical ignition source may be people -either intentionally or not.

Suggestions where fire occurrence in riparian zones may be less common than surrounding uplands:

- In large unconstrained riparian floodplains
- well-developed hyporrheic zones
- larger streams, with a higher deciduous component {#70}
- open, meadow-like riparian zones where fuel moisture remains above the moisture of extinction.
- Intact or undisturbed Cottonwood/willow dominated riparian zones (based upon historical photos where fire occurrence was apparent in uplands but absent in the riparian zone).
- They are probably less common in wide, subirrigated sedge meadow peatland types, that may, or may not, have a shrub component (typically along the active and inactive stream channels). The fuel moisture (especially if there is a seasonally high water table) and the fuel type would dampen or stop a fire from the adjacent upland.
- Fire occurrence is less common in headwater reaches with wet meadow community types since they rarely dry sufficiently to burn.

- The broader riparian areas associated with Rosgen C and E channel types, occurring lower in the landscape probably have a fire frequency that is much lower than the surrounding landscape.
- Where aspen is the riparian dominant. Also in gravel bars dominated a sparse cover of willows (discontinuous fuels).

IV. Indicators of Fire Regimes

What are some specific indicators that fire regimes are different in riparian zones compared to the uplands (fire history, plant composition, structure, etc.)?

The group came up with a list of ~56 indicators (although many were redundant or overlapping). In general, indicators can be divided into:

- Comparisons of species composition between uplands and riparian areas
- Plant adaptations to various fire regimes – uplands vs riparian areas
- Fire history studies (charcoal and tree rings) – uplands vs riparian areas
- Microclimate differences – uplands vs riparian areas

There were numerous comments suggesting that there are few studies that have determined the role that riparian/stream ecosystems play in affecting the fire regime of western landscapes.

V. Vegetation, Fuel, and Microclimatic Components of Riparian/Stream Zones

What vegetation, fuel, and microclimatic components of riparian/stream zones are different from uplands such that fire severity is either decreased or increased? (This includes factors such as vegetation composition, temperature, relative humidity, winds, fuel loads, fuel moisture, fuel arrangement, fuel chemistry, ecosystem productivity, and structure).

In this response the participants formed 8 categories. Categories were separated into those components that increase and those components the decrease the fire occurrence or severity in riparian zones compared to uplands. Here we separated ecosystem properties into vegetation, fuels, microclimate and climate/weather factors.

In general, there are real differences in vegetation, fuels, and microclimate when comparing properties between the riparian zone and the uplands. In contrast, the climatic/weather category is more of a list of how these factors can affect the landscape since they are not expected to differ between riparian zones and uplands. The exception to this would be lightning which is more common on ridgelines compared to the riparian zone (and hence ignitions). Conversely, ignitions from humans could be higher in riparian zones since this is where people tend to congregate.

VI. Referring to the questions above, can you cite conditions or real world examples where riparian zones affected fire behavior, spread or size in a given landscape (i.e., give a real or hypothetical example)? What are the relevant or important features and functions of riparian zones that would increase our understanding of how they influence fire effects on the landscape?

A number of interesting observations and accounts of actual experiences from wildland fires were presented. Accounts from all over the western USA were given including examples from Oregon, Montana, California, Idaho, New Mexico, and alsoVirginia. The examples run the gamut of fire behavior from scenarios where fires were halted by riparian zones to scenarios where fire severity was greater in riparian zones.

In spite of the variation in fire behavior in riparian zones, there were many examples throughout the west where riparian zones were used as control and anchor points. This provides clear evidence that riparian zones are important landscape features for suppression activities.

Some comments were made that extreme fire weather overrides riparian effects. This appears to be in conflict with the observations that that some riparian areas did not burn during large "project" fires where presumably extreme conditions resulted in large acreages of blackened acres. A relevant observation was: "No one has ever closely examined why the riparian areas in some drainages completely burned while others were spared". Another quote worth repeating is: "We will only answer some of these questions through an integrated, interdisciplinary approach." Clearly, data on the microclimate, fuel loads, fuel chemistry, fuel moisture and other relevant features of riparian zones are in need of investigation. Additional uncertainties exist with the definition of "severe fire weather". How does land use affect the probability of severe fire events? In addition, more investigation of the temporal aspects of severe of fire weather is needed. How long (range of variation) do such conditions exist within a 24 hour period during large wildland fires?

What are the relevant or important features and functions of riparian zones that would increase our understanding of how riparian zones influence fire effects on the landscape?

Features of riparian zones that may affect fire behavior and spread include fuel loads, fuel moisture contents, topographic shade, etc. In wet meadows, fuels are too wet to carry fire during much of the fire season. Beavers can raise the water table and create wet environments that affect fire. In grazed areas fuel loads may be too low to carry fire. Others suggested that land use and its multiple effects on fuel loads and arrangement are necessary components of any investigation.

One workshop participant suggested the following was in need of investigation:
Contrasting riparian to upland conditions on the basis of:

1. Fuel loading or amount
2. Continuity of fuels
3. Fuel types
4. Fuel condition (ex. wet or dry)
5. Fuel chemistry
6. Topographic continuity
   a. topographically level landscape vs. deeply incised landscape
   b. wide alluvial reaches in otherwise deeply incised landscape
   c. deep canyons in otherwise flattish landscape

7. Topography of drainage network relative to wind at time of fire

One respondent stated: "Opinions seem equally divided between potential importance of landscape features (valley/channel width), vegetation characteristics, and climatic conditions. Perhaps people's experience with one of these factors leads them to a more restricted view. I'm inclined to think topography and geomorphology are important, but others appear to be convinced that nothing other than weather influences certain types of fire (e.g. crown fires). Are we all working with our own biases?"

VII. **Interdisciplinary Group Presentations (Topic Commenter)**

For this part of the workshop, participants were divided into 4 interdisciplinary discussion groups. Each group was to discuss the following questions and report back to the entire workshop. Following each presentation all workshop participants were asked to comment on the discussion points presented**.**

Table 1. Group members for the interdisciplinary discussion			
1	2	3	4
Steve Wondzell	Bob Beschta	John Pitlick	Bob Ziemer
Pat McDowell	Jeanne Chambers	Bill Baker	Elizabeth Crowe
Wayne Minshall	Phil Omi	Chris Frissell	Dave Perry
Mary Manning	Carol Hunsaker	Elaine Sutherland	Bob Greswell
Jim Agee	Mike Lohrey	Jon Keeley	Ron Wakimoto
Scot Vail	Bob Clark	Laurie Osterstock	Bernie Bahro
Gene Rogers		Gregg Riegel	

Discussion questions:

1. **How has land and water management in riparian zones and streams (logging, livestock, fire suppression, roads, water diversions, etc.) affected fire properties of western forest landscapes?**

2. **2.How does ecological condition of the riparian zones affect fire in the landscape?**

Group 1 report-Relevant points of discussion:

The dominant land and water management activities that have affected fire properties in western forest landscapes include:

- Fire suppression – fuel buildups

- Livestock grazing – results in changes in fuel structure and species composition, and stream incision which dries out the riparian zone
- Roads- altered hydrology, sediment routing, loss of vegetation structure; access points for human ignition sources; facilitates suppression efforts;
- Logging- fuel load changes, forest structure changes
- Invasion of exotics – changes in fuel and composition structures
- Global climate change- incision, compositional changes
- Water Diversions – loss of the riparian zone and function as a fire break; loss of a water source
- Beaver eradication – incision, narrowing of the riparian zones; compositional shift
- Post fire rehabilitation – exotic species, rapid increase in fine fuels, altered sucessional pathways;
- Extirpation of Native American cultures and replacement with the Euro-American culture - changes in land use as described above; changes in Rx fire patterns.
- Cumulative effects- synergistic effects of all of the above

Some Relevant Comments

- While there is widespread agreement that land use affects fire on the landscape, there is concern over the general lack of hard data . More studies and administrative reports of fire observations are needed.

- We have increased fuels in general over the entire landscape (riparian and upland) and only "allow" fires to burn under worst case weather - so….. the controlling factors over riparian vs. upland are different than they were historically.

- Historically, They weren't always fire/fuel breaks, but may have burned differently (possibly lower intensity) - now it's not clear. Certainly the water there is useful for an escape route or water for suppression.

- Maybe the riparian zones aren't complete fire breaks in each situation, but I think they are useful for suppression or slowing down a fire in the right situation. I think we would rather have them there for possible use than not at all.

- I have seen numerous examples where small and medium size fires did stop (or slow down significantly) at riparian zones. These examples include both suppressed and non-suppressed fires. For larger fires in more severe weather this effect is certainly less consistent and may be weak. But if riparian zones didn't function this way, it is possible a few more medium and small fires might have become large fires.

- A healthy fully functioning riparian zone in: a "surface fire" (low severity/ intensity) fire regime, the riparian zone could be a great influence on fire properties.

- A healthy fully functioning riparian zone in: a "moderate severity/intensity fire regime could have less of an influence on fire properties.

- I see very limited use of our 1995 Fire Policy of "wildland fire use" unless be really get a handle on what riparian fuel conditions, stand history, and fire weather conditions provide effective barriers to fire.

- First, we still need a lot of basic information on how riparian systems function and what their current restoration potential is - this assumes that "healthy", intact riparian ecosystems are beneficial to fire management. Second - Post-fire studies of how riparian zones influenced recent fires, especially where weather and fire behavior information is available. This could be collected in the context of generating response curves to address the controlling factors. It could also be thought of as a classification exercise to determine fire response. Finally, we need studies of -fire history which includes the collection of data that links upland fire regimes with those in the riparian corridor

VII. Concluding Comments by all: Each of you please compose an individual summary: What were most important issues discussed? What were issues that have not been addressed? What needs further discussion? What are some information needs?

This section includes a synthesis of the ideas from the end of the first day of the workshop. As is apparent from the questions and discussions, the first day of the workshop focused on how riparian zones function to affect fire regimes at landscape scales and how land use affects that functional role.

What were most important issues discussed?

There were many interesting points presented in this day of the workshop. It is very likely that under many scenarios, riparian zones do play an important functional role affecting fire in landscapes. However, given the complex nature of fire in ecosystems it is very difficult to speak in global generalities. The factors discussed as most affecting any given wildland fire include, the vegetation type, fuel load, topography, land use, and weather.

The weather events at the time of the fire were a popular discussion point where it was emphasized that under extreme fire weather conditions many other landscape features are secondary in importance as they affect fire behavior. Land use and the condition of the riparian zone were also deemed to be important. Among the most innovative ideas of the day was a conceptual graph developed by Dave Perry (Figure 1) and his group that outlined how land use may relate to fire behavior. In this conceptual model, they suggested that the threshold for severe fire behavior due to weather conditions is lower in landscapes with riparian zones degraded by land use.

A few of the significant statements pertaining to the discussion include:

"We have abundant ideas, logic, anecdotes, and now theory, but little systematic information."

"The general agreement that healthy riparian zones do function as fire breaks and therefore influence the structure, hence fire characteristics, of surrounding landscapes."

There is a certain realm of conditions that exist where riparian may have a significant influence regarding fire behavior."

"…The point is that weather can be so severe from a fire standpoint that conditions on the landscape make relatively little difference, but there is a large range of weather conditions for which they do make a difference. Restoring degraded systems is very important for the latter."

And finally,

> ***"whether the weather is cold,***
> ***or whether the weather is hot,***
> ***we must weather the weather, whatever the weather,***
> ***whether we like it or not.***
>
> ***Whether the weather is cold,***
> ***or whether the weather is hot,***
> ***topography and fuels are part of the rules,***
> ***whether we like it or not.***

2. Issues that have not be addressed?

A few of the biggest points raised here include the uncertainty of where riparian zones are effective fire breaks and where are they not. Another difficult question is how do we quantify the water necessary to meet the needs from a fire perspective? Site specific scenarios were also not discussed, particularly fire at the wildland/urban interface.

Many suggested that more research/studies were needed to address the questions raised on this day of the workshop.

What needs further discussion?

It was suggested that among the weaknesses of the discussion to this point was the lack of site specificity. It was suggested that more case studies and specific examples of where riparian zones have affected fire spread be described.

What are some information needs?

A plethora of interesting ideas were discussed in this section; too many to be mentioned here (see actual responses). The quality of statements in this section is reflective of the high degree of expertise of the participants. A few information needs expressed include:

- Studies to quantify specific fire behavior in specific types of riparian systems
- The need to develop a set of attributes of riparian systems that can be modeled for fire behavior
- Post-fire studies of how riparian zones influenced recent fires, especially where weather and fire behavior information is available.
- Fire history data that links upland fire regimes with those in the riparian corridor
- Information on fire effects on riparian zones and vice versa. It seems that all we have is the memorable exceptions that are recalled rather than the more common place fire events.
- Synthesizing information on fire in riparian zones from fires that have occurred in the last several decades.
- Information relating extent of riparian zone degradation to actual decreases in options available to fire suppressionists
- Define the types of riparian systems that have influences on fire and under what range of fire weather conditions are they effective.
- Interdisciplinary research teams to make real time measurements of fuels, weather, and biotic conditions during wildland fires. This would increase our understanding of fire effects in riparian zones and how riparian zones affects fire on the landscape. It would also be of benefit to field test behavior models.

March 15, 2001

Fire Suppression Activities (Topic Commenter)

1. How are riparian zones and streams utilized in fire management activities? For specialists in fields other than fire control and use, what might be some limitations?

A variety of uses and values of riparian zones to fire control activities was discussed during this session. Some of the generalities are mentioned below. Also many brought up the possible limitations of riparian zones for fire suppression activities. This includes concerns of resource damage – soils, stream banks, wildlife (particularly birds and sensitive species), fish, and water quality. In response to concerns over fire control activities and the actual effects of fire in riparian zones one commenter replied: " (1) using fire may make the landscape more sustainable in the face of wildfire; and (2) if only certain stretches of streams are treated in any one year (and not revisited for 10-20 years) - this puts a different temporal/spatial context to the issue of negative effects on sensitive species - the whole watershed riparian zone is not going to be treated in a single year --and probably not with the same prescription, either." Many cited that managers (particularly biologists) use the "precautionary principle" as a rationale for not allowing for prescribed fire use in riparian zones. Others stated this was a mis-interpretation as fire exclusion (suppression) is a severe

perturbation affecting riparian structure and function. Many suggested that an increased understanding of fire effects in riparian zones is greatly needed.

Ways in which riparian zones and streams are utilized in fire management activities include:

1. Barrier to fire spread or anchor point to tie in a line.
2. Water source for operational activities such as a pumpers, helicopter bucket work, or mop-up.
3. Prescribed fire lines.
4. Line for burnout/backfire operations.
5. Safety zones/escape routes
6. unit boundaries for Rx fires
7. spike camps, fire camps, refueling stations, and helibase operations

Limitations of fire use in riparian zones:

1. Effects on T & E species and other sensitive species
2. Effects on birds and their nesting habitats
3. Water withdrawl during fires can negatively affect the aquatic biota
4. Fire camps effects on soil compaction and vegetation damage
5. Water pollution (via diesel, fuels etc)
6. Effects of retardants on riparian zones

ll. Quantifying Necessary Water (Topic Commenter)
We can quantify the amount of water necessary to maintain riparian zones (in order to meet wildland fire management needs). Is this a valid statement? Why or why not?

This is the first of a 2-part question. The second follow-up question was to identify those variables that would be important in quantifying the quantity and timing of water necessary fore fire control and use.

This is a very complex and difficult question given the infinite number of physical, biotic, and fire variables. Many summarized their statements as it is difficult to quantify the amount of water necessary to maintain riparian zones, regardless of purpose…, it can only be done on a very site-specific basis. From a conservative perspective many participants suggested that the hydrologic regime must be maintained as close to natural conditions as possible to maintain the riparian zone itself. "The natural flow regime is our best model of what is needed to do multiple functions -- transport sediment, deposit sediment on floodplains, nutrient cycling, redistribution of organic matter, seedling establishment, seasonal growth of vegetation, cause mortality, etc." Natural or near natural flows (timing and variation) would insure that fire suppression could be met to the maximum extent possible for the landscape scenario in which the riparian zone existed. Respondents added the real difficulty would lie in how much water could be withdrawn without damaging either the channel or ecological functioning.

In terms of meeting fire management needs some considerations included: (1) maintaining the riparian zone (green area) as a fire break; (2) maintaining channels/pools for the procurement of

water, and (3) maintaining the presence of water during base flows (i.e., during the fire season). These needs would require management of flows at all seasons- peak flows, the falling limb, base flows, etc,.

III. Important Variables (Categorizer)

What variables are important to quantify the amount of water necessary in riparian zones to meet wildland fire management needs?

We asked participants to list the variables that would be important to quantify the timing and amount of water necessary to meet wildland fire management needs. This would include both fire suppression needs as well as riparian zone maintenance. Here we created 3 categories: (1)fire suppression/management needs, (2) hydrology/geomorphology needs, and (3) biotic/ microclimatic needs. Approximately 74 variables were listed. Many are redundant and repeated in each category. Nevertheless, there are numerous variables that are in need of quantification in order to ascertain follow regimes to meet fire control needs.

IV. Fire Behavior Models and Riparian Zones (Topic Commenter)

IVa. Current fire behavior/suppression models adequately consider riparian zones (Agree/Disagree?)

There was a consensus that current models could predict behavior and differences in uplands and riparian zones. However, this is rarely done (if ever) in the western USA. This could be done with the BEHAVE and FARSITE models. For example if there are differences in physical inputs such as fuel loading by size class, fuel moisture content, slope, and weather conditions such as wind speed and direction, and relative humidity, then models could arrive at differences in the behavior of riparian and uplands. This is rarely done as the riparian zones constitute such a small portion of the landscape (1-2%). Numerous fuel models might be needed to adequately describe conditions in a single reach of a riparian zone—a grass, shrub, and tree model(s) in the same small area. Specific models could be developed in riparian zones using NEWMDL and TESTMDL.

Some caveats to the potential value of the models include numerous model limitations such as the microclimate nuances that are not included in the models. In terms of FARSITE, spatial limitations limit its value. Resolution (pixel size and accuracy) of input information and how it is used to characterize fire behavior is critical. If the data are not of a resolution capable of determining vegetation and topographic differences, then they will be of little value. However, given the potential role of riparian zones in landscape fire, modeling efforts should be undertaken.

In terms of which models to use (FARSITE or BEHAVE), one respondent stated it would be better to use BEHAVE to compare differences between uplands versus the adjacent riparian zone. FARSITE still needs better calibration.

A good discussion on riparian values and approaches to management is embedded in this discussion (but was not very relevant to modeling).

IVb. Can they be used to determine how land/water use in riparian zones may affect fire in western landscapes?

Conceptually this is possible at the site level if the proper variables are collected for inclusion in the model. This would include adequate measures of fuels, fuel moisture, and differences in moisture content. While this is conceptually feasible no studies have been conducted to validate whether models are robust enough to produce realistic outputs. This is a technically difficult task and current models may not be sensitive enough to detect how compositional, structural, and microclimatic shifts in riparian zones affect landscape level processes. One respondent stated: "The main use of these models is in long range planning on fire incidents or complexes of incidents or in landscape modeling for fuels reduction and fire use. They need well trained fire behaviorists who are very familiar with the model (not easy to find)".

At best, it was suggested that current fire behavior models are useful in land use planning. To this end, a project could be implemented where model runs are made with different parameters of riparian conditions. The difficulties would be in model validation. As one stated: "It is only better than nothing if the output is better than nothing".

IVc. If you do not know fire models, what parameters would you suggest are necessary to predict how riparian/stream ecosystems affect fire properties?

A number of parameters were suggested as being important for fire behavior models that could discriminate between riparian zones and uplands. This includes: vegetation cover, structure (layers and size class distribution), live fuel moisture, valley bottom width and gradient, adjacent vegetation characteristics, and total riparian zone width, and upland slope dimensions (note many of these are parameters in BEHAVE).

It is clear that the spatial dimensions of the FARSITE model are need of revision. A 30m pixel size would be too small for many 1-3rd order streams (as much as 85% of the stream length in many western river systems). Accurately parameterizing each pixel (fuel model, fuel loads moisture content, etc, would be a difficult task.

V. Effects of Land and Water Management

What are the effects of land and water management on efficiency and capability of fire suppression and management?

There are a number of land and water management effects that influence fire control and use. Fire exclusion has resulted in compositional changes in the riparian zones as well as the uplands. This includes increases in fuel loads as well as structural shifts of shrubs to conifers (in some limited cases). Other land uses have decreased the fuel moisture contents, and changed microclimates, and/or riparian zone widths (roading, logging, grazing, channel incision). Land and water management that results in channel incision results in the replacement of riparian

vegetation and a moister microclimate with upland vegetation and a drier microclimate. These would complicate suppression efforts and diminish their values as control lines and safety zones. It was stated that livestock grazing impacts more acres in the west than any other land use. Livestock grazing removes fine fuels which essentially can eliminate the capability of fire occurring in areas managed where grasses are consumed before the fire season (i.e., early or season-long grazing which encompasses many of the traditional west-wide grazing strategies).

Diversions of flows along with regulation of flows by dams has diminished the width of streams. This diminishes the functional role of streams and riparian areas as natural fire breaks. Also, their value as safety zones and sources of water would be diminished.

It was also suggested that upland changes, particularly land uses that affect fuel loadings (exclusion and logging) will negate any moderating effects that riparian zones would have on fire spread and behavior.

In additional to land uses, one factor mentioned was societal attitudes and the need for more environmental education on fire and riparian issues. Urban interface, smoke management issues, and riparian protection needs may present barriers for efficient use of riparian zones in fire management.

VI. Examples of Wildfire Spread Ending at the Stream/Riparian Zone Edge

Can we find/cite specific examples of where riparian zones and streams have been used in fire management? (i.e., halting the fire or functioning as a fuel break)? These can be actual observations, evidence from forest structure, species composition, fire scars, etc.

There are numerous examples throughout the western USA where riparian zones have been used in fire control and management. Conversely, riparian zone vegetation is not "fire-proof". Under severe fire weather (temperature, wind, RH, fuel moisture contents, etc.) any site with adequate mass and continuity of fuels would support sustained combustion. Nevertheless, given the unique microclimate, topographic position, and presence of water in riparian zones, they have many valuable uses in fire control and use.

A number of examples were cited throughout the west in many different forest types and under many different scenarios. Many suggested more studies are needed to determine what are the multiple factors of riparian/stream ecosystems that combine to halt fire or greatly diminish fire spread.

VII. Fire Suppression and Water Diversion

VIIa. What are the effects of water diversion on fire suppression?

We asked the participants to address structural and biological changes in riparian zones and streams as a result of water diversion and particularly as it affects fire behavior and spread across the landscape. In general, conclusions were that the effectiveness of diversion to alter channels and riparian systems (which may or may not be important to fire management) would depend on the frequency, magnitude, and timing of those withdrawals. Respondents stated that diversions decrease the wetted width of the stream and width of the green areas of riparian zones. This would decrease the efficacy of riparian zones to stop fires. Also it was mentioned that dead fuel loads increase where diversions result in the death of riparian vegetation (trees). If diversions result in the conversion to a dominance of upland vegetation. Fuels would dry out earlier during the fire season, but be of a lower loading.

In terms of suppression efforts, if pool volumes are decreased, then the ability to draw water is reduced. This could be the direct result of losses in water flows as well as the loss of pool forming processes (losses in peak flows). Drafting from a diverted stream may have fewer and shallower sites that provide available water sources for engines or tenders resulting in the sucking up silts and sands that could ruin fire fighting equipment.

Conversely, diversions (reservoirs) are used as water sources. These are effective "dip" sites for suppression. In the areas where the water is used (e.g., irrigated meadows) the green area is increased. However, this is likely to occur in a limited area- more miles of stream length are negatively effected (diverted "source areas") than positively effected (the "sink areas"). Also, the irrigated meadows are on private lands while diverted landscapes are often public lands.

2. Are there any real world examples where diversions have affected the efficiency or safety of fire suppression crews?

As with other questions, isolating the effects strictly to the diversion or impoundment would be difficult to document. Few have consciously addressed this issue. It was stated that fire fighters have gone into wet areas and meadows rather than shelter-up a number of times. They provide excellent safety zones. When planning operations riparian zones are areas where crews can escape to in emergency situations without much preparation. Conversely, one stated that in 31 years of needing to get to water, there was never a situation where its absence apparently compromised safety.

VIII. Group Presentations (Topic Commenter)

Key question:
How do riparian zones and streams influence the rate and extent of fire spread?
In this group presentation we divided the participants into their general field of expertise (Table VIIIa).

Table VIII a. Disciplinary groups of specialists for group discussions on 15 March 2001.			
Hydrologists & Geomorphologists	**Aquatic & Plant Ecologists**	**Fire Scientists/ecologists**	**Fire Management, control and use**
Steve Wondzell	Wayne Minshall	Jim Agee	Scot Vail
Pat McDowell	Chris Frissell	Phil Omi	Mike Lohrey
Bob Beschta	Elaine Sutherland	Carol Hunsaker	Gene Rogers
John Pitlick	Elizabeth Crowe	Ron Wakimoto	Bernie Bahro
Bill Baker	Dave Perry	Gregg Riegel	Laurie Osterstock
Bob Ziemer	Mary Manning		Bob Clark
	Bob Greswell		
	Jeanne Chambers		

VIIIa. Hydrologists/Geomorphologists

This group recognized the great void in data relating fire behavior and spread at landscape scales. Here they present recommendations for research and better observations during wildland fires. Studies are needed to unravel the complex relationships between the physical components of the landscape (hydrological and geomorphic features) with fire behavior and spread.

Recommendations:

Develop a multidisciplinary team to formulate models and hypotheses; gather data and test hypotheses on influences of riparian zones and streams on fire spread and behavior.

Some preliminary models we propose:

- Effectiveness of riparian zones in diminishing fire spread vs. stream order (and/or other characteristics).
- Riparian zones and fire properties (the efficacy in decreasing fire spread or lowering the severity of fire behavior) in relation to stream order

Potential control variables to consider in models and hypotheses above:

- Stream order
- Valley shape, width
- Orientation of streams (relative to typical direction of fire spread)
- Channel (wetted) width
- Channel depth (wetted depth, residual pool depth)
- braided vs. single-thread
- ecoregion
- riparian vegetation type
- beavers

- hydrologic regime (rain vs. snow, or elevation within ecoregion)
- flow regime/flow variance (baseflow:median flow)
- season of fire occurrence

And the more complex ones:

- Disturbance history (or regime)
- drought regime
- flood regime
- Channel floodplain interaction/connectivity, hyporheic
- Land use (current and historic) and human perturbations (logging, grazing, diversion, etc.)
- Pebble counts

Most comments were in agreement with the need for more research..

VIIIb. Aquatic and Plant Ecologists

The aquatic and plant ecologists developed the following information/management needs to better understand the role of riparian zones on landscape fire

1) What are the effects of water removal on fire suppression in riparian zones?
2) What are the effects of thinning on riparian zones?
3) What are the effects of prescribed fire on the riparian biota?
4) What are the historical fire regimes in riparian areas & their associated upland ecosystems?
5) What is the role of fire disturbance vs. flood disturbance?
6) What is the role of riparian areas as "fire breaks"?
7) How do riparian/stream ecosystems influence fires suppression or fire extent?
8) What is the role of riparian zones in managing fire? (may slow down fires if not stop them - such a delay in rate of spread may have kept the fires smaller in size).
9) How, and under what characteristics do riparian areas affect fire properties at landscape scales?
10) How do degraded or diverted riparian/streams affect landscape fire properties and how would that vary from restored or re-watered streams?

VIIIc. Fire Scientists/Ecologists

Research information and management and needs:

- How to predict fire behavior so it will be meaningful at the right spatial scale? We need models that can discriminate riparian zones from uplands. Are current fuel models appropriate for riparian zones? FARSITE is not likely at the correct scale for riparian zone applications.

- What are the conditions under which riparian zones act to alter fire behavior? Are there thresholds?

- There is a need for data acquisition for fire severity modeling (severity is the ecological effect). Behavioral modeling now assumes independence of landscape elements which makes severity tougher to estimate. Both behavioral and ecological models are in need of improvements.

- What are the effects of large scale "restoration" projects on riparian response? How would riparian restoration affect the uplands (act as a fire break)? Conversely, how would uplands restoration affect the riparian zone?

VIIId. Fire Management

Research and information needs discussed by the Fire management group included the following:

- Develop a Photo Series of riparian fuels. This would be similar to those developed for upland fuel types throughout the USA.

- Explore the application of foams and retardants to protect and enhance riparian zones.

- A formal research review study of EA's, EIS's, and Burn Plans to determine where prescribed fires were planned with riparian zones identified as potential control lines.

- Develop a water consumption/needs model applicable for a variety of channel types, to predict value of potential sites for a various fire management uses (i.e. as a Pre-Attack (Fire) planning tool).

- What are the effects of water diversions on suppression?

- Fire history studies to establish where the fire held or was controlled by a riparian zone. This could be accomplished using GIS- fire history over-lays, with riparian layers, by vegetation, elevation, stream type (class), etc.

- Water supply in the future as a potential regional fire suppression issue.

- Determine the length of the wet period in riparian zones to the length of the fire season (How long does it function as a fire break?). The potential water availability for fire suppression in the future (due to climate change).

- What is a watershed's susceptibility to drought, based on source of water diversion: ground water source vs. snow melt?

- Develop a series of curves based on fuel moisture, that could be used as a predictive tool. Fore example develop a model to determine the conditions where a given riparian zone would provide effective suppression needs; or how effective the riparian zone will be in

changing fire behavior under different fire weather scenarios. Models such as these would be useful in the decision-making process during wildland fires. Variables include weather, fuels, topography, shading, wind reduction and riparian conditions at the time of the fire.

IX. Final Truths (Vote)

Final Truths
In this section, 7 conclusions that arose out of the discussions of the workshop were revisited to gage the degree of scientific agreement. Participants were asked to respond to the statements along a scale from strongly agree (5.00) to strongly disagree (1.00). If all respondents strongly agreed, the score would be a 5, and if all strongly disagreed, the score would be 1. Statements below are ordered based upon the degree of agreement (highest to lowest). The numbers before each statement are the means of the degree of agreement or disagreement of each statement.

4.58 Statement 1. While observations and intuitive knowledge would suggest that riparian zones are valuable for fire management and safety, we lack much quantification to address many needed resource management needs.

There was strong agreement that we need more quantitative information on the functional role of riparian zones as they affect fire patterns on the landscape.

4.38 Statement 2. Riparian areas influence fire behavior/fire properties. However, we also recognize that fire is one of the natural disturbances shaping riparian stream ecosystems. This suggests a total fire exclusion policy in these areas (riparian zones) is unwise and unnecessary.

It was recognized that the unique vegetation, microclimate, and topographic features of riparian zones function to affect fire behavior and spread. In many cases riparian zones have been effectively used in fire control and use.

In addition, it was recognized that fire is a natural disturbance process in riparian zones. As such, fire has a role in riparian zones and a total exclusion policy of fire is discouraged. It was recognized that other natural disturbances shape the composition and structure of riparian/stream ecosystems. In particular, floods or high flows are significant disturbances. Diversions which influence these processes also affect riparian structure and function. Alterations in structure and function could also affect the fire properties of the riparian zone.

4.23 Statement 3. Riparian zones and streams have some influence on the fire properties of forested landscapes

It was recognized that riparian zones play an important role affecting fire on the landscape. Under some conditions, riparian/stream ecosystems act as fire breaks halting the spread of wildland fires on the landscape. In other cases riparian zones have been used by fire

suppression forces as safety zones, burn out points, and water sources. These uses likely have resulted in fires of smaller area.

4.15 Statement 4. Riparian areas influence fire in the landscape where fuel moisture, loadings, composition and topography are different. This is true where fuels and microclimate may be strong controlling factors during fires. Under extreme weather events, fire behavior is largely influenced by weather variables.

*Comparing riparian zones to uplands, the unique presence of surface water, composition, fuel moisture, fuel chemistry, microclimate, and topography combine to affect fire behavior. There is a limit to the degree in which riparian zones affect fire behavior. Under conditions where fuel moisture is low (near or below the moisture of extinction) and under severe fire weather conditions (high winds, low relative humidity and high temperatures) riparian zones may burn with similar behavior as the uplands***.**

4.08 Statement 5. The long-term effect of land and water management (exclusion, water diversions, etc) can affect the function of riparian zones on the landscape. Fuel loads, vegetation composition, geomorphology and hydrology can be affected such that fire intensity/behavior is much greater than historically occurred under a similar weather scenario ("The Perry model", Figure 1, Page 8).

Water diversions can alter riparian/stream ecosystems such that the fuels, species composition, and microclimate become similar to uplands. Under these scenarios the differences in fire behavior between riparian zones and uplands are diminished. This would diminish their value in fire control as firefighter safety zones, and control lines.

4.00 Statement 6. Access to water sources is important in fire management activities (prescribed and wildland fires). However, it is difficult to describe or generally state the value except that they are important for safety, containment, and mop up activities.

There are a number of cases where riparian zones have saved lives when used as a safety zone. Riparian zones are used as foundations of control lines and the starting point where backfires are lit to halt fire spread. Streams are frequently used as sources of water in fire suppression efforts. Quantification of these values is quite difficult because it is impossible to ascertain how fire behavior, severity and size would have differed with more (or less) water available. In addition the natural variation in riparian zones, landscapes, and in wildland fires limits formulation of universal generalizations.

3.58 Statement 7. Riparian zones/streams in steep first order high elevation streams have little, if any influence on fire behavior because of few differences in the upland vs. riparian environment.

There was less agreement in this statement than the others. In headwater streams, the species composition may not differ from that of the uplands. These are small

areas that are limited in their effectiveness as a fire break (i.e. the fire can easily spot over the small riparian zone). However, some disagreement was expressed with this statement because of the unique position of headwaters on the landscape. In headwater streams topographic shade and microclimate are often different enough to slow the rate of fuel moisture loss relative to rates in more exposed uplands (especially south slopes and ridgelines). Differences in microclimate, fuel moisture content, and presence of surface water, could influence fire behavior even in small headwater streams under certain seasonal and weather conditions.

Number of Votes in Each Rating

Statement	SA (5)	A (4)	N (3)	D (2)	SD (1)
1. While obs	15	11	0	0	0
2. Riparian	14	9	2	1	0
3. Riparian	10	14	1	0	1
4. Riparian	8	15	2	1	0
5. The long	9	10	7	0	0
6. Access to	6	15	4	1	0
7. Riparian	5	11	5	4	1

WORKSHOP OUTLINE

Workshop on Multiple Influences of Riparian/Stream Ecosystems on Fires in Western Forest Landscapes
March 13-15, 2001

March 13, 2001 Introductory Session, Viscount Suites Hotel Tucson, AZ
1:00 - 4:30 PM

1:00 – 1:30 Welcome and introductions of Participants - Boone Kauffman, OSU
1:30 – 1:45 Why hold a workshop on the relationships of fire and riparian zones - *Larry Schmidt, USFS, Ft Collins, CO*
1:45 – 2:30 Ecological relationships of riparian zones and fire, - *Boone Kauffman, OSU*

Break 2:30- 3:00

3: 00- 3:45 Fire ecology and fire history of riparian ecosystems - *James Agee, University of Washington*
3:45- 4:30 The use of riparian zones and streams in wildland fire suppression - *Mike Lohrey USFS, Portland OR*

March 14, 2001 (8:00-5:00) University of Arizona, Center for Management of Information
TOPIC: Fire history and natural relationships of fire and riparian zones

8:00 AM Session begins

1. Description/discussion of CMI (U of A). 15 minutes (Ana Lopez)

2. Premises related to the workshop objectives

- Riparian zones have a strong influence on fire properties (size, intensity, frequency, and severity of fires) in western forest landscapes
- Land and water use alters the role of how riparian stream/ecosystems affect the fire regimes of western forest landscapes.
- Riparian zones/streams are key areas for many aspects of fire suppression operations (fire lines, back fires, safety and escape, water sources, etc).
- Land and water use can affect the efficacy of fire suppression efforts.
- Restoration of riparian zones has benefits to wildland fire management of the landscape.

A. This question encompasses all that we will be discussing for the next two days. Do you Agree/Disagree with each of these premises?

Format: Open Discussion (10 minutes); Electronic Discussion (20 minutes) - Topic Commenter

B. How do riparian zones affect the fire properties of western forested landscapes?

Format: (Open discussion-questions 5 min; Electronic discussion 15 min)

By **fire properties** we are referring to the size, return interval, fire behavior, and fire severity in western forests (**Behavior** = intensity, rate of spread, resistance to control, etc.; **Severity** = the ecological effects of fire).

3. Are fire properties and fire regimes in riparian zones different from their surrounding uplands? (Fire regimes are manifested in their frequency, magnitude, and extent)? In what forest types do they vary? How do they vary? Where might fire occurrences be more common in riparian zones than uplands? Where might fire occurrences be less common compared to their surrounding uplands?

Format: (Open Discussion 5 min; Electronic Discussion 10 min)

4. What are some specific indicators that fire regimes are different in riparian zones compared to the uplands (fire history, plant composition, structure, etc.)? (List/rank)

Format: (Open Discussion 5 min; Electronic Discussion 10 min; Categorizer 20 min)

COFFEE BREAK (15 minutes, 10:00- 10:15)

5. What geomorphic, hydrologic, and topographic factors or characteristics of riparian zones and streams influence fire in western landscapes? How?

Format: (Open Discussion 5 min; Electronic Discussion- Categorizer 20 min, Vote/rank factors in order in which they most strongly affect fires, 10 min.).

6. What vegetation, fuel, and microclimate components of riparian/stream zones are different from uplands such that fire severity is either decreased or increased? (This includes factors such as vegetation composition, temperature, relative humidity, winds, fuel loads, fuel moisture, fuel arrangement, fuel chemistry, ecosystem productivity, and structure).

Format: (Open Discussion 5 min; Electronic Discussion- Categorizer 21 min, Vote/rank factors in order in which they most strongly affect fires, 10 min.).

7. Referring to questions 5 & 6, can you cite conditions or real world examples where riparian zones affected fire behavior, spread or size in a given landscape (i.e., give a real or hypothetical example)? What are the relevant or important features and

functions of riparian zones that would increase our understanding of how they influence fire effects on the landscape?

Format: (Open Discussion 5 min; Electronic Discussion Topic Commenter)

Lunch 12:00- 1:15 (on your own)
1:30 Group session - 1 Broken down into Inter-disciplinary groups (sort of).

TOPIC:
How has land and water management in riparian zones and streams (logging, livestock, fire suppression, roads, water diversions, etc.) affected fire properties of western forest landscapes? How does the ecological condition of the riparian zones affect fire in the landscape? Present specific examples where altered stream flows/degraded riparian condition affected fire severity? Has riparian vegetation change resulted in changes in the landscape (uplands) because they no longer function as fuel/fire breaks?

Assignment of groups and description of discussion task (15 minutes 1:3- -1:45)
(Bring Laptops) Flip Charts Provided
Group composed of a Chair, Recorder, Reporter and Contributing Members
1:45- 2:45 Group discussion for 1 hour

BREAK 10 minutes
2:55-4:30
Presentation of Group1 (10 minutes)
Comments on Group 1 results - Open discussion (5 minutes), Electronic discussion -Topic Commenter (5 minutes)

Presentation of Group 2 (10 minutes)
Comments on Group 2 results Open discussion (5 minutes), Electronic discussion-Topic Commenter (5 minutes))

COFFEE BREAK (15 minutes)

Presentation of Group 3 (10 minutes)
Comments on Group 3 results Open discussion (5 minutes), Electronic discussion-Topic Commenter (5 minutes)

Presentation of Group 4 (10 minutes)
Comments on Group 4 results Open discussion (5 minutes), Electronic discussion-Topic Commenter (5 minutes)

4:30-5:00
Synthesis of Information and Ideas generated (J.B. Kauffman)
Format: (Open Discussion) 10 -15 minutes

Concluding Comments by all: Each of you please compose an individual summary: What

were most important issues discussed? Issues that have not been addressed? What needs further discussion? What are some information needs?
Format: (Open Discussion Electronic Discussion-Topic Commenter) 10-15 minutes

March 15, 2001 (8:00-4:00) University of Arizona, Center for Management of Information

TOPIC: WHAT ARE THE VALUES AND USES OF RIPARIAN ZONES AND STREAMS FOR WILDLAND FIRE MANAGEMENT AND HOW DOES LAND USE AFFECT SUPPRESSION EFFORTS

8:00 am Session begins

1. **How are riparian zones and streams utilized in fire suppression activities?**

Format: (Open Discussion 5 min; Electronic Discussion 10 min.)

2. **We can quantify the amount of water necessary to maintain riparian zones to meet wildland fire management needs. (Agree/Disagree) Is this a valid statement? Why or why not? What variables are important?**

Format: (Open Discussion 5 min; Electronic Discussion - List Categorizer, 10 min.; Topic Commenter, 10 min; List Categorizer- 10 min)

3. **A. Current fire behavior/suppression models adequately consider riparian zones (Agree/Disagree?)**
   B. Can they be used to determine how land/water use in riparian zones may affect fire in western landscapes?
   C. If you do not know fire models, what parameters would you suggest are necessary to predict how riparian/stream ecosystems affect fire properties?

Format: Open discussion, 10 minutes; Electronic Discussion 20 minutes.

COFFEE BREAK (9:20-9:40)

4. **What are the effects of land and water management on efficiency and capability of fire suppression and management**?

Format: (Open Discussion 5 min.; Electronic Discussion 20 min.)

5. **Can we find/cite specific examples of wildfire spread ending at the stream/riparian zone edge (i.e., halting the fire or functioning as a fuel break)?** These can be actual observations, evidence from forest structure, species composition, fire scars, etc.

Format: (Open Discussion 5 min.; Electronic Discussion 10 min.)

6. **A. What are the effects of water diversion on fire suppression?**
   B. Are there any real world examples where diversions have affected the efficiency or safety of fire suppression crews?

Format: (Open Discussion 5 min.; Electronic Discussion 20 min.)

Lunch 11:15- 12:30 (on your own)

12:30 Group session - 2 Broken down into "Disciplinary Groups" (sort of): (1) Fire Management, (2) Fire Science, (3) Riparian/stream ecology, and (4) Hydrology/geomorphology.

TOPIC: What are some knowledge gaps/needed research on the relationships of riparian zones and fire in western forest landscapes?
Assignment of groups and description of discussion task
(Bring Laptops) Flip Charts Provided
Group composed of a Chair, Recorder, Reporter and Contributing Members
12:30- 1:30 Group discussion for 1 hour
Break 10 minutes
1:30-3:30
Presentation of Group1 (10 minutes)
Comments on Group 1 results Open discussion (5 minutes), Electronic discussion- Topic Commenter (5 minutes)

Presentation of Group 2 (10 minutes)
Comments on Group 2 results Open discussion (5 minutes), Electronic discussion- Topic Commenter (5 minutes)

COFFEE BREAK (15 minutes)

Presentation of Group 3 (10 minutes)
Comments on Group 3 results Open discussion (5 minutes), Electronic discussion- Topic Commenter (5 minutes)

Presentation of Group 4 (10 minutes)
Comments on Group 4 results Open discussion (5 minutes), Electronic discussion- Topic Commenter (5 minutes)

3:30- 4:00 **Discussion: Recommendations for Suggested Follow-up actions for Agencies and Researchers.**
Format: (Open Discussion 5 min; Electronic Discussion- List Categorizer)
Comments on the Session- What did you think of this session?
Format: (Open Discussion 5 min; Electronic Discussion- List Categorizer; Topic Commenter 20 min)

4:00 Meeting Adjourns

ACTUAL RESPONSES TO QUESTIONS

*Premise Statements (Topic Commenter)

Participant Instructions

This question encompasses all that we will be discussing for the next two days. Do you Agree/Disagree with each of these premises?

1. Riparian zones have a strong influence on Fire properties (size, intensity, frequency, and severity of fires) in western forest landscapes

agree {#11}

Spatially and temporally variable, especially in semi-arid systems. It depends on geomorphic position and season. {#15}

Agree, but influence may not be equally strong on all of the fire characteristics {#12}

Depends on seasonal severity {#13}

Seems to me that the most important effect might be that it breaks the continuity or an existing fire {#14}

A question, how are riparian areas dealt with in current fire models? {#95}

Not sure how much effect on frequency {#16}

RZs may not have much influence on fire frequency {#17}

Can have a strong influence, but that is very dependent on current weather and fire behavior {#19}

Yes and no. It depends on the vegetation, structure, cover, number of layers, veg pattern. {#21}

This seems intuitive but I wonder how much evidence there is for this as a generalization. How many large fires have had their boundaries determined by riparian zones? How many have not? {#22}

#22 Yes I agree it is easy to say this, and it is almost certainly true, but the science (which would not be all that diffilcult..pattern analysis etc) has not been done, for the most part. {#193}

Good question by 22. Do we have some areas where spatial fire history exists that could be used as case studies? {#174}

Agree. Has this information been synthesized? {#32}

I agree, but don't believe it is STRONG in all cases {#23}

Agree with 23 and 32 - strong is too strong an adjective {#75}

Yes, strong is too strong {#25}

re. #25 Would "important" work instead of strong? {#82}

I'd say "could have an important influence" {#127}

Unfortunately, anything we say about this is largely anecdotal or based on logical arguments at this point, rather than systematic study. We know of some cases where this or that effect occurs, and cases where it does not. Logic suggests wet areas should have this effect etc. There is no solid foundation for much generalization. {#162}

When the vegetation types and structure are different in riparian zones compared to surrounding uplands, then yes, these zones can have a strong influence on fire properties - either functioning as fire breaks or as fuel sources -- which can influence all the named properties. {#28}

There is no question they "have a strong influence in many (probably most) cases but exactly what form that influence takes isn't easy to predict. Clearly riparian areas play a strong role in dictating historic fire pattern and present-day fire behavior. {#29}

I would agree that the influence is strong for larger streams with true riparian vegetation and wider zones, but would say that the 1-2 order streams probably only have a weak influence unless you are talking about prescribed fire. {#30}

I agree. This is a good summary statement. {#58}

It depends, but under some conditions riparian zones could have a strong influence, but in many others it is difficult to see how riparian zones would influence fire properties. Interesting to determine the conditions under which riparian zones influence fire. {#31}

The influence of riparian zones varies with the characteristics of the zone. factors that matter would include the slope of the stream, the width of the bottomland, the slope of the lands adjacent and perpendicular to the stream, etc {#33}

Time of year , size of riparian area in relation to the fuels have an influence. Strong influence may be too much emphasis on the effect of riparian areas on fire spread and intensity. {#34}

I agree that it seems intuitive. Perhaps there are opportunities to look at this as a research topic. {#36}

It depends on the size of the stream and the surrounding vegetation. For example, small streams immersed in a forest canopy will be influenced by but not appreciably affect the fire. Whereas, a larger stream will (is more likely to) have a buffering effect. {#38}

Riparian zones are not divorced from the fire character on the larger upland landscape. Generally, fire severity has increased on uplands in drier forests, and this has had an effect on increasing heat loads in riparian zones, sometimes overwhelming the moist character of such zones. {#65}

Riparian zones differ from upland landscapes in ways that influence fire characteristics. Historically, they sometimes acted as fire barriers, but in drier forests they appear to have burned almost as often (perhaps with lower intensity). {#40}

How does management of riparian zones affect invasive species and what role do riparian zones play in source areas for invasion into surrounding vegetation? {#41}

The riparian influence will depend on the extent and character of the riparian area and the wetland characteristics. In any given year weather conditions and the fuel conditions of adjacent upland types will strongly influence the how riparian affect fire. {#48}

Depends on the type of vegetation in the riparian area in these dry forest zones - some of the riparian areas have low vegetative moisture content by the time the natural fire season starts. Not every stream system does has willows, cottonwoods, aspen and sedges on it and that even when it does, the vegetation is not continuous {#54}

Agree, but the magnitude of the riparian zone and its relationship to the fire regime that it lies in influence how important it is on specific fire properties. {#64}

Re.#73 is this perhaps a function of the current condition of riparian areas that have lost substantial parts of their function due to the past use history . For example incision and drying. {#109}

Comment #78 is important. If only 3% of the fires account for 97% of the acreage, then most fires must be very small. I've seen some numbers suggesting something like 90%+ of all fires burn less than 1 ha. One would have to conclude, that over all, most fires do not interact with riparian zones and the few large fires that account for most of the acreage burned wouldn't be influenced by any but the largest of riparian zones.

That would leave some small percentage of fire types that would potentially be influenced by riparian zones.

That raises another interesting question. Without fire suppression, would the frequency distribution of fire sizes change, so that more fires would be of intermediate size and potentially influenced by the riparian zone? {#189}

If the question were reversed (does the upland zone have a strong influence on the riparian zone) I would tend to be in stronger agreement. to a certain extent, riparian zones are more dependent variables than independent. {#88}

In Yellowstone in 1988, there were some places on the Northern Range (sagebrush steppe) where riparian areas were the only places that burned. {#186}

I disagree with this premise. In general my observation is this because of riparian landform and position they do not affect fire size intensity freq. and severity on the overall landscape. As the year dries out the presence of riparian zones has less and less affect of these fire behavior variables. Early season fires, which would have their fire behavior affected, we put out by our suppression actions. Later in the fire season, they have little effect in these drier forest types. Severity of a fire is often judged by going into such riparian areas and observing fire impact. Theses areas, since they carry water, are very ;much affected, but they make-up a small fraction of the area burned. {#73}

I agree on size. frequency is a function of weather/climatology...from a fuel moisture and ignition source (lightning) standpoint...thus riparian zones didn't have a strong influence on frequency...intensity and severity is also a function of weather/climatology ultimately

Approximately 3% of the fires in western conifer forests account for 97% of the burned acreage.... {#78}

The term "riparian area" needs to be refined. It ranges from intermittent swales with little difference in vegetation, to continually wet and often submerged bogs. The dry intermittent riparian systems can be vital for some life forms that depend on some aspect of its "riparian-ness". {#79}

Riparian zones (including physical, biological, and chemical components together) represent one of a suite of many factors (physical, biological, chemical) that influence fire properties. It also seems important to recognize that these interactions may change through time and are affected by spatial context. {#86}

There are many parameters that govern whether riparian zones have a strong influence on fire in western landscapes. Physical features govern potential vegetation. Condition of the vegetation must be factored in as well. The factors listed (size, intensity, frequency, and severity) all interact with so I guess the answer is it depends! {#96}

Also location (i.e., proximity to fire origin and spread) {#101}

But in RZs where there is water year round, don't these effect the fire properties? In certain area, there are large streams, so I think we have to make our comments and conclusions fit these areas also, not just the extreme of ephemeral streams. {#103}

Is there a different effect for intermittent and ephemeral streams than for perennial streams? Also, there must be a size factor for small vs. large perennial streams. Perhaps we should look at the questions stratified by these stream types, i.e., intermittent, small perennial steams that fires easily "leap" and larger ones. {#147}

Would suggest that the most important effect would be the likelihood of riparian systems to break-up the continuity of a particular fire that moves across the landscape (riparian systems are wetter, have different species, are linear features, occupy topographic low such as valleys). However, in steep terrain, riparian systems may act as chimneys and serve to funnel intense fires up such drainages. {#125}

With respect to #15, the temporal variability should include length of time after the previous fire. {#132}

This is in response to #22. I can think of has many fires that have had their boundaries determined by riparian zones as have not. In most cases the variable that must be taken in account is the prevailing weather. When fires can spot over distances of over a 1/4 of a mile Riparian areas just end up breaking up the continuity of the fire not aiding in the suppression. Sometimes having a riparian area in the middle of your fire is a pain in the ass because now you have fire on two sides of a river and a logistical nightmare. {#159}

This is really dependent on the size, intensity and characteristics of the fire, as well as the size, condition and nature of the riparian zone. Even small riparian areas have a tremendous influence on a low intensity fire (it will often go out or just creep around). Given a high intensity fire, small areas will have little to no influence on the fire but larger areas will play a role, though how strong is really a debatable issue. {#164}

I agree that riparian zones historically played a role in the interior west fire behavior and resulting landscape fire effected burn patterns. In many of today's mid-elevation systems land management practices have altered these impacts. In some cases management activities have increased fuel loading and changed vegetation structure within the riparian zone resulting in hotter fires that have higher resident times. In places where livestock have decreased shrubs and shifted dominance to grained, resulting fire effects are very different than historic patterns. The key in these grained dominated types are the seasonal water table fluxes providing threshold limits for the species that require season long saturated or near saturated conditions. {#195}

2. Land and water use alters the role of how riparian stream/ecosystems affect the fire regimes of western forest landscapes.

Agree {#20}

agree. landuse including upslope uses (or inadvertent upslope alterations such as juniper invasion or tree densities outside of HRV). {#26}

I agree that the importance of this is to often overlooked. How fire behaves in and influences riparian areas is very strongly dependent on the condition of adjacent stands. I have seen a lot of examples in the field that indicate riparian zones are often affected by at least 2 "episodes" of burning , generally associated with fire behavior in the adjacent stand. For example, a common pattern is to see a fire switch from a crown fire to a ground fire as it backs into the riparian zone, then riparian veg is killed (and sometimes crowns) when the fire goes back to high intensity when it hits the stand on the far side of the riparian zone. Homogenization of upslope stands through past management may lead to a lot more extensive riparian mortality like this than we might have seen under a more naturally patchy landscape. {#182}

Land use has a major impact on how riparian systems function and the characteristics of riparian systems. Degraded riparian systems are likely to have a much-reduced effect with regard to their effectiveness at altering fires. {#37}

How about streams degraded by grazing which might be wider and have less fire carrying vegetation than undisturbed, narrow, high grass systems? Wouldn't these be more effective as firelines? {#154}

Is there any evidence or case studies that suggest that stream dewatering has increased fire risk or our ability to suppress fires effectively? {#167}

Yes {#39}

Agree. {#43}

The potential to alter these systems exists. The effects of fire suppression and silivicultural practices (more biomass) in the last 50 years has altered riparian zones. juniper is an excellent example of water held on the mid-slope when it historically was in the stream flow {#44}

Re #44 I believe the rainfall that supports Juniper is typically so small that it would merely be used by other forms of vegetation and plays no role in sustaining the riparian. See the Arizona watershed studies at beaver creek. {#134}

The fundamental issue is the extent to which any land use alters the original disturbance regime (e.g. hydrology, sediment and organic matter production) from upslope areas to the stream and its riparian system. {#173}

#44 and # 134 discuss an interesting issue. My take would be that juniper may result in greater runoff --and sediment!-- relative to that of a grassland that has fires of sufficient frequency to prevent the encroachment of junipers. {#161}

Yes, this effect may come from the immediate adjacent land uses or from uses within the watershed {#45}

Agree. The degree of affect is highly dependent on the type of use. It is difficult to generalize "landuse" or "water-use" {#50}

Yes, the effect may persist after the use is no longer present {#53}

Agree in general but this is a very vague statement and is relevant to almost anything that goes on in a watershed. {#55}

I agree that fire suppression in riparian areas can have significant effects, however, I think that we have improved the knowledge of our suppression personnel to recognize environmental concerns of suppression act ivies. {#56}

I agree. But more importantly, how? The list of possible land and water uses is nearly infinite. Can we narrow down the question to focus on What types of land and water uses affect fire regimes in which ways? {#60}

Agree strongly. But, land use correlates with physiography, relief, valley size, and other physical landscape characteristics that also influence fire, so effects may be intertwined. {#61}

Yes, especially, logging, grazing, roading. Often, but not always these will exacerbate the effect of fire and reduce the positive influences of the riparian. {#63}

This is certainly true in the arid parts of the west where water use for irrigation or home use has changed species composition to a drier less fire resistant species. {#66}

Yes. grazing has been mentioned as a potentially large impact, and it probably has more influence in dryer ecosystems where the forage may be mostly if not exclusively in riparian areas. {#69}

Of course. Certain management practices may increase the risk of invasive species with characteristics that promote fire frequency. Riparian zones play a critical role in that they act as corridors for invasive species that may alter fire regimes. {#70}

Agree; effects of land-use on hydrologic cycle and annual water balance can be strong {#74}

Intermixed public and private lands present special problems, as riparian zone conditions may be very discontinuous. {#83}

Correction on #50, the correct word is "effect" not "affect" {#84}

Agree strongly - land and water use are integral to function of riparian system. Change in hydrology and sedimentology of uplands in watershed has effect - sometimes huge - on riparian system function. Land and water use within riparian zones has had even greater impact on riparian system function. A lot of systems that have lost water table and changed species composition from more to less fire resistant and resilient species - e.g. sedges to Kentucky bluegrass or other exotic grasses. {#93}

Another factor in land and water use is the changing from a wildland to an urban or urban-intermix area where suppression activities change from protecting resources to protecting houses or other "improvements". Also areas that have had water flows are now dry or drier and do not provide any aid in suppression activity. {#94}

I agree with this statement. Dewatered courses are very flammable due to the deep organic layer produced earlier and the additional downed woody fuel derived from tree mortality. {#97}

Changes in species can provide a fire corridor in riparian areas when more flammable vegetation takes over-either from exotics or plantings. {#99}

Agree, that land use alters how riparian stream ecosystems, but to the degree that the riparian and stream/ecosystems influence large scale fire regimes is uncertain. {#102}

Historically many stream systems in the west were beaver swamps prior to 1840. I would imaging that the influence of riparian areas was much more pronounced in these cases. Accordingly, it seems that altered stream flow and diminished extent of wetland components of riparian would affect the fire regime. {#165}

I am bothered by the way in which the question is phrased. If it were "land and water use alter the role of fire in riparian zones (e.g., what goes on in the upland affects the riparian) I would be more inclined to be able to provide an "answer": yes. I'm not sure, though, that land and water use on uplands affects that way that riparian areas affects larger scale fire regimes is as valid. If forced to answer I would conclude as stated that question is marginally true, perhaps not significantly so{#114}

Certainly evidence that land and water use alters riparian stream/ecosystems, and as with all of the other components influence fire, these changes may affect fire regimes. These factors could certainly have strong influence on post-fire response of the riparian stream/ecosystem. {#115}

Perhaps the topic will occur later in the session, but fires on upslope areas also can have profound affects on downslope riparian systems. For example-- increased runoff, higher peakflows, increased sediment production (surface erosion or mass soil movements), increased large wood loading over time all have the potential (depending upon local conditions) of greatly altering riparian systems. {#146}

Agree. What happens on the upslope with fires often determines the future condition of the riparian ecosystem as well. {#181}

3. Riparian zones/streams are key areas for many aspects of fire suppression operations (fire lines, back fires, safety and escape, water sources, etc).

This is generally true. However, environmental safeguards normally accorded fragile areas such as riparian are often disregarded in the zeal to control the fire. Sometimes these fire control efforts cause more ecologic damage than the fire itself. {#18}

Agree w/18 {#122}

Agree with #18 {#49}

Depends on land management constraints--some areas shouldn't be used for suppression efforts (possible ecological damage). Others may not be critical for managing the fire's growth. {#42}

Fire suppression operations can generally rely on other areas (e.g., ridgelines or other natural barriers). {#141}

I guess so, although I hope they aren't putting lines in next to riparian areas as a regular practice. I worry about the damage done in the name of suppressing a fire that perhaps is a benefit to the system. {#47}

Agree, we routinely use these areas for these purposes. However, in some instances, they may not be available due to ESA issues, etc. {#51}

Perhaps, but to the extent that we allow fire to be put back in the ecosystem, this use may diminish {#72}

Yes, but my agreement is largely based on what I learned from Mike Lorhrey's presentation. {#76}

This again depends on the characteristics of the riparian area. broad wet meadows are certainly more important in suppression strategy than narrow canyon bottom streams. {#91}

Not being a fire suppression person I can't comment with knowledge on this; however, I believe that riparian areas burned when conditions were right and if we keep fire out of them then we are altering the natural processes. And as stated by 18 the cure may be worse than the problem (fire is a natural disturbance) depending on the riparian system. {#92}

Sensitivity to the issue of adverse impacts of suppression activities themselves has markedly increased in the past decade (it needed to!), with very beneficial results. I'm not a fire manager but have worked on a few and can assure you that in the minds of field crews, riparian areas have always been looked at as critical areas of refuge or, depending on fuel and wind conditions, etc, and the size and wetness of the zone, as potential natural fire breaks. {#100}

I agree with 91. Sedge/ willow vegetation complexes in wide, flat valley bottoms are a more effective firebreak than riparian shrub types (willow, dogwood, birch, alder) in a narrow valley bottom. And the degree of use they can handle (in terms of soil displacement, compaction etc) will vary. {#105}

Generally, true. extreme fire behavior scenarios often have watershed-level effects, the laws of thermodynamics override the damping effect of a riparian zone under these conditions....this statement is true in cases of low and moderate fire behavior characteristics {#106}

This is a function of pre-fire fuel treatments. Fuel breaks, when extensive enough, act to prevent dependence upon riparian zones during fires, with obvious benefits to these wetland systems. {#112}

The objective of this workshop seems to focus on riparian areas as important to fire control and spread. However, this must be discussed within the context of what most agree is the role of riparian areas: that is, as foci of ecologic diversity, filters of watershed products, refugia from water stress, etc. {#113}

I've seen a lot of meadows that have been used as fire camps and staging areas that have been damaged (compaction and ground disturbance that promotes the establishment of non-native weeds) - apparently considered sacrifice areas during the "emergency" of fighting a fire. It's disturbing to think that more riparian areas would be considered supply zones for fire crews to run equipment and crews through. Again, riparian zones in dry forests may be better suited to be firebreaks and refuges for firefighter safety than water supply sites {#123}

I agree with 92. Most riparian species are root crown sprouters and typically have vigorous growth following fire. They are also shade intolerant and when shade tolerant conifers (grand fir, Doug-fir) come in and shade them out, we've lost that critical component. We need to allow fire back into these systems. Conifer don't contribute nutrients to the stream or hold the banks the way deciduous shrubs do. {#126}

I think this is an issue of place. Certainly larger riparian zones can serve these functions, but small ones probably cannot even as escape routes. {#137}

I agree with #113's concerns. I have never viewed riparian areas in this context so it is difficult to address these questions without some concern. {#142}

Yes, wetlands in general play important roles, however, the contemporary role is far less than in the past as there has been extraordinary loss of wetlands. Interesting sidelight to this is the recent paper suggesting one of the fire-type pines distribution can be explained by Holocene wetland patterns. {#144}

I disagree with this statement. Riparian areas are at the bottoms of canyons, etc. and fires under strong wind conditions blow right on by them. They may not burn, but they are not KEY to aspects of fire suppression strategies. Until we really get the planning done for large scale "wildland fire use for resource benefit", they will not be KEY. We really have never conducted ex post facto studies of fire behavior analyst observations under an array of fire weather conditions to really know what are REAL barriers, safety zones or escape routes. Neither BEHAVE nor FARSITE really help us evaluate these situations. They are useless and dangerous for such evaluations. {#150}

Agree, that they are key however; fire suppressions activity in these zones are influenced by Land and Resource Management Plans (LMRP) and its Standard and Guidelines(S&G's). The S&G's influence the Wildland Fire Situation Analysis and direct the suppression activities that are allowed to occur in the ecosystems. The Incident Commander and their Staff take these into consideration during the planning of suppression activities. {#155}

In answer to #123 it is regrettable that incident bases are established in riparian areas but often there are no other places to put them. On the other hand if line officers are doing their jobs by doing a good WFSA and resource advice. {#196}

4. Land and water use can affect the efficacy of fire suppression efforts.

Agree. But, also, fire suppression efforts substantially influence ecosystem function. Often, suppression efforts disregard normal environmental safeguards. {#10}

In dry forests (where I've worked) there is often little water available in streams for fire suppression efforts - hardly enough to fill a bladder bag, let alone a bucket - I question the emphasis on maintenance of flow in these streams for fire suppression efforts - better to concentrate on the fire break properties of these systems {#24}

Long-term land use of uplands is a major factor in the character of fires and therefore the efficacy of fire suppression efforts. {#57}

Suppression efforts should be constrained by land and water use practices/decisions {#67}

I agree with 24! If we are dewatering small streams to "save" a forest type that historically has a frequent fire return interval, we've probably done more damage to both systems. I guess it depends on the situation. {#68}

Sure, but this doesn't say much {#98}

Agree with 68 and 24 for 1-3 order streams that I work with. These systems make up a large proportion of the forested areas. I think we need to make a distinction based on size of steams or flow volumes before this argument makes much sense. {#107}

Are we talking specifically about land and water use in the riparian areas of interest? I guess it doesn't matter, because the answer will still be a sort of uninteresting "yeah." {#117}

And water use during fire suppression operations can affect the function of the streams and the health of the land. Fire suppression can be more damaging than some other land uses and should not be considered a benign use. {#131}

I'd guess that in the greater scheme of things, the ecological effects of land and water use on riparian areas (e.g., as they affect vegetation species composition and greenness, water tables, stand structure and coarse woody debris have a much larger influence on fire behavior and effects than does the provision of water for direct suppression activity. {#139}

Agree, however, this is almost too open-ended {#140}

Land use in the past has certainly altered the efficacy of fire suppression - just look at western fire stats - more fires and more severe fires in drier forests than ever before. These have attendant effects on riparian values even if the riparian area does not burn. Water use, even if it dries streams, may not have that much impact on fire suppression if it is a weather-driven event. {#157}

Disagree that the western fire stats are compelling. There are competing explanations for trends in area burned. These include global warming, increasing efficiency at gathering data, and past management practices (including suppression, grazing, more people in the woods). {#183}

Fuel vs. weather driven events - historically in these drier forests, fires were much more fuel driven, due to limitations placed on fire spread and intensity by frequent fire. 2oth century suppression has eliminated this feedback control, so that fires are now more weather-driven events -- and as soon as the weather shifts the fire is controlled. But it was not (in my view) that way historically in these drier forests. {#175}

Agree, but suppression activities that occur in these areas are influenced by the Standards and Guidelines in the Forest Plan. {#168}

I agree. Land use alterations are not firebreaks. Unmanned they generally don't stop fires. They are really only safe places to make stands against on coming fires. Water use can be view as a competitor for water that could be used for fire fighting. Some water

uses may actually make water more available for suppression actions. Dams, ponds, diversions, etc create places where water could be pumped or drafted. {#170}

This needs to examined in the context of weather patterns that play a determining role in fire severity; In my part of the world, severe weather readily carries fires through and/or over riparian zones. {#179}

5. Restoration of riparian zones has benefits to wildland fire management of the landscape.

Relating this to benefits of fire suppression would be difficult. This could only be accomplished via modeling or post-hoc after the fire has moved through an area {#46}

Agreed, but of greater significance is that restored riparian systems (i.e., those that exhibit improved ecological functioning from current conditions) have much greater benefits to wildlife, fisheries, water quality, and favorable conditions of flow. {#71}

Restoration of uplands, because of their larger scale on the landscape, will have more significant effects on fire management that restoration of riparian zones. {#188}

Agree with comment #71!! {#138}

Restoration is not well defined. does it mean that the riparian system has restored function - e.g. re-creating a functioning floodplain or does it mean that we create some new structure that wasn't there. Not good for riparian systems to impose an idea of what would be good places to aid in fire suppression, e.g. creating artificial pools, thinning and removing fuels (especially riparian shrubs) that are vital for riparian function and for all the species that depend on them for habitat and food. {#172}

The "Agreed" in statement #71 refers to the original statement, not the message on the preceding line. {#80}

Agree--restoration of riparian zones should provide options for future management of wildland. {#77}

I agree with both 46 and 71. I think the benefits are restored ecological function with all the associated habitat features that benefit the resources out there on the land, not the fire suppression efforts. {#81}

Yes. Long-term fire suppression often results in succession to different forest types - compositionally and structurally - that render them more susceptible to high intensity fires and thus reduces their efficacy as fire breaks and safe zones -- they are indeed more rather than less hazardous. {#85}

In general this is a true statement, there may be some instances where the climax riparian community type may not be as beneficial to fire suppression as an earlier seral state. {#87}

Agree with #90 -- and would add thinning to prescribed burning. Some areas are in such an advanced stage of succession that it would take repeated, rather severe fires to accomplish objectives of killing later-successional conifers. Thoughtfully designed thinning efforts (e.g. only in winter on frozen snow-packed ground) would have less impact on fragile riparian soils and reduce potential for exotic invasions. {#178}

Agree- I think it should improve both function and suppression efforts. Restoration that involves prescribed fire may be very effective in terms of wildland fire management. In semiarid, systems converting sagebrush dominated systems to graminoids (where the potential exists) is a good example. Another example is areas where conifer encroachment into deciduous bottoms has been a problem, e.g., P-J and other tree species into aspen, cottonwood dominated riparian corridors. {#90}

No blanket yes answer to this one, based on what we heard yesterday. {#108}

Agree, to the extent that riparian zones act as natural firebreaks. Other possible benefits include the role of riparian zones as refugia for animals (and plants, microbes...?) during fires; the role of riparian zones in protecting streams from excessive sediment inputs following fire. {#110}

Not so simple; must be an ecosystem-specific answer and specific to the particulars of the structure or function to be restored {#116}

This is probably true to some extent across the board. if fire is to play a role in a more natural way, restoration of "natural" conditions seems to make sense. the challenge is to figure out what "natural" is. some parts of the country have been influenced by human behavior for hundreds if not thousands of years and the concept of going back to "pre-European" conditions is a quaint fantasy. {#118}

If restoration of the riparian zones includes sufficient fuels management to allow the riparian zone to be effective in fire management then there is a benefit. Restoration of the riparian areas cannot be apart from the restoration of the entire landscape. {#119}

Does fuel management in some cases conflict with ecological goals for the restoration? {#145}

I guess it depends on how the manager defines restoration. For example, if it is the creation of artificial pools large enough to fill bladder bags or establishment of road access for pumpers, then those "benefits" might override the ecological benefits that many of us have in mind. {#121}

Those should not be included in riparian zone restoration. {#151}

This is a "chicken or the egg" topic.....if we restore fire to the landscape (politically difficult, if not impossible) the riparian zones would be "restored" {#124}

Not necessarily. There may be other problems in the riparian zone. {#153}

I am curious if there is enough empirical data to show this, or if it is only an intuitively appealing hypothesis. Several comments seem to suggest agreement, even strong agreement, yet the question, as posed, is quite general. {#128}

I agree with #116, we have to look at the specific area types in order to make this conclusion. I don't think we can make a blanket statement for all forests in the west.. {#129}

This is possibly true, but the data seems to be weak. However, I strongly suggest that in the list of the reasons or justification for riparian restoration, benefits to wildland fire management would not show within the top 100 reasons. {#133}

I disagree with 133! I would assume that it could be a very high and important reason especially since the restoration of fire regimes would be an important property of the restoration of biological diversity! {#158}

Alternative state and threshold concepts may play a role here. We need to know what the current potential of the system is. For severely degraded areas, we may be looking at entirely new types. In this case, "designer ecosystems" can be created that take fire characteristics into account. {#135}

Depends on what you mean by restoration. If stream has been incised and RZ has been de-watered, restoration to raise the water table (which takes a long time) should have positive effects. In other types of stream that don't incise (and they are many), restoration may have less effect on fire management (but great ecological benefits). In some cases we need to restore the RZ and stream to a condition that may have negative impacts on fire management (increasing veg. and fuels) but need too be done anyway for non-fire ecological benefits. {#136}

Certainly key to processes that can influence the consequences of fire. {#143}

I agree with 46 and 71 but again think this is most relevant to streams of 3rd order or greater. Often the 1-2 order streams have large trees right down to the edge of the steam. There may be some increase in the amount of vegetation or a different type of vegetation (herbaceous, shrub, understory trees) on 1-2 order streams because of the moisture but for wildland fire management I can't believe that these stream systems would play much of a role in suppression. The restoration benefits exist for other resources. {#148}

Maybe 1st and 2nd order streams are important for fire behavior in some dry western forests. I would not rule it out. {#163}

I agree strongly with the statement that restoring riparian zones must be part of a larger landscape restoration package, albeit a very important part. If the landscap4 as a whole is highly flammable, the beneficial effects of riparian zones may be overwhelmed. {#152}

Agree. This may be a scale issue. Larger scale restoration efforts may positively influence water balance in the uplands and consequently hydrologic regimes within the riparian corridor. But system type and characteristics are certainly important. {#156}

Isn't the argument that an improved RZ creates more fuels, then more fires a red herring? If there is more water in a perennial system then would not the vegetation remain somewhat green for a longer time and thus decrease fire intensity? see #136 {#160}

Agree with #160. Again need to think entire riparian corridor, watershed context. {#169}

Agree, with qualifications. The question implies that restoration will benefit fire management; however, restoration is more art than science, thus to presume it will benefit fire management you must be able to predict the outcome of the restoration, which I think is hard in many cases. {#177}

One of the serious problems with any restoration program is that often the purpose is too narrow without consideration to the effects on other processes. There are many examples of restoration activities that were exactly the wrong thing to do for important elements of the landscape. A focus on fire is probably one of those aspects where the focus is much too narrow. {#184}

I can think of far more valuable attributes of riparian systems that would be the reasons for restoration. {#185}

I agree and disagree with this one. Unless we really to the "wildland fire use planning" the restoration of riparian zones may have marginal benefits to fire management on the landscape resolution. {#187}

We need to take restoration into the realm of strong science, and are doing so in many instances. Restoration "experiment" are great tools for understanding system dynamics and need to be structured in that context. {#190}

Restoration must and should be based on science and not art. There is much that should be considered in a restoration plan such as existing and "natural ecological processes" etc. An "art would not follow the basic principles of restoration! {#191}

Restoration of riparian zones should not take place solely for fire management purposes, but in doing so should provide some options for future management. {#192}

II. *Riparian Zones and Fire Properties (Topic Commenter)

How do riparian zones affect the fire properties of western-forested landscapes?

By fire properties we are referring to the size, return interval, fire behavior, and fire severity in western forests (Behavior = intensity, rate of spread, resistance to control, etc.; Severity = the ecological effects of fire).

We should expect that prescribed natural fires will be markedly limited by riparian zones due to the weather conditions under which they are allowed to burn. Wild fires are more likely to less constrained. {#4}

Agree, but would alter the wording on this -- "early season fires" "fires burning under moister conditions" rather than "PNFs" and "late season fires" or "fires burning under drier conditions" rather than "wildfires". {#18}

Agree with #4 {#6}

Doesn't this depend on system type and season. {#5}

Riparian zones that have higher humidity and comprise facultative and/or obligate wetland plants can definitely act as fire breaks depending on the intensity of the fire in the surrounding uplands and the size of the riparian zone. {#7}

Via their effects on fuel load and microclimate. {#8}

Seems that one could generalize if they fall back to the basics of comparing fuel load, fuel character and microclimatic effects relative to upland vegetation. {#33}

May not affect frequency {#9}

Agree with #9 {#10}

This varies by the vegetation types, the associated fuel loading characteristics (depth of the fuel layer, size of the fuels etc..), the live vegetation layers, cover, and continuity of the herbaceous undergrowth. The severity of the fire (mortality to conifers) isn't a critical issue for the fire-adapted shrubs which sprout after fire. {#11}

If frequency isn't different in uplands vs. riparian zones I wonder if SEVERITY is different - And I wonder if you could get at the difference in fire severity in riparian zones vs. uplands by characterizing the scars themselves -- if you assume larger scars resulting from more severe fires compared to smaller scars/lower severity fires..... {#34}

In drier landscapes riparian zones appear to have moderated fire behavior due to higher fuel moisture, and in perennial streams the presence of a true natural firebreak. But the presence of fire was about the same in riparian zones and uplands (a little longer fire

return interval). True at least for most low-severity fire regimes (gosh, who wrote this one). {#12}

In a previous section someone asked how riparian areas are included in fire prediction models. I don't recall seeing an answer, but IF riparian areas are specifically excluded from these models, one might safely conclude that riparian area have a small role in effecting fire properties. {#13}

Or that the models are way less than perfect..... {#38}

Degree if degradation and encroachment of upland species may also play a role here. Effects of stream incision, water diversions all play a role. {#14}

RZs may have more influence on rate of fire spread, and on actually stopping fire, under certain kinds of drainage patterns and perennial stream density. Compare dendritic systems with parallel or pinnate systems, for example... (I haven't but someone should do this.) {#15}

Agree with comment about fire impact on fire-adapted shrubs. most riparian shrubs are adapted to any kind of disturbance that can top-kill the plant. {#16}

This strongly depends on condition. In an intermittent 1st order stream there may be no difference, except the channel and topography may provide an intense chimney effect (this is topographically driven). In a wet meadow, the fire conditions are greatly affected by the vegetation/water. IT ALL DEPENDS/ ONE CANNOT GENERALIZE AT THIS SCALE. {#17}

Very small streams, probably only an affect early in fire season. {#19}

This is a question that has many different answers, depending on the size, and condition of the riparian area, and the fire size and intensity. Again, every riparian zone has the potential to alter fire behavior, because of higher relative humilities, etc. {#20}

Agree with 17. Not all riparian zones are equal...We all know that of course! {#21}

My experience is that riparian areas primarily serve to limit the extent of fires and that when they are unburned, they provide core areas for the beginning of restoration efforts. {#22}

Size could be determined by the riparian zones to a degree. the ultimate fire behavior characteristics would be driven by the vegetation (age) and weather at the time of the fire {#23}

Southern Sierra Nevada. 1-3 order streams would affect prescribed fire, but I don't think they would affect a wildfire in most cases. 3-4 order streams and higher could influence

ground fire depending on wind conditions. Larger steams and rivers certainly create more of a microclimate, especially near the ground. Again under the right weather conditions they could play a role in affecting even crown fires. {#24}

The historic extent of riparian wetlands was much more extensive. (Dobyns) The increased density and extent of these riparian areas likely had a much greater influence on the behavior and extent of the natural fire regime. Certainly catastrophic situations would overwhelm these effects at times. I believe that current conditions have rendered riparian areas less influential in the current scheme of management. {#25}

The effect of riparian zones will depend on the severity of the fire season and condition (loading, depth, arrangement (horizontally and vertically) of fuels before, within, and after the "fire encounter". Over the long term riparian zones should reduce the areal extent of fire (in most cases)--still the exceptions will be significant. {#26}

The significant effects on fire behavior in riparian zones is not so much the vegetation but the topography of the zone. Deep canyons, narrow canyons, all make good funnels and chimneys. Areas where a stream channel takes a sudden turn can bounce wind in to different areas. Fire spread and intensity is greatly influenced by the speed of the winds as they are pushed through narrow channels and up canyons. The vegetation in the wetter zones may not even be effected but everything on the upland side is threatened by the wind effects of the riparian topography. {#27}

I agree with #17. We have to look at specific types of streams and their properties in order to make these type of statements. {#28}

Beyond saying "Yes. they typically have an effect," it gets a bit treacherous to generalize about what specific effects. What's obvious is that the pattern of fire behavior and effect is often spatially influenced by riparian zones. There are probably general patterns of influence (i.e. lower intensity and severity in riparian areas, somewhat greater than random likelihood for fire boundary to terminate at a riparian area, etc., but the exceptions are important, and I would not stake my life or my ecosystem on any very specific prediction. {#29}

It also depends on time of year. Grass in wet meadows can dry in the fall and readily carry a fire, when at other times could not be ignited with napalm. {#30}

There are difficulties in assessing this through paleo approaches (e.g., tree rings and fire scars).
Fire scars found on trees in a streamside forest may represent a crown fire coming from the uplands that hit the ground and eventually went out. It may be a surface fire in the riparian zone, but one of little effect, representing the tail end of a crown fire. Or, the scar may represent a real
surface fire coming in from the uplands, or a surface fire burning in the actual riparian zone. Researchers have been too uncritical about this problem of evidence. {#31}

To the extent that riparian zones act as fire breaks, over the long term they contribute significantly to the patchiness of seral stages and fuel accumulations, from which it follows fires would be more frequent on a larger landscape, but less extensive (excepting extreme weather conditions). {#32}

Agree that generalization is not possible. Also not possible to generalize that an entire riparian zone in any given spot on the landscape will have the same properties. Generally there are 2 to many different plant communities in one riparian zone that are of varying sizes and will have completely different effects on fire behavior {#35}

Today with altered fuel loads, the difference between riparian areas and uplands isn't perhaps as noticeable as in past times due to the shift to a more weather-driven fire regime where fuels are less important (overwhelmed by excessive heat for accumulated fuels) {#36}

One of the factors that influences the impact of a riparian zone, even a narrow one, is the aspect of the adjacent slopes. south facing slopes with a low intensity backing fire typically do not cross to the opposite (north facing) side of the canyon when they back into the damper riparian area.
As for #13, I wouldn't give fire modeling that much credit. {#37}

Re # 13 Or that they are small and inconvenient to deal with in our current modeling. {#39}

Since I know very little about fire, I can only hypothesize. I'm guessing that in many mountain landscapes, the riparian zones of first and second order streams are too small to have much of an effect on fire. The exception might be subalpine meadows and areas that have been glaciated, where the valley form is not really fluvial in origin. So, I think there is a strong scale-dependence. {#40}

These are all working hypotheses:

RETURN PERIOD -- Essentially no effect on terrestrial ignition points

FIRE BEHAVIOR-- Where riparian zones represent a discontinuity in fuel types, or topography, then they may have an important influence

FIRE SIZE -- This may be the most important effect. May reduce total size or even where total size is not influenced, the presence of riparian zones may break the continuity of the burn area and be a major contributor to creating a mosaic of burn patterns on the landscape. Note, if riparian areas are effective at reducing fire size, then they w

FIRE SIZE -- If fire continuity is altered by functional riparian system, then the overall severity of a fire may be influenced. Locally, the severity of fire in the riparian zone may be significantly different that adjacent terrestrial areas {#41}

It is true that some 1-3 order streams can have substantial meadows at mid to high locations in the watershed. These could be useful in helping stop a fire--but they are not continuous. {#42}

Historically they played a large role in affecting fire extent since little suppression actions were taken. Native people probably utilized riparian zones as barriers to fire spread. Under our current conditions, since we managed our landscapes with high intensity wildfire, they have limited affect on fire properties. Current SMZ restrictions my make them more susceptible to sever fire. They have high RTC because of our management guidelines, not do to their bio-physical conditions. {#43}

In larger streams: fire breaks

In wetland (low vegetation) areas: lowered intensity, fire breaks, speedier recovery (within the first year)

In smaller streams: Increased intensity on south-facing catchments

In all sizes: little effect on fire size during high fire danger years. These fire storms can effect
/ jump {#44}

#27 yeah this is critical {#45}

In areas where the riparian zones are in ecosystems where fire regime is functioning, then the role of the riparian zone can be evaluated on its influence on fire. {#46}

It seems that issues of drainage size, elevation, and topography influence how riparian zones my affect fire properties. In unconstrained segments of larger drainages, where riparian biomass is high, fire may be progress of a fire may be diverted or slowed, but in dry years or under extreme weather the affect may be the opposite... {#47}

The effects of micro climates on the effect of fire is often felt at night with the diurnal variation bringing a cooler moister environment. {#48}

To answer this question riparian types need to be defined by the dominate vegetation life form: tree (conifer and deciduous) shrub, and herbaceous. Each of these types will have a different fuel load, fuel moisture, and interact with the physical feature in the landscape resulting in a specific behavior. {#49}

*Fire Properties or Riparian Zones Compared to Uplands (Topic Commenter)

1. Are fire properties and fire regimes in riparian zones different from their surrounding uplands (Fire regimes are manifested in their frequency, magnitude, and extent)? In what forest types and how do they vary?

Consider the physical as well as the vegetation aspects! {#9}

is the difference significant enough to protect? I would hope it would be in certain systems {#10}

Look at the contrast between the upland and the RZ -- in veg, geomorphology, soils. Where RZs are less different from the uplands, there will be less difference in fire properties and regimes. Where RZs are more different from uplands, there will be more difference in fires. {#11}

The ambiguity of the fire record in riparian zones makes this very difficult to determine using paleo approaches (e.g., fire scars, tree rings). {#12}

There really are opportunities to look more at the fire scar record and reveal more information about fire severity - size of scars, density of scarring in a population of trees for a given fire event - which should be applied more in fire history analysis. {#26}

Re 12: We can at least use historical fires (even last 2 decades) where we have direct evidence. This could be summarized -- there are probably enough fires for the general patterns to show. {#20}

Not sure historical fires would be representative; many seem to assume historical fires are not natural in intensity {#46}

In situations where coniferous vegetation in continuous from uplands to riparian zones - either e.g., in headwaters or where fire suppression has led to succession and continuity - there will be little difference. Alternatively where there is a difference in vegetation type, there will be different fire properties - but as has been pointed out this distinction is dependent on weather conditions and may disappear entirely. {#13}

Again, I think this is a scale-dependent problem, with topography playing an important role. {#14}

Yes and we should discuss how topography affects fire regimes {#18}

In intermittent steepland 1st order coniferous streams, there may be very little difference between the channel and the uplands. However, these channels often provide the structure (wood, water, nutrients, sediment) that supports the riparian ecosystem downstream. In larger, less-steep streams, riparian systems may be more moist and be quite different in structure from the adjacent uplands. {#15}

In landscapes with stream terraces, typically there are differences in veg., moisture, etc. going from upland to high terrace to low terrace -- these should have an influence on fire. {#43}

They TYPICALLY OCCUPY LOWER TOPOGRAPHIC POSITIONS AND ARE GENERALLY INFLUENCED BY THE ACCUMULATION OF SOIL WATER DRAINING DOWN SLOPE. I'm not meaning to shout. just hit the caps key accidentally. {#16}

In semi-arid rangelands with degraded riparian corridors (incised streams or streams with diversions - wide valley bottoms), fire severity and intensity may be higher due to higher fuels (Basin Big sagebrush dominated). This may also be the case (at lease for intensity) for riparian corridors with P-J encroachment.. {#17}

The riparian zone fire regime would be different--less severe and lass frequent--in any forest type
where the riparian zone has a significant component of hardwoods and/or shrubs forbs with relatively high foliar moisture. {#19}

Not sure less severe is right; usually where fires are less frequent, they are more severe {#49}

But even the extent of change reported in Chan's work is likely enough to affect the fire behavior of a fire moving into a riparian zones and perhaps in the landscape as a whole! {#45}

There has been very little research regarding microclimates above aquatic zones, in adjacent riparian zones, and uplands. However, research in western Oregon forests indicate that increased in humidity (associated with the effects of the stream) do not extend very far from the channel. Agee had some data indicating that understory plants in riparian zones may have higher moisture levels. Conclusion of all this: Microclimate effects of aquatic riparian systems to not extend very far away from the main channel. {#22}

In the warm dry DF-PP types, in high gradient, first to third order streams, most riparian zones have historically been shrub dominated. In the absence of fire, the shade tolerant conifers, grand fir and Doug-fir, have established in these shrub communities and eventually are shading out the shrubs. This occurs in narrow valley bottoms where the conifers occupy the toe slopes and terraces (if present). When the conifers shade out the shrubs, the composition and structure is more similar to the upland vegetation, so the fire behavior is most likely similar too. If any shrubs are present, following fire there will be a release if most of the overstory is removed. {#23}

Yes, when the veg (fuel) and topography are driving the fire behavior characteristics. no, when the weather is dependent variable in fire behavior. {#24}

#11 makes an excellent point - gradient between the uplands and riparian areas could be an important key to determining the intensity and extent of differences in fire properties and regimes from the surrounding uplands. {#52}

Yes, this is scale dependent, if we are talking about river basins, it vary a lot. At the watershed scale it begins to vary less. The vegetation is influenced by the fire regime. {#25}

Yes and no, they vary by topography, geomorphic setting, etc. Large wet meadows in 1st and 2nd order streams in many instances rarely dry to the point that they will carry fire. On the other hand, on very small riparian areas dominated by the same or similar upland species will respond in the same manner. {#27}

Riparian areas are less likely to be points of ignition if in healthy condition {#28}

It's hard for me to separate the influence of vegetation, topography, basin size, gradient, and weather. It seems that an individual watershed should be considered in light of this context.. {#29}

The historical to current change (time) seems to mask the once-likely more significant differences between riparian and upland forests in dry forest types. This has to be separated in discussion from differences between forest types (a spatial rather then temporal change). {#53}

Currently, there is high severity in uplands and riparian zones in drier forest types, so there is a strong temporal element in comparing uplands and riparian zones. Historically, both were primarily low-severity in ponderosa pine and mixed-conifer forests (most of those types of forests). Frequency was about the same, intensity was probably a little less, severity low in both uplands and riparian. fire likely kept the areas open enough that a high deciduous component could exist in the riparian zone. {#30}

Disagree with this {#59}

In the southern Sierra Nevada I would say that you start to see a difference for streams once you move into 3rd order and larger. These are perennial and have wider zones with significantly more green understory. They are, of course, generally lower gradient.
Pine forests at 4,000 ft. and lower have fewer meadow and perennial streams at 1-3 order.
Mixed conifer and fir forests have more perennial streams at 1-3 order with more headwater meadows and seeps. {#31}

Probably. the microclimate of even a narrow riparian area influences both live and dead fuel moisture. The influence this has on overall fire behavior would be dependent on a lot of other factors. {#33}

Re #34: Agree entirely. The landscape pattern of vegetation (structure, species diversity, etc.) all indicate riparian areas are different {#63}

I think natural patterns of vegetation tell us they are different in many, perhaps most cases. Over broad areas of mixed conifer forest in the Klamath Mtns and the northern US Rockies where I have worked, there is higher species diversity, fine scale patchiness of stand structure and many more large, old trees than occur n most adjacent upland slopes. {#34}

In lower elevation forested where the historic role of fire was high freq/low Intensity, there was probably little difference between fire frequency in the adjacent upland and the riparian areas. In the mixed fire regime types, the mix implies differences if susceptibility to fire and all fire was lethal. In such areas, depending on longer term drought conditions, the fire properties were different for most of the fire season. In severe drought, the entire drainage would burn. {#38}

Relative to our previous discussion, since this transcript is electronically available I believe it should be provided to all participants. Of course the summaries will be the most valuable, some of us however, would like to evaluate the process and also see to what extent summaries faithfully translate the full range of variation of opinion. {#40}

Definitely in most cases {#41}

They vary in dry coniferous forest types depending on the valley width and soil depth, the degree of development (age, height) of the riparian vegetation, the amount of soil moisture or proximity to the water table, and the aspect.

They vary in wetland vegetation depending on the soil moisture, plant density and height. {#44}

In regard to #26, in many riparian areas there are on fire scarred remnants; the above ground veg is destroyed completely or is killed and decays within a couple of years. {#47}

RE #40 I also like the idea of the comments having some reorganizing, etc. (i.e. Ziemer's suggestion) to make some sense of all the "information" flowing into these sessions {#48}

I would imagine that elevation, steepness, and other environmental gradients would need to be considered, along with the type of riparian zone. Meadow, shrub, forest fire properties would vary from their upland environments based on the degree to which these gradients change. Again these distinctions would depend on the variations in fire weather and climate. {#50}

In the interior west the answer is generally yes. On the western slopes of the Cascade Range and the coastal forests of the Pacific Northwest I would say this generalization does not hold.
In the Interior west, vegetation is strongly governed by plant soil water gradients that are related to geomorphic patterns. The ecotone breaks from upland to riparian zones often are very distinct both in species composition and life form. These features directly effect fire properties between upland and riparian vegetation. {#51}

I agree with 40 and 48 also. These comments are very useful. {#54}

In some less-arid regions of the west, there is a large shrub component in even first-order riparian areas, and I suspect, as Jim Agee's presentation suggested (or implied?) this may play a very substantial role in moderating fire behavior and effects (intensity and severity mainly). {#55}

As with many other questions, the answer is: IT ALL DEPENDS. The conditions are so variable that it is very dangerous to generalize at a landscape scale. Perhaps ecosystems might be a point of generalization. Arid southwest scrubland, for example, might be a point where processes might be generalizable. Similarly, northwest conifer rainforests might be generalizable., ETC. {#56}

Has anyone compared the influence of riparian zones in landscapes with different drainage pattern - fire movement behavior? Effects will be different when the typical direction of fire movement is parallel with the drainage network, vs. perpendicular to drainage network. {#57}

The point made yesterday that the riparian areas often cannot be sampled directly for fire history is an important consideration. It may lead to incorrect inferences about the amount of fire that actually burns through riparian wetlands of any extent. {#58}

In terms of vegetation types, they correlate strongly with geomorphic characteristics and hydrologic regime. Since our understanding depends on our experience, capitalizing on everyone's understanding of specific systems may be of most benefit. {#61}

Fire regimes in narrow riparian zones in low-order streams are probably the closest to their surrounding uplands because either the vegetation is similar to the uplands or the size of the riparian zone is not enough to cause a great enough physical difference (soil moisture, relative humidity, etc.) between the riparian zone and the upland. the larger and wetter the riparian zone, the smaller the extent of the fire. I think this is correlated much more with position in the watershed - stream order, discharge, hydrograph, parent materials, sedimentology, etc. than the forest type. {#62}

The final report will have all of the comments. They will simply be organized for easier reading. {#64}

Steep topography, constrained smaller streams in denser forest types seem likely to be little differentiated from surrounding upland. But in the same landscape, but drier climate, where NPP is significantly higher in RZs than in adjacent uplands, seems that RZs would facilitate fires. Conversely, in gentle topography or in unconstrained reaches where development of substantially different riparian vegetation is possible over relatively large areas, it seems that RZs could begin to act as fire breaks. Here the size of the stream would, perhaps, be less important that the interaction between the floodplain and the stream (e.g., the wet meadow in a headwater stream). Interestingly, if this conceptual model is useful, then the streams defined as "response reaches" by Dave Montgomery would be the areas where RZs exert the most dramatically different effect on fire behavior (relative to uplands). But these reaches are also most susceptible to change, for example, channel incision, which would change the stream-floodplain interactions and there by change the relationship with fire. {#65}

Ok the question is in what types do they vary?

Lower to mid-elevation interior ponderosa pine types probably have the most distinct regimes and resulting fire properties as compared to mid- to higher elevation forests {#122}

2. Where might fire occurrences be more and less common compared to their surrounding uplands?

Fire occurrence differences correlate to the gradient in soil moisture and relative humidity differences between the riparian zone and the surrounding uplands. The size of a riparian zone is also a critical factor in the occurrence of fire. a narrow band of a wet sedge community surrounded by acres of subalpine fir and lodgepole pine will burn entirely (and re-sprout within a matter of days). A larger wet meadow will may be untouched or barely burn in very small patches regardless of the intensity of the surrounding upland fire. {#21}

In steep, 1st order channels, fire occurrence may be the same as uplands, but severity may be greater because of concentration of heat and fuel in the draws. {#32}

In the southwest fires in riparian areas may be more common due to higher fuel loads and human caused activity such as camping fishing. Because the fuel loads are so much higher the damage to the riparian vegetation is greater than to the surrounding vegetation- if there is any. As you move to areas of higher moisture the effects to riparian areas might be equal to or less. {#35}

I would think that fire occurrence would be less in open, meadow-like riparian zones, as opposed to incised, closed-canopy areas {#36}

In wet meadows, fire occurrence/intensity might be much lower than adjacent uplands. {#37}

Even in wet meadow, it depends on weather conditions. I have seen wet meadow areas under extreme weather conditions where biomass in the wetlands (from early season growth) allowed the fire to burn longer than adjacent uplands. {#82}

I still think that the gradient (vegetation and physical features) between riparian areas and surrounding uplands (at the time of the fire) will greatly influence fire occurrence. {#110}

Hear hear. nothing burns like a wet meadow when the water table is lower than usual. {#88}

In fact I think a lot of wet meadows would be forests if these were not true! (if u don't mind my appending myself). {#91}

Again this is all weather dependent. {#39}

One of the limitations of charcoal studies in low-intensity/high frequency fire regimes is that you get very little signal of fire -- and could make incorrect inferences of fire occurrence & consequent importance to the system. {#95}

Fire occurrence is based on ignitions, and there cause. {#42}

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Less common than surrounding uplands: Any steep drainage.
More common: high elevation areas where fuels are conducive to start and spread. {#116}

Add to #84. I think the classic riparian willow-cottonwood areas probably did not burn. In e. Oregon there are riparian aspen etc that Oregon Trail immigrants described as burned, but likely these areas were where the adjoining sage/grass areas ran in and stopped. Deciduous/gravel bar, etc were areas that fires had a tough time moving across ---larger river systems. Who was the guy in upper Missouri River basin that described the seemingly stable landscape of cottonwoods by back cutting and creation of new point bar deposits - classic distribution of negative exponential. fire wasn't even mentioned, probably because it didn't spread through these areas. {#117}

84 is an interesting observation and consistent with some of the other observed historic changes, {#118}

*Fire Properties or Riparian Zones Compared to Uplands (Topic Commenter)

1. Are fire properties and fire regimes in riparian zones different from their surrounding uplands (Fire regimes are manifested in their frequency, magnitude, and extent)? In what forest types and how do they vary?

Consider the physical as well as the vegetation aspects! {#9}

Is the difference significant enough to protect? I would hope it would be in certain systems {#10}

Look at the contrast between the upland and the RZ -- in veg, geomorphology, soils. Where RZs are less different from the uplands, there will be less difference in fire properties and regimes. Where RZs are more different from uplands, there will be more difference in fires. {#11}

The ambiguity of the fire record in riparian zones makes this very difficult to determine using paleo approaches (e.g., fire scars, tree rings). {#12}

There really are opportunities to look more at the fire scar record and reveal more information about fire severity - size of scars, density of scarring in a population of trees for a given fire event - which should be applied more in fire history analysis. {#26}

Re 12: We can at least use historical fires (even last 2 decades) where we have direct evidence. This could be summarized -- there are probably enough fires for the general patterns to show. {#20}

Not sure historical fires would be representative; many seem to assume historical fires are not natural in intensity {#46}

In situations where coniferous vegetation is continuous from uplands to riparian zones – (e.g., in headwaters or where fire suppression has led to succession and continuity) - there will be little difference. Alternatively where there is a difference in vegetation type, there will be different fire properties - but as has been pointed out this distinction is dependent on weather conditions and may disappear entirely. {#13}

Again, I think this is a scale-dependent problem, with topography playing an important role. {#14}

Yes and we should discuss how topography affects fire regimes {#18}

In intermittent steepland 1st order coniferous streams, there may be very little difference between the channel and the uplands. However, these channels often provide the structure (wood, water, nutrients, sediment) that supports the riparian ecosystem downstream. In larger, less-steep streams, riparian systems may be more moist and be quite different in structure from the adjacent uplands. {#15}

In landscapes with stream terraces, typically there are differences in veg., moisture, etc. going from upland to high terrace to low terrace -- these should have an influence on fire. {#43}

They typically occupy lower topographic positions and are generally influenced by the accumulation of soil water draining down slope.

In semi-arid rangelands with degraded riparian corridors (incised streams or streams with diversions - wide valley bottoms), fire severity and intensity may be higher due to higher fuels (Basin Big sagebrush dominated). This may also be the case (at lease for intensity) for riparian corridors with P-J encroachment.. {#17}

The riparian zone fire regime would be different--less severe and less frequent--in any forest type where the riparian zone has a significant component of hardwoods and/or shrubs forbs with relatively high foliar moisture. {#19}

Not sure less severe is right; usually where fires are less frequent, they are more severe {#49}

But even the extent of change reported in Chan's work is likely enough to affect the fire behavior of a fire moving into a riparian zones and perhaps in the landscape as a whole! {#45}

There has been very little research regarding microclimates above aquatic zones, in adjacent riparian zones, and uplands. However, research in western Oregon forests indicate that increased in humidity (associated with the effects of the stream) do not extend very far from the channel. Agee had some data indicating that understory plants in riparian zones may have higher moisture levels. Conclusion of all this: Microclimate effects of aquatic riparian systems to not extend very far away from the main channel. {#22}

In the warm dry DF-PP types, in high gradient, first to third order streams, most riparian zones have historically been shrub dominated. In the absence of fire, the shade tolerant conifers, grand fir and Doug-fir, have established in these shrub communities and eventually are shading out the shrubs. This occurs in narrow valley bottoms where the conifers occupy the toe slopes and terraces (if present). When the conifers shade out the shrubs, the composition and structure is more similar to the upland vegetation, so the fire behavior is most likely similar too. If any shrubs are present, following fire there will be a release if most of the overstory is removed. {#23}

Yes, when the veg (fuel) and topography are driving the fire behavior characteristics. no, when the weather is dependent variable in fire behavior. {#24}

#11 makes an excellent point - gradient between the uplands and riparian areas could be an important key to determining the intensity and extent of differences in fire properties and regimes from the surrounding uplands. {#52}

Yes, this is scale dependent, if we are talking about river basins, it vary a lot. At the watershed scale it begins to vary less. The vegetation is influenced by the fire regime. {#25}

Yes and no, they vary by topography, geomorphic setting, etc. Large wet meadows in 1st and 2nd order streams in many instances rarely dry to the point that they will carry fire. On the other hand, on very small riparian areas dominated by the same or similar upland species will respond in the same manner. {#27}

Riparian areas are less likely to be points of ignition if in healthy condition {#28}

It's hard for me to separate the influence of vegetation, topography, basin size, gradient, and weather. It seems that an individual watershed should be considered in light of this context.. {#29}

The historical to current change (time) seems to mask the once-likely more significant differences between riparian and upland forests in dry forest types. This has to be separated in discussion from differences between forest types (a spatial rather then temporal change). {#53}

Currently, there is high severity in uplands and riparian zones in drier forest types, so there is a strong temporal element in comparing uplands and riparian zones. Historically, both were primarily low-severity in ponderosa pine and mixed-conifer forests (most of those types of forests). Frequency was about the same, intensity was probably a little less, severity low in both uplands and riparian. fire likely kept the areas open enough that a high deciduous component could exist in the riparian zone. {#30}

Disagree with this {#59}

In the southern Sierra Nevada I would say that you start to see a difference for streams once you move into 3rd order and larger. These are perennial and have wider zones with significantly more green understory. They are, of course, generally lower gradient.
Pine forests at 4,000 ft. and lower have fewer meadow and perennial streams at 1-3 order. Mixed conifer and fir forests have more perennial streams at 1-3 order with more headwater meadows and seeps. {#31}

Probably. the microclimate of even a narrow riparian area influences both live and dead fuel moisture. The influence this has on overall fire behavior would be dependent on a lot of other factors. {#33}

Re #34: Agree entirely. The landscape pattern of vegetation (structure, species diversity, etc.) all indicate riparian areas are different {#63}

I think natural patterns of vegetation tell us they are different in many, perhaps most cases. Over broad areas of mixed conifer forest in the Klamath Mtns and the northern US

Rockies where I have worked, there is higher species diversity, fine scale patchiness of stand structure and many more large, old trees than occur n most adjacent upland slopes. {#34}

In lower elevation forested where the historic role of fire was high freq/low Intensity, there was probably little difference between fire frequency in the adjacent upland and the riparian areas. In the mixed fire regime types, the mix implies differences if susceptibility to fire and all fire was lethal. In such areas, depending on longer term drought conditions, the fire properties were different for most of the fire season. In severe drought, the entire drainage would burn. {#38}

Relative to our previous discussion, since this transcript is electronically available I believe it should be provided to all participants. Of course the summaries will be the most valuable, some of us however, would like to evaluate the process and also see to what extent summaries faithfully translate the full range of variation of opinion. {#40}

Definitely in most cases {#41}

They vary in dry coniferous forest types depending on the valley width and soil depth, the degree of development (age, height) of the riparian vegetation, the amount of soil moisture or proximity to the water table, and the aspect.

They vary in wetland vegetation depending on the soil moisture, plant density and height. {#44}

In regard to #26, in many riparian areas there are on fire scarred remnants; the above ground veg is destroyed completely or is killed and decays within a couple of years. {#47}

Re #40 I also like the idea of the comments having some reorganizing, etc. (i.e. Ziemer's suggestion) to make some sense of all the "information" flowing into these sessions {#48}

I would imagine that elevation, steepness, and other environmental gradients would need to be considered, along with the type of riparian zone. Meadow, shrub, forest fire properties would vary from their upland environments based on the degree to which these gradients change. Again these distinctions would depend on the variations in fire weather and climate. {#50}

In the interior west the answer is generally yes. On the western slopes of the Cascade Range and the coastal forests of the Pacific Northwest I would say this generalization does not hold.
In the Interior west, vegetation is strongly governed by plant soil water gradients that are related to geomorphic patterns. The ecotone breaks from upland to riparian zones often

are very distinct both in species composition and life form. These features directly effect fire properties between upland and riparian vegetation. {#51}

I agree with 40 and 48 also. these comments are very useful. {#54}

In some less-arid regions of the west, there is a large shrub component in even first-order riparian areas, and I suspect, as Jim Agee's presentation suggested (or implied?) this may play a very substantial role in moderating fire behavior and effects (intensity and severity mainly). {#55}

As with many other questions, the answer is: IT ALL DEPENDS. The conditions are so variable that it is very dangerous to generalize at a landscape scale. Perhaps ecosystems might be a point of generalization. Arid southwest scrubland, for example, might be a point where processes might be generalizable. Similarly, northwest conifer rainforests might be generalizable., ETC. {#56}

Has anyone compared the influence of riparian zones in landscapes with different drainage pattern - fire movement behavior? Effects will be different when the typical direction of fire movement is parallel with the drainage network, vs. perpendicular to drainage network. {#57}

The point made yesterday that the riparian areas often cannot be sampled directly for fire history is an important consideration. It may lead to incorrect inferences about the amount of fire that actually burns through riparian wetlands of any extent. {#58}

In terms of vegetation types, they correlate strongly with geomorphic characteristics and hydrologic regime. Since our understanding depends on our experience, capitalizing on everyone's understanding of specific systems may be of most benefit. {#61}

Fire regimes in narrow riparian zones in low-order streams are probably the closest to their surrounding uplands because either the vegetation is similar to the uplands or the size of the riparian zone is not enough to cause a great enough physical difference (soil moisture, relative humidity, etc.) between the riparian zone and the upland. the larger and wetter the riparian zone, the smaller the extent of the fire. I think this is correlated much more with position in the watershed - stream order, discharge, hydrograph, parent materials, sedimentology, etc. than the forest type. {#62}

The final report will have all of the comments. They will simply be organized for easier reading. {#64}

Steep topography, constrained smaller streams in denser forest types seem likely to be little differentiated from surrounding upland. But in the same landscape, but drier climate, where NPP is significantly higher in RZs than in adjacent uplands, seems that RZs would facilitate fires. Conversely, in gentle topography or in unconstrained reaches where development of substantially different riparian vegetation is possible over

relatively large areas, it seems that RZs could begin to act as fire breaks. Here the size of the stream would, perhaps, be less important that the interaction between the floodplain and the stream (e.g., the wet meadow in a headwater stream). Interestingly, if this conceptual model is useful, then the streams defined as "response reaches" by Dave Montgomery would be the areas where RZs exert the most dramatically different effect on fire behavior (relative to uplands). But these reaches are also most susceptible to change, for example, channel incision, which would change the stream-floodplain interactions and there by change the relationship with fire. {#65}

Lower to mid-elevation interior ponderosa pine types probably have the most distinct regimes and resulting fire properties as compared to mid- to higher elevation forests {#122}

2. Where might fire occurrences be more and less common compared to their surrounding uplands?

Fire occurrence differences correlate to the gradient in soil moisture and relative humidity differences between the riparian zone and the surrounding uplands. The size of a riparian zone is also a critical factor in the occurrence of fire. A narrow band of a wet sedge community surrounded by acres of subalpine fir and lodgepole pine will burn entirely (and re-sprout within a matter of days). A larger wet meadow will may be untouched or barely burn in very small patches regardless of the intensity of the surrounding upland fire. {#21}

In steep, 1st order channels, fire occurrence may be the same as uplands, but severity may be greater because of concentration of heat and fuel in the draws. {#32}

In the southwest fires in riparian areas may be more common due to higher fuel loads and human caused activity such as camping fishing. Because the fuel loads are so much higher the damage to the riparian vegetation is greater than to the surrounding vegetation- if there is any. As you move to areas of higher moisture the effects to riparian areas might be equal to or less. {#35}

I would think that fire occurrence would be less in open, meadow-like riparian zones, as opposed to incised, closed-canopy areas {#36}

In wet meadows, fire occurrence/intensity might be much lower than adjacent uplands. {#37}

Even in wet meadow, it depends on weather conditions. I have seen wet meadow areas under extreme weather conditions where biomass in the wetlands (from early season growth) allowed the fire to burn longer than adjacent uplands. {#82}

I still think that the gradient (vegetation and physical features) between riparian areas and surrounding uplands (at the time of the fire) will greatly influence fire occurrence. {#110}

Hear hear. nothing burns like a wet meadow when the water table is lower than usual. {#88}

In fact I think a lot of wet meadows would be forests if these were not true! (if u don't mind my appending myself). {#91}

Again this is all weather dependent. {#39}

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Fire occurrence is less common on headwater reaches with wet meadow community types since they rarely dry sufficiently to burn, in the mixed conifer zones of the east side of the Cascades. Fire occurrence is probably the same as upland areas for those that are dominated by the same species as the upland areas. In general, the broader riparian areas associated with Rosgen C and E channel types, occurring lower in the landscape probably have a fire frequency that is much lower than the surrounding landscape. {#115}

Less common than surrounding uplands: Any steep drainage.
More common: high elevation areas where fuels are conducive to start and spread. {#116}

Add to #84. I think the classic riparian willow-cottonwood areas probably did not burn. In e. Oregon there are riparian aspen etc that Oregon trail immigrants described as burned, but likely these areas were where the adjoining sage/grass areas ran in and stopped. Deciduous/gravel bar, etc were areas that fires had a tough time moving across ---larger river systems. Who was the guy in upper Missouri River basin that described the seemingly stable landscape of cottonwoods by back cutting and creation of new point bar deposits - classic distribution of negative exponential. fire wasn't even mentioned, probably because it didn't spread through these areas. {#117}

84 is an interesting observation and consistent with some of the other observed historic changes, {#118}.

IV. Indicators of Fire Regimes (Categorizer)

Participant Instructions

What are some specific indicators that fire regimes are different in riparian zones compared to the uplands (fire history, plant composition, structure, etc.)? Please list them.

1. Features like structure, diversity, composition could all be influences, but since riparian systems are strongly affected by hydrologic disturbance regimes, they are more likely affected by hydrology
2. Other than direct evidence of fire, characteristics of riparian zone will be more strongly affected by the hydrologic disturbance regime
3. Fire history
4. Vegetation types (esp. compared to adjacent uplands)
5. Successional status of uplands and riparian zones
6. Direct postfire observations - did it burn or not when the uplands burned.
7. Overstory and shrub species diversity and their known fire tolerance
8. Plants with higher moisture content in riparian zones; Differences in fuel moisture contents live and dead fuels.

9. The influence of water alters composition more than anything else.
10. Fire scars – differences between uplands and riparian zones
11. Plants unburned in areas where surrounding uplands have burned
12. Can't use indicators; need real data on fire regimes
13. Frequency similar (at least where it has been studied in dry forests) -- fire scars used with appropriate interpretation
14. Stand density
15. Charcoal in alluvial soils/deposits
16. Density of large, old trees
17. Tree/shrub rings
18. Difference in understory vegetation or multi-level forest canopy
19. Life history characteristics
20. Hardwoods vs. conifers
21. Lack of fire scars in Cottonwood trees that are strongly wetland influenced.
22. Look at disturbance adaptations of vegetation (e.g., mostly sprouters if fire frequent)
23. Structure of vegetation in riparian zones often much more complex than in surrounding uplands - may be related to geo/hydro disturbance though fires & floods are correlated -- perhaps not confounded. Overall disturbance regimes need to be understood.
24. This is the problem; fires and floods are confounded
25. Population age structure
26. The fuel chemistry differences - silica free ash, volatile oils content, etc... perhaps the deciduous trees in riparian are less fire prone for this reason.
27. I am not certain that the fire regimes are different, and I don't think you can use composition to make that distinction.
28. Depth of organic matter layer
29. The presence of fire sensitive veg in riparian zones as compared to upland suggests fire is less frequent (grand fir, Engelmann spruce in rip zone, for example)
30. Comparisons in fire severity (above-ground, below-ground mortality)
31. The fire regime for the area
32. Topography, though a separate category, is an important variable that affects vegetation
33. History part is difficult as it is questionable how valid it is to make landscape scale inferences from non-random fire scar sampling
34. Remember that the roots often are not killed. So riparian vegetation post fire may grow more rapidly than before. i.e high "fuel loads" in riparian areas may be indicators of lower intensity fire in the past more reliably than they are indictors of high-intensity fire in the future!
35. In some cases, lots of very old downed logs in riparian areas that are virtually absent up slope (presumably because they were consumed by fire)
36. Avian, insect populations and their adaptations to fire-created habitats
37. In Central American riparian systems coffee trees and shrubs do not respond well to fires.
38. Contrast in species composition of trees is A GIVE AWAY, particularly if we go from deciduous to conifer, riparian to upland.
39. Presence and duration of water; depth to water table
40. Ignition source

41. Seems that most indicators could be counter intuitive. Presence of shrubs and hardwoods as an indicator, but many are root sprouters. Difference in understory veg is possible, but only in-so-far as fire return interval is shorter than regrowth/recovery of understory veg.
42. Distribution of life history types differ between riparian and uplands
43. Fires and floods are not correlated. Fires are controlled by fire weather (we heard yesterday). Floods are controlled by flood weather. Don't know if anyone has looked at how these compared
44. Structure may be difficult to use as a fire indicator as it reflects 20th century land use -- grazing/fire suppression
45. The specific characteristics and composition of the riparian zone vegetation compared to the uplands
46. Scars from debris slides that were fire-initiated
47. Historical photos - do recognized fires stop at riparian zones
48. The presence of striking differences in surface fuels, particularly large quantities of 1000 hr fuels.
49. Flood or damage from high water flow after fire activity in the upland or riparian and effect on plant species
50. Moisture content of vegetation in riparian areas
51. Scour has a big impact on viable life histories --- hence the high resprouter proportion in riparian areas
52. Slope/aspect and elevation
53. Degree of decay of LWD
54. Current fires -evaluate scorch in riparian vs. upland
55. Whether or not the vegetation in the riparian is fire adapted. Example: cottonwood bosque. even the old growth cotton wood is vulnerable to fire kill
56. Charcoal

V. Vegetation, Fuel, and Microclimatic Components of Riparian/Stream Zones (Categorizer)

What vegetation, fuel, and microclimatic components of riparian/stream zones are different from uplands such that fire severity is either decreased or increased? (This includes factors such as vegetation composition, temperature, relative humidity, winds, fuel loads, fuel moisture, fuel arrangement, fuel chemistry, ecosystem productivity, and structure).

Vegetation components that <u>increase</u> fire occurrences and severity

1. Long fire return intervals – could increase severity
2. High biomass of grasses – flammable fine fuels
3. Low crown base height
4. Increased vegetation mass (grass, shrub, tree density)
5. Resin content and other properties of the wood
6. Land management history, grazing, harvest, prescribed fire- could increase or decrease fire

7. Water diversions that decrease water available to vegetation.
8. Presence of exotic plants
9. Species composition: conifer vs. deciduous
10. Increase growth of shade-tolerant species (fuels) following fire suppression and grazing
11. Low or highly variable water tables; woody/more xeric vegetation
12. Higher biomass, but only if it dries out
13. Trees that are killed by a disease or insect epidemic
14. Higher stand density and higher leaf area index = higher fire severity
15. More fire sensitive vegetation (thin bark true fir/spruce) leads to higher fire severity
16. Complex structure - many layers of vegetation that can be ladder fuels to move fire vertically
17. Herbaceous layer--sometimes very dense and lush, but flammable when it dries out

Vegetation components that <u>decrease</u> fire occurrences and severity

1. Hardwoods - increase in amount of willow/alder; vegetation composition -- broadleaf species may be less flammable
2. The presence of wetland-obligate plants due to high water tables - vegetation dependent on high water tables (meadows, etc) with a constant high moisture content.
3. Natural flammability of vegetation (chemistry, not live fuel moisture) tends to be less in riparian
4. Vegetation moisture content - high leaf and stem water content
5. Deciduous plants with a fuel chemistry that decreases fire intensity
6. More deciduous = higher foliar moisture
7. Lower volatility of vegetation in riparian zones (ethers, oils)
8. Higher stand density and higher leaf area index = higher relative humidity, lower fire severity
9. Adaptation of most riparian plants to disturbance - decreases fire severity because plants only top-killed.
10. Adaptation of riparian plants to disturbance - many can quickly re-seed a burned area and re-establish the potential community composition within a short time frame
11. Generally more abundant non-vascular ground-dwelling plants (mosses in particular) that cover ground fuels and also provide moisture to ground fuels
12. ***Reduction in overstory may reduce severity in long run but perhaps will increase frequency since the area will dry out earlier.***

Fuel components that <u>increase</u> fire occurrences and severity

1. Increased quantity of large woody debris
2. Gravitational input of woody debris- downslope input into a riparian zone
3. Increased quantity of decomposed large woody debris (simulating fire behavior more like 10 hour fuels when dry)
4. Higher crown bulk density due to higher productivity in riparian zone
5. Build-up of fuels from natural accumulation, or flood debris making a fuel bed
6. Lower height to live crown due to layering in riparian zone (in theory at least)

7. Insect and pathogen related mortality
8. More wood debris - due to higher productivity
9. Under extreme conditions, early season growth may provide concentration of fine fuels in riparian areas (probably most important in nonforested areas).
10. Down hill riparian subject to burning rolling debris from upland fire starts
11. Land and water uses- if water table drops (due to diversion) and vegetation dries out, high biomass increases flammability relative to lower biomass uplands;
12. Other activities such as logging that increases down wood loads

Fuel components that decrease fire occurrences and severity

1. Moisture content that remains above the moisture of extinction for a longer time period during the fire season for both dead/down material and live plants
2. Hardwood vegetation – fuel chemistry which depresses fire, higher foliar moisture contents…
3. Flooding event that removes fuel: both fine and large fuels
4. Often has a shorter time exposure to sun than fuels on upland (topographic shade)
5. Fuels may be removed/transported downstream by periodic floods or covered by sediment, so that fuel buildup is lessened
6. Plant chemistry reduces flammability
7. More rapid decay of down wood within riparian

Microclimate components that increase fire occurrences and severity

1. ***Diurnal wind flow during the day - hotter drier wind flow in the afternoon***
2. The stream channel itself may provide an "edge" so that light penetrates into adjacent forests, decreasing fuel moisture
3. Down valley winds concentrated in riparian zones may lead to increased drying
4. Potential for trapping of combustible gases during inversions (this happens at times in confined canyon settings, with intense blowups resulting)
5. Valley bottom air movement distinct from overlying air patterns

Microclimate components that decreases fire occurrences and severity

1. Temperature of valley - cold air sinks
2. Diurnal variation at night - cooler moister air
3. High relative humidity
4. Higher RH - higher dead fuel moisture contents
5. Amount of water in stream contributing to humidity of riparian zone
6. Greater shading by cottonwoods adjacent to sagebrush, for example, may increase fuel moisture under cottonwoods
7. Maybe taller structure, more layers in veg. reducing wind speed in riparian zone?
8. The depth to the capillary fringe of ground water – maintaining higher fuel moisture contents
9. Surface water in wetland portions
10. Lower amount of direct sunlight due to topographic position/shade
11. Cooler temps due to shade
12. Plant species shift towards water conserving species (to mesic from wet) resulting in less gas flux contribution

13. Proximity to standing or running water
14. Lower fuel temperatures, higher fuel moistures – increase in energy needed to reach the combustion point

Climate and weather components that decreases fire occurrences and severity

1. Any differences between upland and riparian zones are microclimatic differences; Climate is not different! But the ecosystem response to climate would be expected to vary.

2. Precipitation should be similar for uplands and the riparian zone
3. Lower lightning frequency in valley
4. little wind or wind direction cross the grain of topography
5. Wet cycles and extended runoff may make riparian less susceptible to fire.
6. Periods of wet, cold rainy weather (that keeps campers/arsonists at home)
7. Where fire season coincides with a precipitation season (i.e. southwest vs. northwest where fire season is dry season)
8. El Nino events depending upon the region
9. Low interannual variability in precipitation, i.e., mild or infrequent drought stress
10. Predictable seasonal wind pattern
11. Extremely wet years
12. Wet years
13. Unusual wet dry seasons
14. Lack of foehn winds
15. In lower precipitation zones the contrast between high moisture in the riparian and uplands likely decreases severity

Climate and weather components that increase fire occurrences and severity

1. Higher likelihood of lightning ignitions in uplands
2. Multiple dry seasons
3. Drought proneness, e.g., areas with strong El Nino Southern Oscillation signal on spring precipitation
4. Wet years followed by dry years (buildup of fine fuel then dries out
5. Extremely dry years
6. Interannually variable seasonal wind patterns
7. Global warming
8. Climatic changes will likely affect both riparian and upland fire potential
9. Late season drying trends across most of west (excluding SW)
10. Length of the fire season
11. Pacific Decadal Oscillation (so there all you el Nino fans!)
12. At higher elevations there may be no distinction between upland and riparian susceptibility
13. Increase in foehn winds

Real World Examples (Topic Commenter)

1. Referring to the previous 2 questions, can you cite conditions or real world examples where riparian zones affected the severity and behavior of the fire (i.e., give a real or hypothetical example)?

Repeating something I said earlier. I've looked at 200+ early historical photographs of riparian vegetation in the southern Rockies, and there is no evidence of fires visible in these photographs. {#6}

I wonder if these photos represent a random sample of riparian zones? {#46}

The Grand Canyon of the Yellowstone did not function as a fire break (1988). {#62}

1977 Marble-Cone Fire, Los Padres NF: we used riparian zones repeatedly for anchor points for lines constructed on ridges {#7}

In extreme weather conditions (i.e., dry, hot, and windy), virtually everything burns... {#9}

Roads are often ignition sites (people). Roads are often in valley bottoms. {#10}

From Mick Harrington, RMRS: "I observed a couple of harvested units within the Bitterroot fires where trees were cut up to the riparian zone. The wildfire was mixed severity in the upland but in the uncut, dense riparian zone it became a stand replacement, crown fire. I also observed shrub dominated riparian zones that experienced a severe fire treatment, but which I expect to recover well this spring. I observed backing fires that failed to burn into riparian areas because of high fuel moistures." {#11}

Coyote Fire, Fremont NF, Sycan Marsh effectively stopped the fire on one flank.
Kates Basin, Wyoming, Wind River eliminated spread to the east. {#12}

Railroads and roads commonly go through riparian zones in mountainous regions, and fires can be started in this way {#14}

In the San Gabriel River drainage (Angeles NF), under low severity burning conditions the riparian zone vegetation will hinder fire progress compared to upland Douglas-fir/chaparral slopes {#15}

No effect example, wind driven event: 1994 Foothills Fire on Boise Nat. Forest spotted 3/8 mile north across river. More than 90% of acreage burned was north of river. {#16}

Simnasho Fire, Warm Springs Reservation, Deschutes River stopped fire spread to the east. {#17}

In my experience (relatively hot, crown fires) the riparian has had little effect on severity and behavior over a range of 1st through 4th order streams or the fire has moved up the valley bottom and possibly exacerbated the effect of the fire. starting about 5th order and higher, the stream/riparian interface has sometimes, but not always stopped or impeded the effect of fire. {#18}

1985 Wheeler Fire, Los Padres NF we used riparian zone for anchor point for backfire operations to establish control line on north side of the fire {#19}

Ponderosa pine, Sierra National Forest, late May.
Prescribed fire lighted at top of slope and backing down (understory of bear clover, manzanita, small cedars) fire did not cross 1st order stream (width of 0.5 m or less). {#20}

Little French Creek, Payette NF. Idaho. Subalpine fir/lodgepole pine/Engelmann spruce in bottoms. Three fires: 1900, fire skips over riparian zones, does not burn it. Stand replacement in uplands. 1933. fires does same thing again. Subalpine fir and spruce old growth still exist after the 33 in the riparian zone. 1980's. Spruce beetle (D. rufipennis) kills all spruce in riparian zone (doesn't affect uplands because that's all pure lodgepole pine after 33 fire). 1994. Fire hoses over riparian zone but will not burn in uplands, due to all the additional fuel added by spruce beetle kill in 1980's. {#21}

In steep canyons of Buffalo Creek fire (Colorado), the fire ripped through the riparian and upland zones regardless--due to high winds {#22}

(#6:) There is conversely much photographic documentation in the N. Rockies showing strong evidence of stand-replacing fires in riparian zones (Gruells' pubs from the 1980's). {#23}

I have no previous experience here, so I would like to see some examples where fires have jumped across relatively wide, open RZs (broad alluvial or glaciated valleys); I would also like to see some examples of RZs that have stopped fires, when all other elements of weather (temperature, wind, etc.) would suggest continuation of the fire. {#24}

#18 refers to Yellowstone and Central Idaho, specifically. {#25}

On the Cottonwood fire (Tahoe NF) the fire burned with equal severity streamside vs. upland areas due to drought conditions/high winds {#26}

In very dry years, riparian areas may be have a concentration of fuels that don't exist in the uplands, and in those cases, may support more intensive and extensive burning. {#27}

Reconstructing fire history in crown fire systems (e.g., high elevation lodgepole pine), we commonly can find instances of 2-5 mile spotting distances. This spotting distance has

been observed even in contemporary fires (e.g., Yellowstone 1988). Obviously no stream or wetland can affect this potential for fire spread. {#28}

1987 Silver Fire and Galice Fire, Siskiyou NF: used riparian zones for control lines/anchor points {#29}

South Fork Complex, Oregon, South Fork of the John Day used as part of the containment line, eliminated fire spread to the east. {#30}

Ques on #33: Are these Bosques dominated by native vegetation or exotic woody (tamarisk?) -- my understanding is that with native veg/free-flowing (i.e. not dewatered) streams the riparian systems would not function this way. But exotic woody-invaded/dewatered streams are the norm now not the exception. Restoration would be necessary. {#68}

Major fires burning along the Bosque's of the Rio Grande south of Albuquerque. Only in the riparian zone is there a continuity of vegetation to carry fire. Fire moves longitudinally along the stream network, presumably regardless of topographic features such as valley floor orientation relative to prevailing winds. Is an extreme example, but Jim Agee showed something similar in a coniferous forested system.

SO, not sure if climatic effects would wipe out this veg/soil/topo interaction, but it is possible. Many of the ash soils in the Blue Mts. (eastern Oregon) support widely spaced forest because of thin soils on uplands. Fine soils have been deposited in shallow headwater swales which are now densely forested with shade-tolerant species. These areas have high fuel loadings and may readily carry fire along the stream network until it contacts more continuous patches of upland fuels, allowing fire to propagate more widely through the landscape. {#33}

I have visited burned areas in several areas in northeast Oregon. In all of these areas the severity of the fire was lower in the riparian zone than in the surrounding uplands. Riparian vegetation re-sprouted from live root crowns and/or re-seeded areas within a few days or weeks of the fire occurrence and total cover and compositional richness of these areas was always greater than the surrounding uplands within the week to 4 year post-fire interval within which I visited these fires. Some specific locations are: 1. Pleasant Valley in Hell's Canyon NRA, which burned during the Salt Creek Fire of 1996 (?). the pine forest in the uplands surrounding the riparian areas burned with a high severity and riparian communities were entirely top-killed; 2. White Creek in the Elkhorn Mountains, which burned in the Tower Fire of 1996; 3. East Fork Fly Creek in the Upper Grande Ronde watershed, which burned in the Boundary Fire of 1995. {#36}

Historical reconstructions of fire scar data in dry forest types appear to stop (not always) at streams. Whether they cross or not, fire severity is low (historically). a caution: where there are sample sites scattered across landscapes, we often use a fire boundary as the stream where scars are found on one side but not the other....the fire may have actually

crossed the stream but not made it to the sample site (or simply not scarred trees there), so we have to be careful about using reconstructed extent where a priori we have assumed streams to be boundaries when the above conditions occur. {#38}

Real example:
Upland (upper 2/3 to 3/4 of slope) pinion juniper woodland in which hand ignition failed to create a black line.
Riparian (intermittent water) consisted of ponderosa pine.
Aerial ignition was three strips of ping pong balls across the lower third of the slope down to the bottom.
Resulting fire behavior in the "riparian" area was intense enough to cause a crown fire all the way up the hill in the pinon juniper.
Investigation of the subsequent deployments and fatality, however, attributed crown fire in P/J to unexpected wind event, so take the above observations as you will. {#39}

Valley Complex, Bitterroot NF, Riparian and Stream areas used on various pieces of different fires for control lines and anchor points {#40}

In the Coast range of Oregon- Mary's Peak in an area that burned at the turn of the century, it is apparent that trees in the riparian zones have a lower fire severity and intensity that those of the uplands. The spp composition of riparian zone is dominated by Western red cedar while upland trees are Doug-fir and western hemlock. In the uplands there is a mosiaci of patches of even-aged hemlock where the fire was stand-replacing and patches of fire scared Doug-fir where the fire was an underburn. Even Char heights of trees are different in the riparian zone that the uplands. This is a steep canyon with a second order stream. I would assume topography and microclimate were the most important variables affecting fire behavior and effects. {#41}

On Pistol and Bush Creeks in the Frank Church wilderness, the fires rolled down valley and jumped the Middle Fork of the Salmon where they burned large swatches moving upslope on the opposite side (or even bounced back across the river again) {#45}

Re # 16, 24, and 45 It is clear that riparian has no effect on fires that spot ahead. Not sure if this is a proper measure of riparian effect or lack thereof. {#63}

Brushy Ridge Complex, North Carolina, River used as anchor point for constructing indirect line {#47}

One general statement I can make, based on close observations of half a dozen large fires it the Klamath Mtns, Blue Mtns, and northern US Rocky Mtns over the past 15 years, is that riparian stands treated by thinning and so-called fuels reduction techniques did NOT burn with lower intensity or severity than nearby, untreated riparian stands; in fact more often the reverse has been true-- the treated stands burned with greater severity and often complete mortality. I suspect this has a lot to do with wind conditions at the ground, which are moderated by dense brush, multi-layer canopies even downed woody debris.

Thinning to crate an open understory increases ground level windspeeds; it may also shear and thus disrupt what under low-wind conditions are humid riparian microclimates. I surmise such wind effects may generally offset, perhaps overwhelm the importance of "ladder fuel" structure in determining fire behavior and severity within riparian stands. But obviously the science has yet to be done to be done to test this. {#48}

In central Nevada during the early 70's prescribed fire was attempted in riparian areas. They were difficult to ignite in the early season and required sustained drought conditions to burn. They burned intensity and the fire severity was high in the portions burned. (Genz & Quilter?) {#49}

When the Stormy Complex burned over fire camp and helibase, the helibase (in a broad valley bottom) was pretty much completely spared because of an apparent high water table that supported grass cover even when the uplands were dry enough and the weather severe enough to create extreme fire behavior. {#50}

Last year indicated that prolonged periods with the ERC's above the 85th percentile for the Bitterroot created situations where the riparian zones appeared not to be barriers to fire spread. This needs to be studied further. Where large quantities of 1000 hr fuels were present in the riparian areas, fires spread slowly but were very severe in the drainage bottoms. Where winds could actually affect the fire behavior and fuels in the riparian the fires immediately crowned out and were very severe. Forget KDBI in the West as a useful indicator of conditions. {#51}

In the dry, Doug-fir, ponderosa pine zone, tall riparian shrub communities (willows, birch, alder, dogwood) in relatively narrow valley bottoms were historically maintained by frequent, low to moderate intensity fires. They now have shade tolerant grand fir and Doug-fir established in the undergrowth, and eventually maturing and shading out the intolerant shrubs. This is due to fire exclusion from these fire adapted systems. As a result, the composition and structure of the riparian zones is similar to the uplands, and the fire moves quickly through these systems, usually as a stand replacement, crown fire. Historically, when the uplands burned frequently, the fires were typically low to moderate intensity surface fires, and infrequently, stand replacement fires. This question is hard to answer without considering the fire regimes of the adjacent uplands, so I addressed those here. {#53}

Wet forests with well-developed riverine systems (like western Olympics or Vancouver Island) - current and historical fires seem to stop at these major streams - 1978 Hoh fire, 1961 Queets fire, 1890's Hee Haw fire (no, this is not the Buck Owens/Roy Clark one, Phil), 1890's Boundary fire (all in Olympics), and historic fires cited by sources in western B.C. {#55}

Shenandoah Complex, Shenandoah NP, Fall 2000: we used riparian zones control locations {#57}

1992 Onion Fire, Fremont NF one of our "problems" was an organic fire in lake bed...continued to burn until winter weather flooded the site {#64}

Storrie Fire 2000. Fire stared approx. 100 ft. above feather river South facing slope in Oak woodland with some pine overstory. Fire spread rapidly to the east following the prevailing wind following river channel. River channel split in 2 bouncing winds to North and east. Fire followed Yellow Ck. drainage and North Fork of Feather river in the riparian zone. In No. Fork Feather fire stayed in uplands used river as suppression tool . Yellow Creek got nuked in the riparian zone. Where the fire eddied at the confluence of the No. and middle Forks of the Feather river the fire spotted to the south side of the river in o a wilderness area. Due to wet drainages and north aspect able to pick up spot fire at 7000 ac using old burns and wet drainages without committing anyone to direst attack and only using helitankers to pick up small spots across drainages.. As the fire moved to the north in yellow creek used an extremely large meadow and creek system to hold the north flank. Fire moved into two additional east west drainages but were out of alignment with the wind but due to the extremely dry conditions fire moved easily through these 2 riparian areas. Wherever we had alignment with the wind riparian areas were no better or worse as a suppression tool than the rest of the vegetation, however, where winds were out of alignment or were on cold slopes riparian areas could be used as in the suppression action. {#65}

I think that "stand replacing" fires in the riparian may be unusual in the case of shrubs, in that the shrub roots generally remain alive and will come back as the same dominant vegetation fairly quickly . These effects are stand replacing only in the sense of the amount and height of the woody vegetation. Often growth of shrubs after fire is more vigorous than before because of lack of competition from trees. {#66}

#28 I disagree. In areas w extensive wetlands, by simple probability a large share of embers will land on sites with little probability of fire spread. This may not be prevalent in most arid land forests but there are some low-intensity/hi frequency regime forests where extensive wetlands do (or once did) occur and even long-distance spotting may have been partly attenuated. {#69}

In Summit and Tower fires in Blue Mountains in 1996, most of the larger graminoid-dominated meadows did not burn at all or very little within severely burned surrounding uplands. {#70}

A multitude of fires on the Boise NF - Riparian areas frequently were unburned although this was not universally true. No one has ever closely examined why the riparian areas in some drainages completely burned while others were spared. {#72}

1998 Florida Fires: cypress bogs or "bays" were dry and did not stop fires as they would normally {#74}

In Los Alamos canyon, which lies pretty much perpendicular to the spread of the Cerro Grande fire, there remains patches of green trees along the stream course even though both sides of the uplands were nuked. Some other valley bottoms were burned through pretty completely. Would be interesting to figure out why. {#76}

I have seen riparian systems react as life buffers and fuel breaks to having no effect to advancing fire behavior, both in very similar vegetation types (shrub and wet graminoid [Nebraska sedge meadows]. If fuels loads are at or above the threshold for potential ignition and moisture contents are at or below the threshold, fire will continue to spread regardless of species composition, vegetation structure, age, basal area, density, and height. At this point the advancing and immediate thermal properties of a fire are negating any potential microclimatic attributes (relative humidity, wind speed and direction). Fire intensity at this point is the sole driver of fire behavior. {#77}

On the Cleveland Fire (1992) on the Eldorado N.F. the South Fork of the American River had no influence on fire size, intensity, or severity. The fire burned 24,000 acres in 5 days, much of this was stand replacement in a Mixed Conifer vegetation type. Yet, during 1987 and again in 1994 the Cleavey River held large fires on the Stanislaus National Forest. Riparian areas work just like any fire line, suppression resources will take advantage of them to contain the fire. When resources are available to in a timely manor to support, improve, and hold the line they usually work. In areas where fire regimes are nearly intact and fires are managed to meet resource benefits, riparian areas are often used to retard fire spread and limit extent. {#78}

Pringle Fire, Deschutes NF, 95, the fire jumped the river, but was contained in the riparian area where it just crept around, it burned vigorously on the other side of the river in upland area. {#80}

1992 Sand Creek Fire, Klamath County, OR fire spread into Klamath Marsh and stopped {#82}

Under high drought severity and/or high winds none of this matters. Yet these are the fires that get the most attention. Seems like we are talking about fire management options on fires that relatively few people care about. {#85}

#69 I agree with #28. {#87}

Fire started North side of eel river spotted during north east winds, spotted across river to the west. Fire stopped south movement when it intersected with wet meadow and a curve in the river (winds had died so don't know if the river had any effect). Where the fire hit the meadow it completely died out. {#89}

Comment 70: Right on. I used one of those meadows on the Tower as a place to put Columbia Helicopter's tank, which we filled from the stream by pump. {#91}

2. What are the relevant or important features and functions of riparian zones that would increase our understanding of how riparian zones influence fire effects on the landscape?

Continued wet meadow {#3}

Heavily grazed grasslands where fuel is extremely limited {#4}

Some of the worst managed riparian zones in scrub/grass systems have become more fireproofed than the "best" areas because there is no fuel to carry a fire. Conversely, overgrazing that leads to incision can produce dry conditions during summer, whereas in the un-incised areas or areas where beavers are active, water tables are high and wet vegetation can remain all year -- reducing fire. {#32}

There is a real lack of studies that provide much insight regarding this question. It would seem that folks working in fire suppression would have some views that might be useful {#5}

I agree with #5, the fire suppression people would have the most relevant information on this. {#8}

Landscape information on fire history (uplands and riparian corridor), that includes vegetation and geomorphic response for a variety of systems could be very useful. {#13}

Manipulative restoration experiments that utilize prescribed burns, utilize an interdisciplinary approach the includes both the fire suppression folks and ecologists, and examine fire behavior as well as ecosystem response would also be very useful. Past fires, where fire behavior was documented, provide opportunities to examine the characteristics of the pre-burn riparian systems. {#34}

We need to keep in mind that we are dealing with a managed (i.e., impacted) landscape. Thus, our concepts of what constitutes "relevant features" is based on the presence of those management impacts. For example, beaver have been extirpated from the vast majority of their former range. Without them back in the system our view of relevant factors is limited and potentially biased. {#31}

Degree of stream regulation - de-watered vs. free-flowing streams {#35}

Some of the worst managed riparian zones in scrub/grass systems have become more fireproofed than the "best" areas because there is no fuel to carry a fire. Conversely, overgrazing that leads to incision can produce dry conditions during summer, whereas in the un-incised areas or areas where beavers are active, water tables are high and wet vegetation can remain all year -- reducing fire. {#37}

Seems that in restoration work, there should be some input form the fire work, not just the veg and bio perspectives. {#42}

Most of the ongoing physical science fire studies are presently looking at post-fire erosion and landslides effects. i.e., researchers are mostly on the hillslope). Few are examining the effect on the physical character of the streams and even fewer have looked at effects on the biota (fish, macroinvertebrates, etc.). I'm not aware of many studies where riparian vegetation dynamics has been specifically studies. What's really needed is a comprehensive integrated look at all of these resource values. {#43}

I agree whole heartedly. We will only answer some of these questions through an integrated, interdisciplinary approach. We need to take advantage of the past fires and the opportunities for prescribed burns. {#54}

Discontinuity or continuity between vegetation types/structure {#44}

Understanding vegetation succession within riparian areas and where we are in this successional regime -- and what management activities have (or will) modify vegetative pattern and structure. {#52}

Examining vegetation succession on the basis:
1. Disturbance regime - natural and anthropogenic
2. Geomorphic position and relationship to hydrology
3. Hydrologic regime
4. Vegetation establishment requirements {#73}

Contrasting riparian to upland conditions on the basis of:

1. Fuel loading or amount
2. Continuity of fuel
3. Fuel types
4. Fuel condition (ex. wet or dry)
5. Fuel chemistry

1. Topographic continuity
   a. topographically level landscape vs.
   b. deeply incised landscape
   c. wide alluvial reaches in otherwise deeply incised landscape
   d. deep canyons in otherwise flattish landscape
2. Topography of drainage network relative to wind at time of fire {#56}

Opinions seem equally divided between potential importance of landscape features (valley/channel width), vegetation characteristics, and climatic conditions. Perhaps people's experience with one of these factors leads them to a more restricted view. I'm inclined to think topography and geomorphology are important, but others appear to be convinced that nothing other than weather influences certain types of fire (e.g. crown fires). Are we all working with our own biases? {#58}

They are zones arrayed in a fractal pattern across landscapes where water is pumped from belowground and stored in the surface in vegetation (foliar moisture), or transpired to the atmosphere to increase relative humidity. Positive feedback loops come into play, for example the accumulation of CWD resulting from infrequent (or less severe) fire provides another source of water storage that acts to increase relative humidity and feed water to plants. On the other hand, the high biomass accumulations become high fuels if the water table drops sufficiently and plant moisture drops. The question of plant chemistry is important. Do riparian zones tend to have plants with fire retardant chemical properties? {#59}

It seems like a few studies could be designed using fire scars and slabs, maybe cores for charcoal in meadows, that address the question. If these areas also have or can compile a decent spatial fire history for at least 1900-2000 that would be important. Select the forest types to work in that are going to buy you the most, i.e., cover large parts of national forests and fire prone now. An added benefit would be to also do this fire history work where you know that landscape scale (100-200 acre) prescribed fire treatments are ongoing with ecological studies.
To be most useful this should be a joint activity between fire specialists on the forests and research ecologists. {#60}

A carefully designed experiment, including low-high severity prescribed fires, could attempt to isolate effects such as stream channel steepness, vegetation cover, moisture gradients, effects of management activities, etc on fire severity in riparian vs. upland areas. This experiment would need also to control for post-fire weather events, primarily precipitation duration patterns. In the absence of carefully controlled experiments we are just shooting in the dark with reliance on anecdotal evidence. {#61}

I agree this is very important {#67}

As a hypothesis, I would suggest that functional riparian systems would be much more resilient to fire than degraded riparian systems and more likely to affect fire behavior. If so, it would be important evaluate the effects of pristine, healthy, intact riparian systems upon fires in comparison to degraded riparian systems. Not aware of any such study! {#71}

Examine the former hypothesis for major ecosystem/fire types. {#83}

Knowledge of the timing of the buildup, movement, and decay of above-ground riparian products (on site, imported, and exported), together with weather patterns that lead to increased fire probability in areas with generally low likelihood of fire. {#75}

Reference to 61: I have asked about trying to get moderate to high severity prescribed fires for my watershed experiments and the fire staff on the forest think I am crazy. At this point in time the only place I think one could get the moderate to high severity prescribed fire treatments might be on one of the national parks. In the case of Sequoia-

Kings Canyon NP the USGS (in their wisdom) just last year eliminated their long-term watershed study on prescribed fire. {#79}

It is extremely important to understand the dynamics of riparian obligates (salamanders, etc) when prescribing riparian changes or burning. {#81}

Refr #58 and whether weather is an overriding factor or not. It seems to me most useful to think of weather as being an overriding factor under extreme conditions, but under less extreme conditions many other factors may come into play to influence fire severity. Reflecting on Mark Twain, It's the latter which would seem to be of most interest. {#84}

Don't underestimate the difficulty of doing landscape scale fire treatments in the current mindset of the public and fire staff. {#86}

grazing! {#88}

How they dry out in response to "drought" should be studied! Timing of drying versus snow pack quantities or runoff timing should be considered. An expost-facto study of FBA's and their observations of riparian effects on fire behavior could be undertaken and quantified against the actual fire behavior and NFDRS variables of the day . the fuel conditions of the riparian should also be characterized. {#90}

VII. Interdisciplinary Group Presentations
(Topic Commenter)

1. Group 1

Fantastic Group 1 Wondzell, McDowell, Minshall, Manning, Agee, Vail, Rogers

1. **How has land and water management in riparian zones and streams (logging, livestock, fire suppression, roads, water diversions, etc.) affected fire properties of western forest landscapes?**

2. How does ecological condition of the riparian zones affect fire in the landscape?

Depends on place - in some places "overprotection" from surface fires has caused the riparian zone to fill in with conifers, replacing hardwoods - in other areas the "original" riparian vegetation is gone but not being replaced, resulting in a Drying out effect, thinning of vegetation cover.

Land Management Effects on fire Properties

Fire Suppression (indirect effects)

In forested areas, more conifers and more shade tolerant conifers are the major effect. In non-forested areas, sometimes more conifer (juniper) from fire suppression alone. If deciduous component decreases, and increased layering from ground to crown, possible increased fire severity.

Grazing

Upland changes, like juniper invasion - grazing and fire suppression - has dried uplands and indirectly dried out the riparian zone. Stream recovery can result in more vegetation (grass replace juniper) as well as better soil moisture storage and summer flow (Wayne Elmore's BLM work - Bear Creek, Oregon).

Where grazing has resulted in juniper invasion, fire intensities can increase, although fire will spread less under usual conditions because of lack of fine fuel. So fire regime in riparian zone will change. But there will be fewer fires because of the loss of fine fuels from the ecosystem—a loss of grass productivity.

The invasive can be quite flammable where they have replaced natives - e.g., cheatgrass vs. perennials.

Roads

Road incises the stream, can add sediment directly and thru runoff by inline ditches - destabilize channel and side slopes. Aggradation can result in less flow at surface. Loss of pools can't fill backpack pumps for emergency pumping operations.

Do provide access for trucks to water.

Water diversions

Can at worst completely remove the riparian zone.

Where sub gravel flows continue, the riparian zone will still function for vegetation but maybe not for aquatic organisms.

3. Specific Examples

Subsidence in fine-textured soils, loss of soil aggregation potential.

Has riparian vegetation change resulted in changes in the landscape (uplands) because they no longer function as fuel/fire breaks?

Both often burn in similar fashion. Evidence for fires getting bigger because of riparian change is difficult to document - they can spot right over the riparian zone under the conditions we usually see them.

Acres burned may not be the best criterion of success.
Acres burned by severity class may be better: how many acres burned out of historic range of variability –

What % of historic fires (last 20 years) have seen riparian zones act as fire barriers? Quite a few, but not predictable based on random criteria - fire weather, condition of zone (how much fuel) - need some site-specific information.

We have increased fuels in general over the entire landscape (riparian and upland) AND only "allow" fires to burn under worst case weather - SO….. the controlling factors over riparian vs. upland are different than they were historically - and one reason why historic information may not be as useful in understanding the difference between riparian and upland.

So they weren't always fire/fuel breaks, but may have burned differently (possibly lower intensity) - now it's not clear. No one is saying "Thank God there's a riparian zone, this wildfire will stop" -- spotting alone will affect spread. Certainly the water there is useful for an escape route or water for suppression.

2. Comments on group 1 presentation

Good job....I was in that group and Jim did a good job of representing the group and communicating our thoughts to the whole group. {#20}

What a great job! These folks should be kept together for tomorrow. {#21}

Maybe the riparian zones aren't complete fire breaks in each situation, but I think they are useful for suppression or slowing down a fire in the right situation. I think we would rather have them there for possible use than not at all. {#26}

Lowland effects from grazing (on fire in riparian zone) are as important or more important than upland effects from grazing.

A more general effect from grazing is channel destabilization and incision (in fine-grained, incisable systems); this leads to drying out, dewatering of the riparian zone.

What are the fires that we "usually see"? There are still many different types of fire occurring on the landscape - of varying intensities and movement (e.g. along soil surface, through crowns, etc.). {#35}

More specificity would improve their discussion. Is conversion of riparian vegetation to exotic annuals a common degradation---not really except in the most degraded of landscapes?

I do think that the "controlling factors" view of fire behavior and effects was quite interesting and important to keep in mind when discussing current fires and their potential ecological effects. {#37}

There has been juniper "invasion" in the absence of domestic livestock. I don't think you can make the case that "grazing" inevitably results in juniper invasion. {#38}

Agree. We need to be careful not to assign all the changes occurring in these systems to grazing. Juniper and pinyon are expanding as a result of fire exclusion and climate change as well as grazing. In some cases, streams are in natural incisional phases and grazing and roads have increased rate and magnitude of incision. {#60}

In some cases overgrazing can reduce fire can reduce fire incidence and spread by removing fuel. So, an overgrazed degraded riparian condition may also serve as a firebreak because it is devoid of vegetation, rather a place where vegetation is robust. {#39}

I also think the shift in understory veg from riparian to types that cure more quickly also reduces the effectiveness of rip zones to be fuel breaks. Ties back to #31 comment and grazing effects. Also, more dead twigs in willows and a highlined form. {#40}

We have had much discussion today about the condition of riparian vegetation and how it is affected by various land use practices. In general this discussion seems to have an implied assumption that riparian condition is related to some aspect of fuels - abundance, continuity, flammability etc. This is only one dimension of the fire equation. We need to factor in fire behavior, and ask -- under what conditions do riparian zones act as fire breaks or as conduits for the spread of fire. It seems that under today's fire regime, riparian zones seldom affect fire behavior at a landscape scale. SO how about under historic fire regimes in areas with frequent, low intensity fire? Sure, riparian zones might have stopped surface fires. But the next year the fire would come from the other side of the valley, etc etc... So even then, as long as fires were very frequent, riparian zones would have had little effect on fire at the scale of landscapes... {#42}

Excellent observations. {#55}

Disagree—if the riparian zone decreases the size of fires, then this response should be seen at the landscape level through time—i.e. through smaller fires

I also agree w/39 but I don't think we'd ever want to manage rip zones for that...let's hope not, right? {#43}

The variability of fire's visits, e.g. it's specific behavior and resultant effects, to any system is still an important concept to keep it mind. A riparian zone may or may not slow or stop the spread of a fire. All fires go out eventually with or without our actions and with or without riparian zones. {#44}

Which historic range of variability? What time scale? How long will it be applicable? {#46}

Seems like Jim's concluding statement might have been a bit more strongly worded than I'd be comfortable with. Perhaps I took it too seriously, but I have seen numerous examples where small and medium size fires did stop (or slow down significantly) at riparian zones. These examples include both suppressed and non-suppressed fires. For larger fires in more severe weather this effect is certainly less consistent and may be weak. But if riparian zones didn't function this way, it is possible a few more medium and small fires might have become large fires. It is a chicken-and-egg problem and we need to be careful to distinguish short- from long-term causal loops. {#47}

Actually, I can recall devising fire suppression strategy around strings of wet meadow lands, where there now is significant tree invasion, so I would say that "thank goodness there is a riparian zone to stop the fire" isn't completely out of line. {#50}

Why not also recognize that in low elevation unconstrained reaches late season fires may have been more common in these riparian ecosystems--- open, high fine fuels, close to ignition sources (people) etc. that the associated uplands {#51}

We continue to focus on extreme events - large fires in the landscape, rather than looking at the whole mix of fires. No question that under extreme events only extremely large barriers will stop a fire (Oceans, etc.). Even on major fires, the weather phenomena driving it will come to an end, and riparian zones, if they are in the vicinity, will come into play in "stopping" the fire. {#52}

Your discussion on question 4 is particularly good for raising the need for thinking beyond traditional metrics--what will it take for agencies to start collecting more meaningful information on individual fires? {#54}

#42 has a point - Fire behavior models can be run to determine where and under what conditions riparian areas as fuel breaks effectively. {#56}

I'd like to see more discussion of the hydrologic effects of vegetation replacement, mentioned here in terms of P-J woodlands replacing grasslands. Some of these species are prevalent in areas with low plant available water and high soil moisture deficits, thus change the land cover has little effect on volume of runoff produced. Would like to see this study {#57}

As you indicated the presence of roads in riparian areas is very complex and can lead to increased or decreased fire incidence and/or severity. This is an area where work could be focused. {#58}

Re #31: Does this drying out sufficiently change fuels so that the behavior of fires is changed? {#59}

An issue that wasn't discussed in the presentation is what are the attributes of a riparian area that would be effective as a fire suppression tool. Fire behavior models could be run to give conditions that would make riparian areas effective fuel breaks. Also an argument could be made from this to show economic benefits and tradeoffs from saved suppression costs by using riparian areas as a fireline rather than line construction.
Another use that should be added is that riparian areas serve as escape routes. {#72}

I really appreciate the view point that the role of riparian areas affecting fire on the landscape has changed as the vegetation, landuse, roads, water diversion and suppression actions have changed over time. A ex post facto study of wilderness fire use might help us define breakpoints and what changes have happened to change the role of riparian areas in limiting fire spread. {#71}

I agree with the conclusion that riparian areas may be useful for reducing fire hazard, stopping fires, etc., but it is certainly not a fix all solution. {#70}

Re the Bear Cr example it is unlikely that the removal of the Juniper accounted for the changes observed. See also the Status of our knowledge paper circa 1974 from Rocky Mountain forest and range experiment station. More likely the change came as a result of the storage and release of flow from the riparian soils. See also Alkali Creek experience in Colorado(Heede and DeBano.) {#69}

Reply to #41. We discussed what you say, and I probably just didn't explain it to the whole group here as well as I should have. {#68}

Comment about % of historic fires have seen riparian zones act as buffers -- this could be perhaps be quantified with wildfire data, espec. if digitized & put in a GIS coverage -- criteria given not necessarily random but use as a stratification for potential predictions - e.g. fire weather, stream order/vegetation type etc. (much of this info is actually available for many National forests - or could be put together by NF staff if $$ were available). {#67}

I disagree that fires burn in similar fashion in upland and riparian zones - especially in the dry forest zone of the landscape, {#66}

Reply to 48 --Looking for where someone said this - frequency may have been similar, but intensity probably not. {#65}

Re the apparent fire frequency in riparian. The results at best are inconclusive because the samples as pointed out had to be taken from the fringe of the riparian. These areas certainly would have been likely to burn but it does not necessarily follow that the riparian was burned. {#64}

Yeah I agree w/ number 42 that where I have seen riparian zones forming fire perimeters is most often in relatively unaltered landscapes. Degraded riparian zones function this way much less often. {#63}

! {#74}

I strongly agree with #60. {#76}

3. Group 2

Super fantastic group #2 : Chambers, Omi, Hunsaker, Lohrey, Clark, Beschta {#73}

QUESTION #1

Overgrazing –

- Stream incision--drying of riparian systems -- hotter burns in some areas (EX: Robison Springs fire, Fremont NF) in sagebrush types, stream incision leads to higher woody fuel loadings in formerly moist sites
- Loss of fine fuels on uplands
- Change in composition of upland species (alter fire behavior); increase
- Potential for invasive species

Roads

- Incision of channels
- Provide access and thus used as firelines
- Provide access and thus source of human caused fires (arson & accidental)
- Road system allows a prescribed fire program (road serve as fire breaks, provide easy access, increase safety factor)
- Source of invasive species
- Dozer lines on fires: severe erosion, change of plant communities

Forest Harvesting --

- Harvest of riparian forest and removal of large wood
  (EX: decreased severity of fire in west. Or Riparian zones)
- Breaks-up continuous fuel types into smaller blocks
- Historically -- harvest of large trees (fire tolerant) in dry site forests
  (EX: Ponderosa pine)
- Short-term increases in fire danger (short-term fuel buildup following harvest and dryer microclimate increase potential to burn)
- Harvesting leads to a major road system (and related issues)

- Second-growth frequently has reduced species diversity
- Second growth may burn more intensively
  (EX: western Oregon forests)

Site prep by burning

- Reduces fuel loads and reduces competition (many forest types)
- Use control burns to control woody shrubs (ex: sagebrush & PJ types) and create vegetation mosaics
- Escape of control burns is periodically a problem

Cumulative Effects --

- Altered hydrology (peak flow and timing) and sediment loadings to streams and riparian systems {#16}

Water Diversions

- Reduces availability of water to riparian systems and thus may alters plant communities and susceptibility to burning (EG: Cottonwood burn along Wood River in Idaho)

Wildland Urban interface

- More people, less opportunity for natural burns
- Large amount of fire $$$ go to protecting houses and not available for other fire related needs

Beavers

- Eradication and reintroduction {#17}

QUESTION #2

-- Beaver eradication has resulted in decrease sizes of wet habitats -- no longer as effective at stopping fire

-- Reintroduction of beavers may accelerate erosion

-- Incision is a major issue, e.g. loss of floodplain connectivity

-- Shift to xeric species is detrimental; increased susceptibility to invasive species {#18}

NOTE: We are concerned by a general lack of hard data .

Also, the role of the above factors on fire severity, behavior is "it depends"

QUESTION #3

May be anecdotal evidence by fire control folks, but little published information/ study results in the scientific literature

QUESTION #4..We don't know {#19}

4. Comments on group 2 presentation

Water diversions can also increase water, because there is not only water diversion FROM riparian areas, but there can be water diversion TO other riparian areas. {#77}

Reply to #77. this seems like an incredible stretch - most water diversions are for uses other than restoring or adding to other riparian flows. It's like saying if we don't clear-cut early successional species will disappear. My suggestion is to perhaps qualify statements like this, like 10% of the time, or something like that. {#80}

In some areas we may have more surface water today than historical because of the creation of storage reservoirs and stock ponds that capture and store stormflow. (excepting where there were beaver ponds) {#78}

Re: overgrazing. Some streams don't incise (coarser bed material), but may widen. We need to think about potential effects of widening. Maybe produces a drier but low fuels zone? Maybe more similar to effects of aggradation than to those of incision? {#79}

Effect of invasive species not always in a particular direction {#81}

Re: Effects of loss of beavers: This is important, and we have only generalities at this point. Beaver pond complexes would have made large, much wetter areas. But beaver complexes may not have occurred throughout the drainage system. The spatial pattern is important and not well known. {#87}

Sometimes loss of beavers leads to more woody vegetation, so not so sure that the response is uni-directional {#90}

The most significant contribution of this group may have been identifying the fact that while there is a lot of agreement about these issues, there is little hard data or research to support most of our conclusions in this field. {#91}

Roads interrupt and divert flow thereby changing the quantity, routing, and timing of water delivered to the riparian, {#92}

I am interested in further discussion of invasive species, i.e. under what circumstances does fire suppression promote invasion versus some other factor, unrelated to fire? {#93}

Reply to 93. I think fire exclusion policy has had little direct effect on invasives. However, if it has led to more intense fires, or the need for large impact fire tactics

(bulldozers, etc.) then it can scarify soil and if a seed source for exotics is there, can aid the invasion process. {#108}

Re no data - Couldn't the fire reports be gleaned for some information that could support these theories? {#94}

As I understand the focus of the questions -- we are supposed to be thinking about how riparian zones may influence fire in the landscape. If we change our perspective, then some conclusions may change. If the question is:

How does pre-fire condition of riparian vegetation influence fire behavior in the riparian zone and the influence of these fires on attributes of the riparian zone. fires influence riparian zones and streams? And how does land use / land management change the condition of riparian veg? Then, maybe, there is lot we can say.

Does the conversion from hardwood to shade tolerant conifer change the resiliency of riparian vegetation? Root sprouting shrubs may well provide bank stability, and filter fine sediment from overland flow relatively soon after fires, where as waiting for regrowth of conifers may take a long time.

Or the invasion of annual exotics may make riparian areas more fire prone than historically., leading to the consumption of large wood that might otherwise be available for controlling channel structure. {#95}

In terms of roads another effect is also they bring Ignition sources to the forest--- with more roads you have more access to start ignitions.

This was a good list of the multiple impact on the forest and effects on hydrology... {#97}

With regard to roads causing incision, it wasn't explained in the last two presentations, but one way is by narrowing the surface through which the stream meanders, given it is a riffle/pool alluvial stream. The stream adjusts to this narrowing by incising. Widening does happen in coarse textured soils and sometimes evidence of both processes is present. Then you can piece together events that led to the current point-in-time situation. (responding to 79) {#98}

Re 79: It is probably possible that stream can both incise and widen. {#99}

I agree that we need more hard data. We also need to make room for the production of findings (such as compilations of fire reports, etc.). I find the emphasize on "proper" research findings as the only useful source of knowledge to be restrictive and unfeasible. It takes far too long and is far too expensive for research community to get out and "properly" give us the answers to all of our questions.. {#100}

What about all those forest closure orders that get signed BEFORE fires occur? re #97 {#101}

It does seem there is a large body of knowledge in fire practioners' experience that does constitute a kind of observational science. Agree that systematic studies, experiments etc. offer another kind of science. {#102}

We just need to pull this info together in a scientific manner. {#120}

Re: #77 Good point. If we feel that water withdrawals dry streams and create adverse effects on riparian vegetation, then adding diverted water to other streams should improve riparian communities. Do we believe this hypothesis? {#103}

Re - 79, Agreed, but the task was to look at those where we knew the effect from a fire perspective, and we know that incision has occurred in some places, followed by a change in the riparian community type - often to a drier site species. {#104}

Some invasive species are highly flammable and change the fire regime in the riparian but others are not and will continue to be present even they may change the quality of litter delivered to the stream. {#105}

Re.87 True although the historic evidence in trapper accounts indicates some extensive beaver swamps through most of the western drainages. See also Cienegas vanishing.... {#106}

Re:93...This was brought out in many of our BAER reports!! a big concern!! {#107}

For question #2 one of our points got lost. Primarily it is stream flow (quantity and timing) that determines riparian condition. So this is a driver that many other things respond to.
Also, this seems like a logical conclusion if we are sure that riparian zones to affect fire behavior, i.e., it should be a given that the better the riparian condition the more effective it would be in influencing fire behavior. But we have to be sure of the initial statements first. In other words, don't go here if we are not sure. {#109}

Large amounts of dollars do go into protecting the intermix because that is where congress is willing to put the money and where the tax payer is willing to support. The case hasn't been made that there is any kind of economic benefit that restoring the riparian areas for fire suppression purposes would make. This comment courtesy of the Pima Co. Republican Party. {#110}

Re #98: There are other ways in which this works too. Fold waves are confined and are higher, resulting in higher stream power and therefore incision. Also there is the hydrologic effect (water routing, faster delivery). And probably some others. {#111}

Robinson Springs Fire was another case of a weather generated crown fire. It ran for two days under a typical summer wind pattern generated by the Alvord Desert heat Low. It stopped running when the smoke from two days of burning "socked -in" the Alvord Desert and effectively shut down the wind for a day. It was on that day that firing operations were successful. Had the fire been allowed to fulfill it destiny on the landscape it would have made the Winter Rim area. {#112}

Roads do keep fires out of riparian zones in many cases, this changes the fire frequency of the uplands to the riparian area, this includes the use of prescribed fire. Often prescribed fires are keep out. Not good. {#113}

Your point about lack of published information is a good one. Perhaps some of the questions/hypotheses that are generated from this exercise could be addressed in a preliminary way by an aggressive and thorough examination of fire records across the West. This could be a time consuming exercise, but the potential database is enormous. At the very least we could begin to see which of our comments can be supported and where substantial data gaps occur. {#114}

#77 Clarification: Water diversions often takes water from one drainage and releases it in another. While the volume in one system is increases the water in the other is increased. All water diversion is not placed in a pipe, Most is conveyed some distance in a natural waterway. {#115}

Data and peer-reviewed studies are definitely needed but I would guess that we know enough in certain systems to proceed with restoration efforts--provided we pose such efforts in terms of testable hypotheses and allow for adaptive manipulations as we gain information along the way. {#116}

Re 94 - Fire reports are notoriously incomplete and inadequate. We can barely capture basics, such as number of fires and acres burned. {#117}

Re #107 Often the diverted water is consumed by the water-loving vegetation that is being grown or is routed out of the system. {#118}

Re:100 -- "Proper" research findings stand up in court, if that's important. {#119}

RE: #93 Hasn't historical fire resulted in reseeding with massive amounts of exotics? {#121}

I really believe that serious effort should go into ex post facto research using a GIS data base already developed on large wildland fires for BAER process. This data combined with face to face discussions with the Fire Team’s FBA on the incident might really get us going. Such studies may NOT always make it through PEER REVIEW, but emphasize the state of the art and would be extremely valuable in developing hypotheses

for future scientific studies. The odds of successfully laying in "plots" prior to the wildfire burning through are small. {#122}

Reply to #122. Good idea. {#128}

Agrees with #80, most diversions are ultimately consumptive and the vast majority of water diverted does not return to surface flow. The exceptions are so limited that focusing on them distorts the dialogue. Certain diversion structures, e.g., hydro facilities, may seasonally reallocate flow in a way that has (at least locally) a riparian - enhancing effect. but again this effect if most often countervailed by diminishment of riparian areas downstream, such as through channel simplification. The diversion question ought to distinguish between flow withdrawal (e.g. for urban use or irrigation) and flow-reallocating use (such as flood control/hydro dams). {#124}

I don' think the organic act would support partially draining one drainage to help another {#125}

BULL! Science and courts are different cultures! {#127}

Re: Question 3 and #100 response. There needs to be a way to quantify and report or publish timely results from our observations. There is very important issue. The research community is not quick enough to respond to this need and fire suppression folks having great observation skills put do not have the time or medium to publish this information. {#129}

Re: monitoring and reporting. The National Park Service is light years ahead of both the BLM and USFS. I feel this pulse and flurry of "let's get fuels treatments planned and implemented" with the "fire money" is what the USFS does best: implement without adequate mechanisms to evaluate whether objectives were met, whether objectives were even appropriate, and what were the results. Why the USFS has not come up with a rigorous monitoring protocol with sustained and periodic review is foolish and shows lack of long term vision. {#206}

NFS fire staff and research staff can work together effectively to improve our data collection and documentation on fires. It would be good to stop the counterproductive dialogue that occurs within the FS that research can't provide the answers quickly enough and that the only good data comes from research scientists (comments 100, 129). The group's comment that we need more "hard data" did not mean that only research scientists could collect these data. NFS staff can collect and document good data--but that is different from observational information. Again, FS strength is when research and NFS staff work together. {#209}

FS needs to establish a mechanism for NFS folks to transmit their information needs and the context of those needs to Research. Research is very talented but not clairvoyant. {#210}

Re: 206: monitoring protocols cannot be one-size fits all. Vegetation is too diverse. {#214}

Re #214 from the author of # 206. I am in total agreement! Your preaching to the choir on this issue. However, we need to work on some form of monitoring that allows us to accommodate vegetation diversity and various types of treatments so we can look at landscape and long term effects. Often what we have now are folks running around taking photos and not setting up COORDINATED monitoring programs that assess a basic host of parameters. {#228}

5. Group 3

Group 3

How has land and water management in riparian zones and streams (logging, livestock, fire suppression, roads, water diversions, etc.) affected fire properties of western forest landscapes?

There are direct and indirect impacts

Logging

- Redistribution of fuels
- Loss of fire-resistant trees
- Increase in finer fuels
- Opening canopy alters microclimate - humidity/temp profiles
- Species replacement with invasive species
- Recruitment of LWD – long term losses
- Shifting pattern of water balance
- Soil compaction (water holding capacity -> species composition) {#14}

Livestock

- Soil compaction (ibid)
- Species composition shift
- Vegetation structure (e.g., fine fuels)
- Vegetation composition (e.g., Depletion of shrub layer)
- Tree recruitment
- Fluvial processes - channel incision - drying of RZ - change in fire behavior
- Fine fuels consumed -> e.g., surface fire regimes replaced with lower frequency crown fire, alternatively exotic annuals (e.g., cheatgrass) invade and increase fire frequency

Fire exclusion

Change in species composition (e.g., deciduous to conifer - slower decomposition in conifers)

Alters woody debris accumulation (e.g. lower tree mortality/shrub topkill, less LWD)
Nutrients tied up
Fuel accumulation affecting fire severity

Roads

Facilitates suppression & decreases fire frequency
Increase in ignition
Increase in human access, e.g., campgrounds
Move invasives and pathogens
Alter sedimentation patterns
Increase "edge" effects surface fuel drying

Water diversions

Need to consider timing of the diversions - might not matter during peak flows
But e.g., Lower water tables -> drier RZ
Alters sedimentation processes -> affects recruitment/composition -> alters vegetation composition/structure
Channel simplification
Potential loss of RZ

How does the ecological condition of the riparian zones affect fire in the landscapes?

Already answered {#29}

Specific examples

E.g., Los Alamos canyon perennial water vs. dewatered (with wells) Guaje Canyon - perennial flow, some tree survival vs. dewatered, no tree survival

E.g., bosques along Rio Grande with tamarisk - burns severely - but note, any dewatered bosque on the Rio Grande (or any other SW river) will be
more susceptible to high intensity fire.

Warm Spring Indian Reservation, central Oregon - logging of PIPO on terrace - fire behavior was extreme in 10-20 y.o. sapling regeneration & burnt the
whole riparian area.

Has riparian vegetation change resulted in changes in the landscape (uplands) because they no longer function as fuel/fire breaks?

This would seem intuitively true from the above considerations

Hondo Fire/Red River e.g., was a specific example - couldn't backfire from the riparian zone because fire suppression -> to high veg. Density

Klamath/Siskyou thinning of RZ seemed to lead to increased fire spread {#30}

6. Comments on group 3 presentation

Water storage and diversion: If water is stored during stormflow and released during drier season, then the riparian might be wetter than without such intervention. Water storage and diversion does not ALWAYS translate to drier riparian conditions. {#130}

Re 130: I think I agree with this. Diversion is only detrimental where it removes water from the system for a long times; not where it increases flows during the dry season. {#144}

Strongly disagree with these statements as changes in hydroperiod will result in changes in riparian vegetation. And, be realistic! Most diversions are into canals or ditches and out of channels. It is a real effect on the western landscape that should not be discounted.

Don't agree that roads decrease fire frequency. They probably decrease fire sizes where they contribute to timely suppression. If the source is lightning the frequency is independent of roads. It's arguable that roads may increase fire frequency if they allow human access to an area. {#131}

Roads increase human access which can result in grater wood removal and consumption thereby reducing fuel loads. {#132}

But not the fuel loads that contribute to the propagation of a wild fire.

Roads also are associated with high-grading of large trees and more cut and scatter slash removal - so generally less resistant landscapes to fire (doesn't mean that restoration logging, done to favor large trees and with slash cleanup, would have same effect). {#146}

More complex than this, since woodcutters leave behind fine components of the tree, and opening the canopy can reduce fuel moisture {#142}

The road issue is complex, but generally it means more fire starts but smaller fire size. so roads are associated with "increases" and "decreases". {#135}

You did add something new. The examples provided were a valuable contribution! {#133}

#131 yes this is a useful and important distinction {#134}

Add to #131: Roads also may increase the chance of early detection and hence suppression of a smaller fire. {#136}

Re: 131 Note group 3 said that roads might increase human ignition {#137}

Livestock (cattle) also thin woody shrubs by rubbing, trampling, and consumption of leaves and branches. {#138}

Can you elaborate on the observation that thinning in the RZ increased fire spread in the Klamath-Siskiyou? {#139}

There was a misprint - re#131, roads were thought to decrease size of fire due to access for suppression etc. {#141}

Reply to 143: Not sure what you mean by "current statutory mandate" but channel maintenance and other resource needs do not require 100% of the flow all of the time. {#161}

Re water storage, how could that be accomplished under the current statutory mandate? {#143}

Agree with #133 {#145}

Water diverted and returned can have multiple effects - sediment and nutrient addition that affect riparian plant communities and stream processes. {#156}

In Oregon there are a lot of small scale withdrawals/diversion for irrigation on the same floodplain, water is returned a short distance downstream. It can be argued that this increases moisture in floodplain (positive effect) or decreases moisture in the whole system for that reach (negative effect). I'm not sure we know which answer is right. If there is a greening due to this kind of irrigation, it may be only be because we are looking at a system that is already incised/dried out due to historic human impacts. {#147}

Very good point on the term "fire exclusion" vs. "fire suppression". I think that it is a much better term to be used for describing the effects of removal of natural fires from the ecosystem. {#148}

Invasion of Russian olives into riparian grasslands would seem to increase fire intensity through increased fuel loading, plus they overhang the stream and increase thermal loading and charcoal and ash inputs to the stream. {#149}

#143 your comment is too cryptic to understand. Say what? {#150}

Not sure that I've seen anyone mention that fire rehab activities, for example the widespread seeding of areas to non-native species, as a factor leading to altered fire patterns in the subsequent stands. Do these species alter natural regeneration patterns or species composition in any way that would be significant from a fire perspective? {#151}

#151 - Excellent comment. Many times rehab species (especially introduced species) can decrease native species diversity. They can also move into the riparian zone following disturbance events. {#176}

The issue about roads leading to more ignitions-the fires are generally caused from other uses than using the road -i.e. camping, hunting which could happen anyway . {#152}

People wouldn't be so common in these areas without roads! {#155}

Re 147, But does not the diversion lessen the effect of the water hydrolics - decreases its ability to move sediment through the system. {#153}

Re 153: Probably not, since most of that sediment movement occurs during a few high flow days, when diversion is not occurring. {#159}

Re148 I thought suppression was related to the action to control wildfire once started rather than fire exclusion per se. {#157}

Under "livestock" and "composition," are you suggesting that grazing/overgrazing results in a depletion of shrub cover? I have seen just the opposite. I.e., grasses/forbs are overgrazed and depleted, resulting in an increase in shrub cover. Maybe your comment only applies to certain shrubs, certain classes of livestock, and certain grazing seasons? {#158}

Roads are associated with greater disturbance in the riparian by logging due to yarding, dragging, etc. in narrow valley bottoms. {#160}

Re: comment 151 See the paper on the effects of fire rehab in the packet. Also there is a great study by Oeschel et al (Ecology) on how seeding exotic grasses dramatically affected the fire severity of the next burn on the site. {#162}

#139 Sure I can take a crack at it. This is a largely anecdotal set of observations of fire behavior on the Longwood Fire, I have seen comparable patterns on fires in the Blue Mts too, where the fire burned thru a mosaic of plantations with stringers of thinned and unthinned riparian zones between units. The thinned riparian zones almost without exception passed the fire thru with high flame lengths and accordingly high crown mortality (maybe due to wind conditions in the opened understory?). The unthinned riparian zones, multistoried and dense, commonly cause transition to slower-burning ground fire and a lot more of the riparian overstory survived. This is under conditions where the adjacent plantations were torching hot and fast. {#163}

Original ideas from John's group: In SW OR and NW CA roads have been the means of pathogen transport to isolated stands of Port Orford cedar Many of these stands are now infected and are dying. This very long lived species is now being replaced by other species that have different decay rates and properties and are more susceptible to fire than

the resistant Port Orford Cedar. A very, very sad story. If you haven't hiked into one of these stands you should try to see them before they are gone. {#164}

Very good point about change in species composition from hardwoods to conifers. these conifers are also more susceptible to fire. {#165}

{#166}

#131 A thought to consider: when roads are used to hold fire under prescribed fire conditions, and the objective to the burn is reintroduce fire, (to the uplands) often the riparian areas are excluded from the burn. {#167}

Re 153: I would suspect that most irrigation diversions (except those associated with dams) may have limited effects on sediment transport. Most sediment would continue to bypass the diversion point during high flows. {#168}

Re 151---That is an issue. Cereal rye is an example. Most non-natives are supposed to be short lived "nurse crops" (annuals typically) but they can persist. We tried to avoid that but the BAER teams did put a lot of annual rye down...what to do?? {#169}

Yes and even the short term nurse plants have dramatic effects on post fire succession; particularly the species that are stimulated to germinate by fire and are lost from the composition due to overwhelming competition form the exotic grasses.

To #150-As a practical manner, I don't think under the various mandates that storage of water would be funded {#170}

Re. 3151. an exp on the Siskiyou following the Silver complex showed that seeded grasses completely suppress native shrub recovery, at least for the first few years (don't know how long that persists). Some of the shrubs--e.g. Cein--have low flammability. {#171}

Re #153: What does the movement of sediment have to do with riparian condition related to fires? If the riparian area is wetter longer into the fire season because of temporary storage, then it may have an influence on fire properties. Sediment is not the issue in a fire discussion. {#172}

Valuable discussion for the comments stimulated on roads. Also good examples--would be great if someone could develop a checklist of items to be analyzed at example sites (those listed by groups 1-4), including ways of validating/refuting claims asserted for these areas. {#173}

#147 Isn’t this in relatively water rich situations? {#174}

Re: 169 -- Plant native plants, or maybe don't plant -- evidence coming out that BAER planting is not effective anyway. {#177}

#164 Yeah, loss of the PO Cedar is also likely to lead to long-term attrition of CWD from riparian zones, especially in ultramafics....but in a lot of Klamath Mtns terrain POC is the first and sometimes only conifer to break thru riparian hardwood layers in streamside zones. {#178}

Sometimes backfires are lit from along roads {#179}

Rehab grass seeding - wipes out native plants that need to reproduce from seed. Even if they disappear in three years they did their job in killing seeders. {#181}

The reference to the influence of timing of withdrawl for water diversions could probably be extended to many of the other factors that we have been discussing, i.e., land management activities have altered the when and for how long riparian areas are susceptible to fire during the average year. {#182}

Water is already being stored -- without additional funding. Look at all of the stock ponds. {#183}

Many of all those stock ponds were built under previous federal initiatives. {#184}

#151 Yes and I think the shrub layer affects convection (chimneying) aside from he question of flammability, I think stands that lack a shrub layer to break up the airspace below the tree crown are set to burn very intensely under some conditions. {#185}

Re 172: If you divert water, you can't transport the same sediment load; if you don't transport the sediment, the river channel will either aggrade or become narrower, either of which could affect the characteristics of the riparian zone (frequency of flooding, depth of flooding etc.) {#186}

You can divert water during bankfull flow (or critical flow) and not change bedload transport. If there is a high suspended sediment load, diverting will probably always have some effect, but in many cases I bet it is minor. {#188}

Re #151 Commenting on my own comment, note this flies in the face of ladder fuel theory! {#187}

Re 151, 187 - Remember that shrub foliar moisture is a key interacting element, too - deciduous shrubs keep that high foliar moisture thru much of the dry season. {#189}

Re 172. Without continual periodic sediment input and movement many of the disturbance species in riparian zones, e.g. willows, alders, and cottonwoods would not find the appropriate substrate for regeneration. I strongly agree that SEDIMENT MUST

BE CONSIDERED when viewing riparian condition. How else do you expect to have recruitment of these species? Particle size and appropriate water potential are absolutely necessary for the germination and survival of these disturbances species. {#191}

#189 Factors that promote shrubs (which may tend to have higher foliar moisture) are often factors that increase drying and reducing humidity near the ground-- {#192}

#172, 191 Strong agreement with 191, flow volume itself (as measured in the traditional way) is much less important, I'll wager, than the sediment dynamics that affect surface and subsurface morphology and vertical flow exchange, thus influencing microclimate, veg, horizontal extent of the hyporheic and thus riparian) zone, etc. {#198}

Non-native invasives are promoted where ever fuels are reduced, postfire, thinned forests, fuel breaks etc {#199}

#189 Yeah for about 1-3 years, followed by decades of site occupation by the shrubs! need to get this in a temporal perspective. {#200}

#188 Many diversions do not go to reservoir storage, they are either direct or below reservoirs so bankfull diversion is not an option. {#201}

That's what I meant, diversion at less than bankfull flow {#202}

7. Group 4

1. How has land and water management in riparian zones and streams affected fire properties of western forest landscapes?

- Grazing practices (fire exclusion) removes fine fuels, limits fire extent
- Loss of water-more (a shift) xeric plants (brush/shrub, trees
- Loss of Beaver (reduced the extent of the moist vegetation
- Roads and Culverts (woody debris is restricted), changes the extent of fire
- Water Diversion
- Invasion of non-native plants
- Logging practices
- Fire Camps, Forest Fire Management Plans annually updated
- Long periods of flammability than may have not occurred historically
- Anthropogenic burning for plants
- Less frequent, more intense fires than may have occurred historically
- Fire suppression as a policy, has had an affect on the upland systems, for example pinon juniper forests over-taking sage shrub systems. {#15}

2. How does the ecological condition of the riparian zone affect fire in the landscape? ***(What's happing in the uplands)***

· A healthy fully functioning riparian zone in: a "surface fire (low intensity) fire regime the riparian zone could be a great influence on fire properties.

· A healthy fully functioning riparian zone in: a "moderate intensity fire regime the riparian zone have less of an influence on fire properties. (has land management changed the fire regime

· A fully functioning riparian zone: what is the natural "historic" disturbance mechanism. This a key consideration in the determination of the system {#33}

In Blacktail Deer Creek, a heavily used grassland (by elk) the fire clear across a relatively wide and normally wet meadow. {#204}

Response curves that change with controlling variables make a lot of sense. {#282}

8. Comments on group 4 presentation

Grazing on Great Plains can stop fires, but if grazing causes a substitution of woody fuels for grass fuels, then fire extent can be larger although propensity to burn may be less. {#203}

Fire camps & other suppression activity/equipment - bringing IN new weeds to susceptible riparian zones {#205}

In Blacktail Deer Creek, a heavily used grassland (by elk) the fire clear across a relatively wide and normally wet meadow. {#207}

I like the response to question 2 - elaborating on the "it depends" issue {#208}

The Barrett info. on burning by Indians suggests localized effects only in low elevation valleys and in some travel zones. There may have been 25,000 Indians in Montana in 1500 A.D., but only perhaps 3-4,000 in Wyoming or Colorado. Cannot extrapolate across the landscape either up in elevation or to other Rocky Mt. states. Probably not much effect of loss of ignitions by Indians except in particular cases where use was consistent and heavy. {#211}

If it is true that native species have a better chance of survival in a healthy riparian zone than in one that has been altered in a manner that makes it more flammable, surviving specimens could provide seed sources for the recovery of the adjacent uplands. {#212}

Did native American burning necessarily decrease fire intensity/severity? Paleoecological evidence says maybe not. {#213}

Re: Comment 203 regarding the Great Plains: Overgrazing the tall grass prairie (eastern edge of Great Plains) may reduce fire spread and allow an increase in woodies - but I

doubt that is true in the short grass or mixed grass prairies. Woody invasion (except in RZs) in the short grass and mixed grass prairies appears to be moisture-limited and it is well documented. Rather than woodies, overgrazing on short grass and mixed grass prairies typically results in an increase in cacti and similar species. In contrast, western grasslands are a completely different matter. {#216}

Good points re culverts, fire camps. When is someone going to blow the whistle on BAER team activities, especially undesirable, non-cost-effective rehab activities. {#218}

Native American burning may be over rated. Some Indian groups have a strong aversion to wildland fire that appears to be perpetuated by elders who acquired those attitudes from their elders who would have predated much of the European influences. {#219}

Re: 216. Woody invasion in short grass and mixed grass prairies is strongly related to fire exclusion - either directly by fire suppression or indirectly by landscape fragmentation. {#220}

Group 4 asks: What is the "natural historic disturbance mechanism" of riparian zones? Good question. My take is that the hydrologic disturbance regime is the fundamental driver with periodic disturbance (usually minor but sometimes major) from fire for dry-site forests. However in areas of steep terrain and moist forest types, stand replacement fires may be the major disturbance regime. {#221}

Re 217 -- Indian burning...In MT and ID, Steve Barrett is a fire historian who has studied this extensively. {#222}

Re 217. See 211. {#224}

Where do you place incident bases, staging areas etc... without impacting the area. Line officer, resource advisor direction is usually responsible for these locations-education of other than fire people is necessary. As to weed there are things that can be done such as washing vehicles that can be done but unit managers have responsibility -more education. {#223}

Re culvert replacement....did I detect some skepticism in this group? You should know there is a fairly tight literature justifying such projects--assuming reasonably competent operators, the volume of sediment mobilized from the culvert excavation and replacement itself (though it may look ugly for a year) is very minor compared to the probable release of sediment from an uncontrolled culvert breach or failure. The main beef I have about culvert replacements is too often the question whether a certain road segment should be retained at all is not asked..a lot of these roads should be "put to bed," not upgraded. As you mentioned, there are often benefits to fish passage as well from larger (and especially bottomless) culverts. {#225}

Re: #218 - Fire rehab activities have more to do with the human need to "do SOMETHING" than with any real need on the ground. And in large part, the need to do SOMETHING is driven by politics. {#226}

Re 226: Nor sure I agree with this completely. There is a political element of "having to do something." But there is also an important resource stewardship aspect to some of the fire rehab activities. Examples of the ladder include clearing clogged culverts to prevent further damage. Examples of the former include throwing grass seed on the fire even when it has little chance of germinating. {#252}

Dave, I like your graph. Ties things together neatly. Steve {#230}

Reponse curves - Response curves that examine the effects of controlling variables in combination make considerable sense. Key is to find appropriate, quantifiable variables and to examine relationships. This could also be a classification exercise for a given ecoregion.. Given this set of variables, this is the response. {#231}

#226 But with bad culverts set to fail, under conditions of increased runoff and mobilization of sediment and debris post-fire, culvert treatments (or permanent removal) are easily justified. {#232}

Re #218: Robichaud et al 2000 (RMRS-GTR-63) is a good start in evaluating BAER efficacy (or lack thereof). Too much post-fire rehab is based on little or no data, and in some cases is exactly opposite of what is known (e.g. grass seeding to prevent landslides in S. Calif), straw bales for effective check dams in channels, etc, etc). This is a definite place where science-based management is lacking. {#233}

#232 In fact in most cases these crossings should have been replaced or removed years ago anyway, regardless of fire. {#234}

I think the concept that there is a suite of severe weather conditions under which management effects and existing conditions lose all relevance is very important and powerful. It would be useful to try to more clearly define the parameters of this. {#235}

The graph - looks pretty good but in low severity fire regimes I wouldn't have the curves al converge like a tip of a banana- historic ponderosa pine was very resistant to even severe weather, so severity would be much less than in today's remnant old growth ponderosa that have late successional as contrasted to old-growth structure. {#237}

#235 Yeah right on, someone ought to run with this conceptual framework {#240}

I believe that it is a rare occurrence today (at least for type 1 or 2 fires) when a fire base camp is located where significant environmental damage is likely to occur. I can count on one hand a base camp that was located at something other than a fair grounds, city park, etc., over the last 10 years. Even at the Valley Complex, camp was located through

a private contract on an area that had been subdivided for home sites, where compaction from construction will be the name of the game. {#241}

Important point regarding the fire control effects of grazing. The grazing of fine fuels throughout the west is a major shift in fire regimes in that it largely eliminated fire from grasslands for long periods of time--well before fire suppression was a big deal. {#245}

Agree with the comments in 221 {#246}

Wildfire will continue to shape landscapes (whether we want them to or not), and if we choose not to try to create situations where these changes will meet our management goals, then we are left with the effects from extreme events only. {#247}

The degree to which Native American burning influenced fire regimes likely varied as a f(lightning strike density and seasonal dispersion, population density, population dispersion). These factors in some Rocky Mtn states translate into little Native American impact. In contrast, there were 350,000 Indians in California, mostly in the coastal ranges, widely dispersed in local settlements, in a region with low lightning strike density and a fire climate that is more severe in the months following the normal summer thunderstorm period, which translates into a likelihood of high Indian impact. Mensing et al's paper in Quaternary Research would tend to support this. {#249}

Great job of brining the controlling factors of fire --- weather , fuels, and composition into a context of management potential. This was among the highlights of the day! This figure should be published and the hypotheses generated by such a graph ought to be tested. {#250}

#245 - Nice paper for Savage and Swetnam about 1830-40 decrease in fire frequency due to grazing (at least interpreted as such) - but not linked with tree regeneration until most of rest of Southwest about 1900. {#251}

#249 -But remember that these fires, once ignited, can burn for months, so can be ignited early and burn late. {#253}

Question for the group: What is the dominant disturbance regime for riparian systems? Is it the hydrologic signature of the flow regime? Is it the direct effects of fire (i.e., burning of riparian vegetation), or is the indirect effects of fire (e.g., increased flows and sediment from upslope areas)? {#256}

Re 256 - My perception is that it's flood flows. {#263}

Re 256: It varies from one ecoregion to another (in some cases within ecoregions). And dominant disturbance is not necessarily the key -- sometime multiple disturbance processes are important. {#264}

BAER plans, like any other activity, needs to be continually reviewed and refined. There are places where not seeding with a nurse crop to protect the site will lead to unacceptable results (the Wenatchee NF), while we continue to overdo it in others. {#257}

I see very limited use of our 1995 Fire Policy of "wildland fire use" unless be really get a handle on what riparian fuel conditions, stand history, and fire weather conditions provide effective barriers to fire. Outside of "Wilderness" we will continue to suppress nearly all fires because the risk of a "wildland fire" not meeting management objectives is too high for even the risk takers. {#259}

Much (nearly all) of the discussion about riparian areas has been focused on riparian area/fire interactions with a smattering of eco-value. To be sure, this is the purpose of this workshop. However, the public value of riparian systems is to protect and to understand the vast ecologic diversity and productivity of these systems. To reduce the discussion to fire interactions is talking about one on the least important aspects of riparian value/management. Perhaps fire is an issue deserving discussion, but it is trivial in the context of the broader discussion of important issues. {#261}

This sounds like a personal value judgment to me. {#273}
I strongly disagree with comment 261 {#268}
I agree with 261: {#269}
I think #261 is at least of equal importance to other views. {#278
RE #261 ----The not-so-clearly stated objective of how riparian zones influences "fire" kind of ignores what I think we have more clearly stated - that the upland probably overwhelms the riparian zone (fire and otherwise). if we accept this premise, then we can talk about fire in riparian zones without always having to preface the remark that our riparian comments is not the most important fire-landscape issue. {#280}

#261 Just doesn't want to play the game we have been invited to play. {#281}

Response curves (comments 231, 235) is a good concept because I think it would help people see the "well it depends" aspect of what we have been talking about. It seems we could populate some of these with empirical evidence. This would be a worthy exercise to be funded with some of this new fire money. If include data from both FS and National Parks (they have some of the hotter controlled fires). {#262}

Good dialogue on the fire curves. You captured what most of the practicing fire behavior analysts/prescribed fire managers think about. National forests are to prepare fire

management plans that would integrate wildland fire use on non-wilderness lands. {#265}

One factor to remember with culvert replacement is that we need to insure transfer of wood and sediment downstream, not just fish upstream... {#266}

#256....It's like Rosanna Rosannadannna says. it's always something. If it isn't one of those, another will take it's place. This isn't really any different from the uplands, you've just added flooding and channel scour to the other suite of disturbances. {#267}

Native Americans weren't growing trees! {#271}

Regarding the 1995 fire policy - we can say anything, but we will get the behavior (human) we reward. {#274}

#271 But native Americans weren't cutting many down either! {#275}

Re #271, yes and Native Americans weren't installing culverts either. {#279}

Information Needs:
-First, we still need a lot of basic information on how riparian systems function and what their current restoration potential is - this assumes that "healthy", intact riparian ecosystems are beneficial to fire management
-Post-fire studies of how riparian zones influenced recent fires, especially where weather and fire behavior information is available. This could be collected in the context of generating response curves to address the controlling factors. It could also be thought of as a classification exercise to determine fire response for
-Fire history data that links upland fire regimes with those in the riparian corridor

$279 yeah, but I heard they were working on a bulldozer, they couldn't {#284}

VII. Concluding Comments (Topic Commenter)

1. What were most important issues discussed?

Influence of riparian zones on fire is very complex --different responses in different places. {#8}

Invasives were thought to be a concern by many but general consensus that we don't know enough at present. In terms of exotics, their effects on the fire properties in uplands is likely much more significant than in riparian zones {#10}

The fire curves were very important. {#11}

Important point. Fire suppression / exclusion distinction. {#13}

Is the water rights thing only an issue for the USDA Forest Service? {#14}

The "it depends" concept. I think the theoretical curves are useful for illustration of this. {#18}

We have abundant ideas, logic, anecdotes, and now theory, but little systematic information {#19}

From fire perspective, the drivers of fire in riparian zones are not the same as they once were. Much more weather-driven now. also when fire does get into riparian zones, generally more severe effects {#20}

Whether or not riparian zones affect fire on the landscape and under what conditions might they be effective barriers to fire spread. {#21}

IT ALL DEPENDS - i.e., site specificity of the responses is extremely important! {#23}

Seems that we can/could make some generalizations, along the lines of D. Perry's response curves for some forest types. Having to or trying to draw a response function get us away from the "It depends" or "we have to define it better". {#27}

I benefited most from hearing about specific examples people had experience with. I also greatly benefited from getting the perspective of the fire managers, who live this stuff. {#24}

The role of the upland vegetation, in terms of stand density (e.g., what fuel model it should be vs. what it is) whether or not the rip zone could function effectively as a barrier to fire.. {#26}

I agree with #11. graphical display of any concept helps put a diverse group closer to the same vision. {#28}

The diversity of ways in which the each of us can interpret the same question. {#29}

The influence riparian areas may have is influenced by a myriad of other factors that are not under anyone's' control - e.g. weather, topography {#30}

The general agreement that healthy riparian zones do function as fire breaks and therefore influence the structure, hence fire characteristics, of surrounding landscapes. {#31}

That the group in general is in agreement with the premises presented yesterday for the fire claim {#33}

Did the group really agree to this? If so, I didn't hear it. {#128}

I agree w/23...it really does all depend...for every "rule" there is an exception...and that is valuable information. We cannot generalize about riparian. {#36}

The general agreement that healthy riparian zones do function as fire breaks and therefore influence the structure, hence fire characteristics, of surrounding landscapes.

I liked the development of a conceptual model that could be used to develop general hypotheses that could be at least initially evaluated with existing fire data. {#44}

The need to consider whole landscapes--rz plus upslope {#45}

Are water rights issues "only and issue" at the extreme end of the curve? And it that what we are trying to address? {#47}

A variety of factors can influence fire behavior; these include weather, forest structure, topography, AND riparian zones. {#51}

Fire is complex phenomena but when you examine fire in riparian systems you need to really stretch your mind and grab some aspirin! {#53}

To me, context is so critical, esp. w/regard to riparian systems! {#54}

Agree with #44 and #45. Linkages between system characteristics and the need for an interdisciplinary approach is critical. Also need to think on larger spatial and longer temporal scales than in the past. {#60}

The apparent heterogeneity of responses could be reduced by regionalizing or sub regionalizing the comments/perspectives. I think there is much more order to the universe than meets the eye. The figure appears to have been useful to some and may simply need a fuller explanation and some refinement to be the focal point for addressing and clarifying the issue I have raised here. {#76}

I agree there is likely some underlying structure -- don't just say "all streams are different" {#143}

Agree that we could have more commonality looking at a specific area, but this is a good beginning of looking at the issue. {#97}

Systematic utilization of existing data/records/observations to look for generalizable patterns. Since we're not likely to get the landscape level experiments that could shed light (because of $), this approach becomes very important {#84}

The notion that there is a certain realm of conditions that exist where riparian may have a significant influence regarding fire behavior. {#87}

Re: #87 - Right on. This was the days biggest contribution. {#105}

Interdisciplinary perspectives have been super. I learned a lot {#103}

Ditto #103 - Very helpful to interact with other disciplines and figure out how what I know fits into what they know and to come up with new ideas. {#111}

I think that the issues we are raising here mainly provide a different perspective on the overall issue of fire. We haven't really 'rewritten the book" just opened some eyes to what it all means. In some cases the focus on riparian will be helpful and in others it will not. {#112}

I think the weather fire behavior perspective is missing the point. In degraded riparian systems weather may be more of a factor today than it was historically. So yes, from a fire fighting perspective this is important. From an ecosystem perspective modeling potential fire behavior should be based ON MOVING DEGRADED SYSTEMS TOWARDS THE APPROPRIATE POTENTIAL ...NOT JUST SAYING IT'S THE WEATHER THAT IS THE OVERRIDING VARIABLE! {#129}

Re 129 - I think the point was that weather is the overriding factor regardless of riparian condition. {#138}

re: 138 I disagree weather is NOT THE OVERRIDING FACTOR. HELL IF THAT IS THE CASE WHY DON'T WE HAVE FIRE WEATHER SPECIALIST HERE? {#148}

129 and 138, the point is that weather can be so severe from a fire standpoint that conditions on the landscape make relatively little difference, but there is a large range of weather conditions for which they do make a difference. restoring degraded systems is very important for the latter. {#153}

Whether the weather is cold, or whether the weather is hot, we must weather the weather, whatever the weather, whether we like it or not. {#154}

Whether the weather is cold, or whether the weather is hot, topography and fuels are part of the rules, whether we like it or not. {#156}

OK, I now see the point, weather is not important {#157}

I take the equivalent limerick about climate is trivial {#158}

Re #153. Not all fires behave in this extreme fashion. So I guess we are both right! {#159}

2. Issues that have not be addressed?

Can similar fire curves be constructed for riparian zones? (Maybe there needs to be more than one variable across the X axis.) {#15}

It would be difficult to create curves for riparian zones in that these zones have a much different spatial scale. there can be a multitude of vegetation type and structures within a vary narrow (on a landscape scale) area. {#34}

Urban/suburban development in and near riparian zones--effects on fire {#41}

To what extent are certain life histories under represented in riparian systems, e.g., annuals don't do well in many riparian areas due either to scouring leading to seed bank loss, or low light levels. Since invasives that are most likely to alter fire regimes are annual grasses this could have important implications. {#42}

We have not touched the most difficult issue, how do we quantify the water necessary to meet the needs from a fire perspective. {#43}

Is there a minimum we can protect, or is it the more the better. {#46}

Broader interaction between geomorphic/hydrologic change and attendant changes in fire characteristics. I don't know, maybe we covered it, but it's not clear that we did. {#55}

Re # 48 and # 43. Read your outline we will get to this tomorrow {#63}

I think perhaps we could have been more formal about "mapping" the geographical experience of the participants. this could be very useful in interpreting their views and reconciling apparent differences. {#64}

What is the overall strategy for OGC, is fire suppression only the first element to the defense? {#69}

A satisfactory distinction between riparian zones that influence fire behavior and those that don't. {#74}

If this truly an important issue within the wildland fire community how do you communicate this to a wider audience. {#78}

How do we get there from here? What researchable topics should be emphasized? Under what conditions are "riparian zones" effective barriers to fire spread. Fuel conditions, landform, wind speeds, etc. What variables should be considered in the study, and what is available and from whom on on-going wildland fires. Who will fund it and who will authorize the researchers to go into fire camps, files, etc. {#80}

perhaps it's intuitive, but the urban/rural interface in fire dependent ecosystems will shape fire management decisions. yes, we do manage fire ecosystems with wildfires, i.e. my largest "prescribed fire" was a 32,000 acre backfire. the sum of all of my management ignitions over 30+ years are only a fraction of that acreage. the politics of protection of homes/property will continue to force fire managers to practice fire exclusion. Ron raised an excellent point in his comments about the Kootenai prescribed burns where one was of little significance and the other ultimately protected a stand from wildfire. treatments have to be meaningful. {#100}

Are the kinds of changes in fuels associated with change in riparian conditions sufficient to alter the response of fire to RZs? We have lots of - the streams incise, the veg dries out, does it matter a hill of beans if the fires would burn through anyway, under any condition. Or another way, how much fuel treatment would be needed to make RZs into fire breaks for a given fire. Fuels models should be able to predict such things? NO? {#102}

The significant challenges involved in attempting to reasonably quantify the riparian/in stream/wetland values and the water flow regime needed to sustain these values. {#104}

#90 - Yeah - it's actually a lot more difficult than rocket science when you think about it.... if we could only develop a few formulas and equations to get where we want to go..... {#120}

Urban interface needs to be addressed as riparian areas are often the source for many postfire problems. {#133}

3. What needs further discussion?

Nothing! {#6}

Beaver in the landscape. They once were prevalent in many systems and thus it behooves us to better understand their role, their potential for recovery, and the potential for affecting riparian systems. {#37}

The water quantification issue. {#50}

It would be good for those people that think they have some good examples of what we have been talking about to put those down on paper for potential case studies. This could be done very briefly here probably by a few people. Also indicate if data exist on these

situations or at least good documentation of the weather conditions and fire boundaries (some large fires are flown with the boundaries taken by GPS now). {#52}

I agree, case studies and any data that people may have should get to use. {#58}

How is riparian/wetland considered in current fire models. A brief discussion. {#66}

Most critical need is how do these linear arrays of ideas interact as positive and negative effectors to form a true interconnected pathway. {#67}

I think it would help to focus (refocus?) the issue of fire and the water rights question, so we get the other important but underrepresented issues, that clearly are frustrating some folks here, off the table. {#68}

The role of altered flows on riparian systems. If riparian systems are those that develop close to water, then it seems that they would generally be in tune with the hydrologic template (frequency, duration, timing of flows) that move sediment, organic matter, and nutrients, that rewet floodplains, that transport sediment, etc. Even if this is the case, it seems that there is precious little literature that tells us to what extent specific alterations to the flow regime actually alter a riparian system. {#70}

Because I think that we can make some generalizations about the function of riparian zone on fires in landscapes we ought to look at how we do that. Specifically, fire models and fuels models should be available that can tell us much about the behavior of fire in different circumstances. Why not crank some different riparian veg scenarios through such models and see what we predict will happen. The basic ingredients - fuels, weather and topography. SO how does riparian condition relate to fuels, topography is fixed, get a variety of weather scenarios and away we go. Why not? Can't we use the models in a predictive fashion, if for nothing else than to draw up hypotheses. {#71}

More discussion of what is known by people in this room about fire behavior in particular types of riparian systems. {#73}

Whether fire suppression needs really support the need for riparian zone restoration. An analysis of fire suppression policy might suggest that nothing done in the pursuit of this policy has been successful. {#79}

Does the group in general agree with the in stream flow water claim for fire or do they think it is scientifically indefensible? {#82}

Agree with #73. How do the fire behavior people factor in riparian systems in their decision making. Are they important, are they not? When and why? {#85}

Agree with #85 {#88}

Beyond beaver, the whole issue of surface/subsurface flow exchange and the historical extent of wetlands and riparian vegetation associated with hyporheic flow...I think most people lack an understanding of the historical sweep of these processes and conditions and how much has been lost in the modern landscape. and thus how much might be restored if the causes of loss were reversed. {#89}

In regards to number 82 can we even make the claim from a fire practitioner standpoint. {#96}

Let's get into the details, specific fire regimes, in specific vegetation, where riparian areas can or can't make a difference. {#99}

The role of altered flows on riparian systems. If riparian systems are those that develop close to water, then it seems that they would generally be in tune with the hydrologic template (frequency, duration, timing of flows) that move sediment, organic matter, and nutrients, that rewet floodplains, that transport sediment, etc. Even if this is the case, it seems that there is precious little literature that tells us to what extent specific alterations to the flow regime actually alter a riparian system. {#106}

Good comment. There is a great need to find out more about this. {#116}

The state of fire behavior modeling versus the variability of riparian fuels, continuity, spatial distribution, and the interaction of topography with wind. BEHAVE and Farsite (same engine) cannot account for the variables listed above, even if we go out and sample them. {#107}

Re #82: The defense of the instream flow claim relates to the specifics of each claim. They were made for reasons that one could see and measure on the ground, I would assume, and thus have a chance of being defended. re# 99 - I agree. {#115}

#82 -- While I would argue that water is important for riparian systems, I've seen precious little evidence presented to indicate that the amount of water needed for fighting fires is significant. That seems to leave the maintenance of riparian systems as the major potential linkage to a water claim. Here again, I'm not so sure (at least in my mind) how important of a role existing riparian areas play in fire behavior/management. Perhaps if we had more functional riparian systems across the west the answer would be obvious to everyone. {#121}

Contrast the timing and spatial correlation of processes affecting riparian zones versus those affecting fire. Consider both short-term (seasonal) vs. long-term (multi-decadal) problems. For example, how does the magnitude and frequency of extreme floods compare with fires in riparian zones? How do decadal trends in climate affect the hydrology and susceptibility to fire? {#126}

Re 89: Yes, this idea needs to be extended beyond the relatively few places where research has been done. Can active, significant hyporheic zones be inventoried? {#127}

Re 118: Maybe not the only tool, but one tool that may be useful in some situations? {#132}

#82: Seems like a long shot, but then the courts can be pretty strange places. {#144}

Re-118, Tell that to the elk in the picture. {#146}

How do we understand a heavily managed landscape {#160}

4. What are some information needs?

Big information gap about specific fire behavior in specific types of riparian systems. {#12}

Quantification of relationship between uplands/riparian zones esp. mass movement, floods, debris contributions {#16}

Ditto-need to develop a set of attributes of riparian systems that can be modeled for fire behavior {#17}

Re 17: Yes, do this as in #38 below {#49}

Information Needs:
-First, we still need a lot of basic information on how riparian systems function and what their current restoration potential is - this assumes that "healthy" functional riparian ecosystems play an important role in landscape ecology and fire management. Basic linkages between vegetation, hydrologic regime, and geomorphlogy is a good place to start.
-Post-fire studies of how riparian zones influenced recent fires, especially where weather and fire behavior information is available. This could be collected in the context of generating response curves to address the controlling factors. It could also be structured as a classification exercise that examines the alternative states (degraded, intact) on the landscape and their response to fire.
-Fire history data that links upland fire regimes with those in the riparian corridor.

- {#22}

A prioritized list of research needs would be helpful. {#32}

More information on fire effects on riparian and vice versa on common fires prescribed and natural . It seems that all we have is the memorable exceptions that are recalled rather than the more common place events. Some better monitoring/reporting criteria. {#38}

Synthesizing information on fire in riparian zones from fires that have occurred in the last several decades. use fire team records, aerial/remote sensing, etc. You might not be able to answer everything but certainly a lot of useful info would come out. {#39}

How are riparian areas currently factored into current fire models. A brief discussion. {#56}

After this initial look at the issue is completed and a synthesis developed, it might be useful to have another group look at more specific, focused questions arising from this effort. {#57}

I agree with #22 from an info needs perspective. {#61}

The fire curve cartoons … Not a bad conceptualization, but needs a lot of work at parameterization. {#62}

Re: 32: A prioritized list of info needs earmarked from land managers vs. researchers: researchers in general would like to be responsive to management needs but there are no mechanisms to get them those info needs -- and researchers are not clairvoyant. {#72}

Can some of the current funding to be used for fuels management be applied to the development of a system for collection of fire information that could be used to support/refute some of the beliefs that have been put forward today? {#77}

#77 - Excellent idea {#81}

#77 - Yes, too much of the funding goes for on-the-ground risk reductions work when basic understanding is absent. {#93}

Dido #77 {#83}

When you develop "fire groups" or whatever they are for riparian, there are many classifications out there that address structure, layering, species composition, and associated site features. It would be worth it to start w/these as the fire group folks (Fischer et al.) did for the northern Rockies. I know some folks don't use them anymore, but I found them to be useful. {#86}

{#91}

-I think putting together some ideas about how we could better document wildland fires so that data are collected relevant to this topic.
-A list of some good research (or study) hypotheses (questions) and how we might design some studies to address these.

-Some creative thinking about how landscape scale prescribed fire treatments might provide some data on low intensity fires (these may be research watersheds starting up with new fire dollars--there are several, or forests with extensive prescribed fire efforts). -Compilation of data from National Park moderate intensity controlled burns should be looked at --I don't know how much of this there is but certainly some for Sierra Nevada. {#92}

Information relating extent of riparian zone degradation to actual decreases in options available to fire suppressionists. {#95}

Comment 77 Would seem to be a very logical step. Also an appropriate topic for the Joint Fire Science Program to address. {#101}

The difficulty with modeling fire in riparian zones is that it is a thin linear strip on the landscape. All current fire models (as far as I know) treat each pixel or polygon independently of others, so that linear groups of pixels or thin linear polygons cannot be adequately modeled (at least in my opinion) - we model them as if they are an entire landscape (BEHAVE/FOFEM) but FARSITE potentially could model fire spread but probably be much less useful at producing outputs that could be used to model fire effects. {#108}

{#109}

We need empirical data to populate Perry's response curves. {#113}

re 12--They should be studied w/in the upland context, which is what 16 is saying. we all know that. the link to the uplands is critical since rip zones are largely response variables... {#114}

Some fire occurrence data would have been handy to show fire history for a specific area. would have been good talking point to tier the "it depends" discussions. {#117}

77--Who are we kidding? Fire reports are rarely filled out with any integrity or noble intent. {#119}

#77 Where did the Title 4 $'s go to research projects-I doubt many people are going to give up their project accomplishment acres for some research project that might be years in the making when we can make a difference on the ground that year. {#122}

In terms of moderate severity regimes; this is the one area where a lot of information exists on fire effects being dampened in riparian zones (i.e. , studies by Teensma, Morrison , Wiesberg etc.) All have found longer MFRIs in the riparian zone. {#124}

#122 How do you know that you "did any good?" {#130}

Comment 119--Just because it has not been done effectively in the past does not mean we can't change it or put in place an approach that would improve it. Let's GET REAL and forget the PAST! {#131}

What site data must be systematically sampled from the actual site versus what data can be inferred, taken from existing data bases, sampled with some form of remote sensing, or modeled? {#134}

Re: 122 -- really? I keep hearing that NFS folks are finding it impossible to get any treatments in on the ground because of NEPA, court battles, etc. {#135}

Can we define the types of riparian systems that have influence and what conditions are required for them to be effective. I don't buy the new paradigm of fire everywhere any more than fire nowhere. {#137}

Re 124 - Morrison and Teensma did not have data sufficient to make these claims, and I don't think they did. Weisberg did. And the Olson data shows the same (although the frequency doffs are not high). Carl Skinner has data from Klamaths interpreted as riparian 2X upland FRI. {#140}

A simple spatial analysis of the influence of topography (valley width/channel width) on fire severity would be a start. {#141}

#130 We have empirical proof-areas not burned after fuels treatment. {#142}

Re 141 - Student at UW (Washington) Richard Morse tried to do this, did not find very much (thesis date is 1999? 2000?) {#145}

#122, 130 More important. How can you convince ME you made a difference? Whether you know it or not? {#149}

Comment 122: Talk to the Kings River Ranger District, Dave McCandliss and Carolyn Ballard, and the Sierra National Forest. They are working with research to put in place several 200-400 ha experimental treatments in the next few years. This year they are doing several very controlled 4-ha plots in old growth mixed conifer on Teakettle Experimental Forest. This is going to take a significant piece of their time. Ask them why and how they can do this.
BELIEVE IT CAN HAPPEN!! {#150}

Re #141, 145 it's a tricky issue re. scale, I'd need a sample over a large region to detect the likely noisy signals that might exist. {#151}

122: r1 has a pretty decent working relationship with research and mechanisms for transmitting info needs {#155}

March 15, 2001 workshop results

Fire Suppression Activities (Topic Commenter)

1. How are riparian zones and streams utilized in fire management activities?

Control lines {#2}

As sources for water {#4}

Water (RZs, lakes, ponds, streams) is used for:
1. Barrier to fire spread or anchor point to tie in a line.
2. Water source for operational activities such as a pump chance, helicopter bucket work, or mop-up.
3. Prescribed fire lines.
4. Line for burnout/backfire operations.
4. Safety zones/escape routes
5. Unit boundaries for Rx fires

Well, I can just say the usual -- with prescribed fire, the riparian zone is usually capable of slowing/stopping fires because of usually fairly moist fire prescriptions. so riparian zones do make good unit boundaries for many prescribed fires. {#6}

Burn out of riparian to establish fire break. {#7}

Limitations include: compaction of soils, introduction of "new invader" noxious weeds, spread of existing weeds, general vegetation damage (herbaceous and possibly woody), disruption of wildlife activity (cavity nesters rearing young in cottonwood stands abandon the young) {#8}

Live fuel breaks for both suppression and fuels management operations. {#9}

Agree with 5. {#10}

Please address the limitations of fire in riparian zones if you do not know much of how fire is used in fire management activities {#11}

I'm not a fire mgmt person, but to what extent are riparian areas used for heavy duty fire lines (i.e., dozers)?? {#12}

In degraded riparian corridors with heavy fuel loads, fire can be used to create a mosaic of vegetation types within the valley bottom that can decrease fuel loads and enhance resource values. {#13}

Fire camp and operations activities. {#14}

Is there any consideration about the effects of water withdrawl from RZs, lakes, ponds, and streams on aquatic and riparian obligate species? Anyone have any DATA? How about the effects of fire lines or compaction on sediment input? {#15}

As an area to temporarily slow the advance of a wildfire, or if adequate, stop the flanking spread of a wildfire or management ignition {#16}

From a fire control standpoint, riparian zones can provide options much like fuelbreaks, i.e., safe access/egress, places for suppression crews to take a stand, backfire, etc.

From a fire use standpoint, RZs provide anchor points/zones. However, I've heard wildlife biologists including ornithologists proclaim that riparian zones should not be burned under any circumstances. {#17}

Re #17: But don't these areas burn naturally and isn't disturbance and/or succession needed to maintain the natural system. Nature is not static. {#35}

Timing of prescribed fires - limitations: burning plants at times when they are most vulnerable and can be killed by fire rather than just top-killed; burning when animals are using riparian areas for nesting, rearing, etc.
Fire suppression limitations: fire camps, machinery and fire lines in riparian areas with moist, easily compacted soils {#18}

In many uses of riparian zones, careful environmental planning and review is conducted before activities are allowed. However, under "emergency" conditions, too often such planning and review is not done adequately and decisions are quickly made without interdisciplinary input and review. This suggests pre-planned designated activities should be utilized more and spur of the moment decisions not be the norm. {#19}

Safety zones. {#20}

Are fire camps really put into riparian zones, or are they now generally placed in areas such as fairgrounds, private property, etc where compaction is not an issue? {#21}

A limitation/problem: fuel spills {#22}

Drinking water supply . {#23}

#19 - Any data on the effects of either? {#24}

The comment about salamanders is a good example of the constraints faced with using fire in/near riparian zones. I think a response to that is (1) using fire may make the landscape more sustainable in the face of wildfire, and (2) if only certain stretches of

stream are treated in any one year (and not revisited for 10-20 years) this puts a different temporal/spatial context to the issue of sensitive species - the whole watershed riparian zone is not going to be treated in a single year -- and probably not with the same prescription, either. Season may change, timing within season, etc. {#25}

Re: # 15, Yes there are. At times we will have a situation where flows are so low that any use is likely to impact aquatic species. When that happens, we go after other sources, even though the cost escalates dramatically. {#26}

The difficulty is if good quality habitat has become rare, then human disturbance may be more deleterious {#39}

Vegetation in riparian zones is typically disturbance-maintained (fire/flood). There are many wildlife species that are endemic to RZs, primarily due to a dependence on deciduous vegetation. Thus, to maintain habitat for this wildlife it is necessary to disturb the RZ with fire and floods. However, wildlife managers may consider disturbing the RZ as a "taking" -- unfortunately, without the disturbance the habitats will continue to degrade and disappear, presumably with the wildlife species dependent on them. {#27}

As, with #23, another limitation is with regard to retardant drop placement {#28}

Another limitation: road work/use associated with fires can exacerbate stream incision problems if not properly done. {#29}

This question was modified because of the value of not only riparian zones not only for fire suppression, bur also for their values in prescribed fire. This is based on the premise that Rx fire is also needed to maintain tie forest (timber supply) and that streams and riparian areas are also needed for this activity. {#30}

I have used riparian zones as the temporary anchor points for operational periods during a multiple day burning operation (back the fire into a draw in the evening) {#31}

Riparian zones can be used in suppression for : water supplies for water tenders, engines, helicopters, superscoopers, portable pumps, etc...; as natural barriers: as anchor points: as cheap fire line; escape routes; safety zones (if you include the snorkel attachment to the fire tent GSA 333-99-867).
As important is the use of riparian areas as buffers, fireline, natural barriers in Rx burning. Reduces costs, uses less people and if the prescriptions are good probably mimics what would've been natural processes. {#32}

Re: #13. There are inherently a mosaic of vegetation types within the valley bottom. Riparian areas do not succeed to one monotypic vegetation type. This brings up a limitation of prescribed burning in riparian areas - they are spatially and temporally complex and need fire prescriptions that are different than those used in the upland to achieve objectives. {#33}

Re 21: Yes, spike camps, fire camps, refueling stations, and helibase operations can be located on flood plains meadows depending on soil moisture and size needs. {#34}

Good comment 25. {#36}

Re limitations. There has been a long-standing concern among ecologists that burning when fuels are moist damages roots and mycorrhizal fungi, because the season of coincides with when roots and MF are near the surface. I don't know of any data, but it's a plausible concern. This has been mainly an upland issue, but probably applies to RZ's as well. {#37}

Re: 37: Except if fuels are moist, fire is not likely to carry and if it does consumption, and hence severity will be low

Used as a water source, a potential barrier, and potential escape route/safety zone. As a water source to fill, back pack pumps, engines, water tenders, and as a helicopter dip site. As a barrier, when the location, level of moisture, and extent are sufficient to retard fire spread. As an escape route when fire fighters are able to take advantage of the riparian zone to escape a hazardous situation and move to safety {#38}

1. The most common and necessary use is as a water source. With the large accumulations of large diameter decayed logs water, availability in fire suppression mop-up and mop-up on prescribed fires is critical.
2. Another use is for staging or actual fire camps where impact is significant on the riparian resource.
3. On spring prescribed fires the riparian can be used as a control line.
4. In emergencies they can be used as a safety zone. Escape route if scouted previously. {#40}

Re #33 -- Agree {#41}

One of the discussion points about riparian use of fire is that IF the uplands are treated adequately (they are generally not now) a more flammable riparian corridor left untreated would be a better risk than now. {#42}

Prescribed fire in riparian zones is an areas that we have very little effects data about. The recent experience of the FS with the Sierra Nevada Framework Project (amendment to 11 forest plans) illustrates this nicely. Initially some of the wildlife biologists and others wanted no prescribed fire in the riparian zone; final decision was that fire could back into zone but not be actively lighted in zone.
This is an issue for two reasons: (1) lack of data on effects, issue of timing--spring (when most burn windows are open) and summer/fall (when most natural fires occurred although there is debate on this) even though we know these are fire disturbance forests and (2) concern about TES species. The latter is driven by rigid approach by Fish and

Wildlife Service with TES and fear or over use of the "precautionary principle" by some of the wildlife biologists. Bottom line--we need some good research on this. {#43}

Over the long-term we need to recognize that riparian zones will eventually burn (e.g., following prolonged drought). As with the rest of the landscape we need to ask whether we wish to wait for the eventual conflagration or attempt to manage the area ahead of time. {#44}

A limitation of use of fire during the "natural" burn window is the abnormal accumulation of fuels due to grazing in the late 1800's and later fire suppression. It sometimes takes 2 or 3 entries to safely reduce these fuels, and the first 1 or 2 entries sometimes have to be made at the wet end of the prescription rather than at the "natural" timing research determines. This timing issue can lead to a "take" by F&W. {#45}

Standard and guides have been established in some regions to specify which activities are allowed and not allowed in riparian zones during wildfire suppression. A review should be ongoing as to whether these mechanisms are effective in limiting ecosystem damage by suppression activities. {#46}

#27 This is a lot more complex than you have made it out to be. Riparian zones won't "disappear" unless the water does. We need more dialogue ion this!! {#47}

Quantifying Necessary Water (Topic Commenter)

l. We can quantify the amount of water necessary to maintain riparian zones (to meet wildland fire management needs). Is this a valid statement? Why or why not?

Depends {#2}

Wow. Would require a fairly wide "range," probabilities, etc due to inherent variability in fire return intervals, fire occurrence, fuel conditions, fire size, etc. Might be able to come up with a "best guess" on a, say, 10-year average. Finally, land use plans and strategies and tactics change over time so any number you pick now better be somewhat flexible. {#3}

Can we quantify the amount of water necessary to maintain riparian zones, regardless of purpose?? {#4}

I think we can quantify what is needed, but because of the IT DEPENDS that is mentioned all the time, it needs to be done on a very site-specific basis. {#8}

We can quantify--no question!! Can we do this well? Absolutely not!! {#5}

NO! Look at attempts to support in stream flows for other reasons. We can only look to some elements of geomorphic theory on "channel maintenance flows" etc... We have many views of the ecological functions of riparian zones, and some data and theory to

support the relationship between flow and specific function, but these are insufficient to "quantify the amount of water needed". Instead we fall back on much simplified "rules of thumb" like monthly median discharge and bank full flows. {#6}

This is a valid statement for individual riparian areas. Quantifying the amount of water needed to maintain a certain meadow or a certain damp vegetation complex could be done on a case by case basis. Whether we can afford the cost of doing this in a manner that can be defended in a court of law is an issue. {#7}

On day 1, Mike L. suggested: to maintain pools, water for direct application, to maintain veg./channel as a fuel break. I think the most disagreement was on median flow (I think he said the monthly median) as the critical amount for maintaining pools. This is not true in many stream (maybe most?). {#9}

One could figure out the size of the riparian area needed to meet fire suppression needs by modeling the fire behavior expected from the existing fuel conditions, however, since fuels change overtime the sizes of riparian areas would be expected to vary-so stream flow needs would vary? {#10}

Yes, the hydrologic regime must be maintained to be as natural as possible to maintain the riparian zone itself. {#11}

I seriously doubt it. Individual riparian zones have "evolved" with the hydrologic and geomorphologic conditions in a watershed, so it seems those conditions are what the system needs. {#12}

The amount of water needed to maintain a healthy rz should be quantifiable, but the data needed to do it may or may not be out there now. If not, some basic ecologic and hydrologic research will be needed. {#13}

Water sources, such as pools, have to be maintained throughout riparian systems to be effective suppression tools {#14}

Re #11: In practice, maybe we need to start with the natural flow regime as the level needed to maintain channel and ecology, but then answer -- how far below this can we step without damaging either the channel or the ecology? {#15}

I think the difficulty of answering these questions comes back to the "it depends" problem. We would have an easier time if we phrased our basic question as "Are there times and places across the West where (properly functioning) riparian zones have a mitigating influence on fire behavior (spread/intensity), fire effects (severity), or aid in fire suppression efforts?"

If we approached our issues in this way, it would a priori recognize the fact that no statement we make fits everywhere. I think we could all answer "yes" to the above question, although I would like to see your responses. {#16}

Re #11: I disagree. We assume, in the absence of better data, that maintaining "as natural as possible conditions" is the best way to provide for all ecological functions for all species, but we have no proof that such conditions are actually required. {#17}

To maintain riparian vegetation, regardless of suppression activities, we have some approaches that can help to quantify water needs. There is a direct relationship between water tables and riparian vegetation types. As water tables decrease, spatial and temporal variability increases. Thus, theoretically, we can define the amount of water to sustain riparian vegetation within the near stream zone based on the relationship between stream flows and near stream water tables.. This becomes much more complex for the entire riparian zone because of the complexity of subsurface hydrologic pathways. Disturbance flows (often similar to channel maintenance flows) need to be added in to provide for vegetation establishment. {#18}

I have a similar response as comment 5. There is still quite a bit of controversy about what are the correct instream flow needs for fish with regard to hydropower alterations. Scientists have been working on this for at least 30 years and the debate goes on. Be aware that this will be a similar situation.
If this need helps us improve our ability to model and understand the instream flow needs for maintaining healthy riparian systems then hey let's go for it. At best we may loose the water rights argument but further scientific understanding. {#19}

Yes, we can, but it will be extremely variable due to the complex nature of riparian areas and the lack of knowledge about them. {#20}

#6I think we can, without much difficulty, develop and empirically test "ecological responses curves" that plot measurable expressions of "riparian function (e.g., width of seasonally saturated zone, or cottonwood recruitment rate) against change in streamflow. This has been done by various groups in several case studies (e.g., NPS, TNC) and it does NOT depend on the same kind of mechanistic/deterministic models used in "channel maintenance flow" models or IFIM-type models. {#21}

I wonder if we should be taking water out of the creek to suppress a fire that should probably (in some or most? cases) be burning anyway. So I have a hard time with this statement. Other than that, I think that there are a number of variables that would be used to quantify how much water is needed to maintain rip zones alone, but for fire mgt needs...that's out of my realm of knowledge. {#22}

Ultimately, if we can't quantify it, we may lose it. Many riparian plants need a nearly continuous supply of water for survival/maintenance. If water supply is restricted, damage to riparian will be greater than when it is sufficient. The stream biota is directly

dependent on the amount wetted perimeter. Riparian soils and water holding capacity can be destroyed by excessive draw down. One way to quantify would be to look at channels from which all or most of the water has been diverted. These are relatively easy to find in parts of Idaho and Montana. {#23}

Re 17--- There certainly are not data to suggest that modifying natural processes is better for biological diversity. "natural systems" is a more conservative approach to conservation biology {#24}

A basic ecological theory has been that there is some range of natural variability within which riparian ecosystems historically varied. Certainly, a key forcing variable for NV is the hydrologic regime. To maintain the ecosystem, it is essential to mimic a good portion of the variability in the hydrologic system, including periodic floods as well as base flow. {#25}

Phrase it another way: if we knew how much water was needed for fire suppression activity, would it represent a large/small amount of the water "needed" to maintain riparian zones? {#26}

Re: #9. Remember, we did not attempt to quantify the flows from a riparian perspective in the Klamath - the amounts were based on the premises provided i.e., anchor points, safety zones, etc. We assumed (always dangerous) that these amounts would "take care" of riparian needs. {#27}

Re #27. Not likely to be the case, since the water needs for management are likely less than the entire hydrologic flow. {#36}

Perhaps the amount of water needed for fire management should not be based on median monthly flow during all years, but flow during dry years. It is during those dry years that fire is more likely. {#49}

Re #23: Yes, quantify and defend that number, in court or in the court of public opinion. {#28}

This is too utilitarian a question. If one accepts the premise that riparian zones are important for wildfire management, then it is the very properties of the riparian zone is important to maintain. (humidity, fuel moisture, wind flow, vegetative composition and structure). Thus, the water necessary is that needed to maintain the integrity of that ecologic system. If, however, a riparian zone has no unique fire property (such as perhaps upland swales), then maintaining that zone for fire objectives is not necessary. So the problem comes down to identifying those properties of fire management that are unique in riparian zones and how to maintain those properties (water quantity and timing, geomorphic processes that deliver components (water, wood, sediment, nutrients, etc) to those riparian areas that contribute to the maintenance of that unique structure. {#29}

#18 Yeah this is the kind of thinking behind the approach I was describing in my comment #21. w can do this , and it is being done. It may not be 'conventional' yet but it is certainly feasible. {#30}

"Fire mgt needs" are not an annual draw on the riparian zone of any stream, but a need that is periodic at best and is generally going to exist at low(er) flow conditions. In fact there may be difficulties in quantifying flows necessary for fire management needs - and these needs may occur at critical times for aquatic organisms. {#31}

Can we quantify? -- We are pretty good at making conceptual arguments that water is needed to maintain riparian systems. However, the actual quantification of a "claim" is several orders of magnitude more difficult. Some of this difficulty is administrative. States regulate flows for the purposes of diverting to a beneficial user a fixed amount for a specific time period in an orderly way. Yet stream systems are inherently variable in the amount of flow at any given time. It's very tough to find common ground regarding state water laws and hydrologic disturbance regimes. {#32}

In the Sierra Nevada most fire season flows are maintained by releases from diversions. Here the natural order of things has changed but the riparian vegetation and pools are maintained or enhanced from what would have been the pre-settlement conditions. {#33}

Re 33 I do not think that The Sierra riparian zones below diversions bear any semblance to pre-disturbance riparian zones!

Quantifying the amount of water necessary to meet fire management needs would be difficult--firefighters will always overstate their need for water (just like air tankers). {#34}

I agree with # 29! {#35}

Maybe one approach would be to evaluate the effects of water withdrawal for fire purposes on systems that are otherwise intact? It wouldn't answer the question posed above, but it would provide some information that could address the root problem (i.e., the working hypothesis might be: if we maintain a natural hydrograph, infrequent water withdrawal for fire will be possible and not have negative effects). {#37}

Re #18: At base flow, change in discharge often results in change in median velocity of water flow, not in stage height, thus water tables can maintain a more-or-less constant height over a wide range of base flow discharges (I have data to show this in a variety of stream types). My data show that there is little change in water table height as a function of discharge!

Rather, channel morphology, as affected by channel changes such as incision, will have the long-term effect on water table height. Thus, we get back to the "channel maintenance flows" arguments. {#38}

#34 I agree except for drinking water. {#39}

Another major factor to be considered in this quantification is the ongoing human-caused climate change. How will this affect hydrology, vegetation, fire regime, etc. 50 to 100 years from now? Climate changes will likely be substantial. Our planning horizon should be least this long. {#40}

#32 Maybe partly because hydrologists and biologists have only been marginally better than lawyers at quantifying and accounting for variability (natural or uman0indiced). {#41}

I believe we can quantify the flow regime needed to maintain pools. I am less certain that we have sufficient knowledge at this point to quantify the flow regime timing and quantity to sustain healthy riparian/wetland conditions. There is some interesting work in New Mexico on quantifying the long term quantities of water necessary for fire control/suppression activities. The average annual need would likely be insufficient to meet the instantaneous needs for a given fire. The Median flow approach used by Lohrey is interesting especially when applied in a selective way to larger streams. Over the long term the amount needed is the median of the median flow because it is capped at the median value. Clearly there is lots of opportunity to develop more knowledge in these areas. {#42}

Why we need water for wild land fire management? In the urban wildland intermix areas there is always a very high demand for water during suppression and this will only increase into the future. In the uplands if vegetation management is used to manage fuels and reduce the hazard, need or potential demand may less into the future, but if the constraints on managers are such that they are allowed to modify vegetation and the hazard increases, the potential need for water to be used for suppression is likely to into the future. {#43}

Hyporheic processes are important to both the stream and riparian components. If this linkage is interrupted for appreciable times or frequencies the functioning (water transfer, nutrient dynamics) will be diminished or destroyed. {#44}

Yesterday our group discussed the ability of current models to capture riparian influence on fire behavior. The fire people said they do not. It seems that we would also need to work on improved fire models to be able to evaluate the riparian system in a holistic way. For example, we want to know what the amount of water is that is needed to maintain a healthy riparian system. We would also want to be able to model what the effect of using the riparian system to manage a wildland fire might be otherwise this is just another example of "extractive" resource use. {#45}

Clarification: There needs to be more water available than what would actually be used for operational activities. For example, a helicopter bucket can't dip from a shallow

source. So the amount actually used for fire management is only a fraction of the amount that needs to be there. {#46}

I think we can truly quantify the amount of water needed to maintain riparian zones AND it will take a lot of information that we don't have. At the current time there are no data for the timing, duration and quantity of water needed for the establishment and maintenance of various life stages for the thousand+ species of vascular plants occurring in western riparian zones. Even if we narrowed down the group to a couple of hundred key plants, we don't have the information for them. Currently the best way to quantify the amount of water needed for maintenance is (probably) to figure out what the base flows, hydrographs, flooding regimes across the floodplains, and water table characteristics (depth, seasonality, chemistry, etc.) within floodplains corresponding to riparian vegetative communities. Hydrology also interacts with microclimate and geomorphology to maintain these communities so those elements would have to be considered as well. {#47}

47 Good point {#51}

Re #38: This is an interesting point. A summary of knowledge in this area would be important for research and management. {#48}

I believe the modeling efforts should work at quantifying the water needs to maintain riparian systems, period. That's plenty to do. The emergency action or the prescribed fire needs can/should be paid for (budgeted) in response to water rights claims. The other uses of riparian zones for fire management activities (fire line, escape routes, etc.) come with the territory. {#50}

No, not on a landscape basis. riparian zone water flow/quantity will vary by season and location (vertically) in the drainage. on a site-specific location, yes. if the we want to talk about a specific pool historically used for filling engines, sure. it's the amount of water necessary to establish and maintain a drafting operation.....but, if that pool is dry, the water is acquired somewhere else. I know of no fire that became significantly larger due to the lack of a place to draft "that critical load of water that would have stopped that fire". fires that escape suppression efforts are the result of the D=rt functions....Distance=rate*time...where the growth of the fire exceeds the fireline production rate....water squirting devices (engines) can be quickly overcome by fire spread rates....more important tools are airtankers, dozers and helitankers {#52}

I do not think that one can quantify amount of water needed until one can articulate the requirements to maintain a riparian zone. This includes water quantity, timing, storm flows, delivery of nutrients, sediment, wood, detritus, channel structure, etc. Changing the frequency of large storm flows may be all that is needed to eliminate the riparian vegetative structure, even though there is adequate water flow during "normal" flows. {#53}

#38 Maintenance flow arguments alone are not sufficient. There needs to be a strong riparian vegetation component. Geomorphology, water tables, and riparian veg are all highly correlated. we need more work on these relationships in a predictive context. {#54}

Re: #24: I didn't say that abstraction was better, just that we have little data to show how much we need! {#55}

The natural flow regime is our best model of what is needed to do multiple functions -- transport sediment, deposit sediment of floodplains, nutrient cycling, redistribution of organic matter, seedling establishment, seasonal growth of vegetation, cause mortality, etc. When we begin to remove water from this natural disturbance regime we can argue that it will have negative impacts to ecological processes and functions. The difficulty is the quantification where people expect linear response functions to be easily displayed. It isn't possible. These are complex, interactive systems with multiple feedback mechanisms and non-linear responses to perturbation {#56}

#9 Misinterprets what Mike said. High flow are needed to create pools median flows to fill them {#57}

If would be useful to try to quantify the amount of water needed for individual riparian areas to function as we determine they "should". It might not get us anywhere in state court in terms of a water right, but ultimately we may be able to use the information in federal court in other ways to attempt to fulfill the management obligations of all of the enabling congressional legislation - ESA, MUSY, etc. {#58}

#42 I agree the monthly median flow approach of Lohrey is intriguing and probably is scale-appropriate, in ecological terms. case studies I am aware of re biotic uses have some to similar conclusions, i.e., if there is a volume of water that can be taken with minimal ecological consequence, it lies in the higher-than average-but-not-really-high flow domain, where some loss may have limited consequences. {#59}

I believe that a flow, depending on the area, size of stream and stream type, that we can come up with a very good educated guess as to what is necessary to maintain the riparian area. We all agree they have utility, so why not try to protect them with the tools we have instead of throwing up our hands. {#60}

Re #47 And this is just considering the vascular plant portion of riparian zone function {#61}

Agree with #29. {#62}

We should focus on maintaining the disturbance regimes-- not the specific outcomes (e.g., number of pools) {#63}

At his point we can only generalize. To maintain cottonwood stands you would need to be able to quantify not only the amount of water necessary to maintain the physiology health of the existing vegetation. In addition we need to quantify the flows necessary for channel and sediment movement. Without periodic disturbance events that deposit sands, gravels, and cobbles cottonwood regeneration will not happen.

Water is needed for:

1. Maintaining vigor of existing stands to provide propagates fro recruitment
2. Energy for channel maintenance and sediment movement.
3. Sufficient water potential for seedling germination through the development of a young stand. Because particles sizes are large the water level must be high enough so that water is plant available (low water potential).
4. Timing of water must be sufficient to move propagules down river. {#64}

III. Important Variables (Categorizer)

What variables are important to quantify the amount of water necessary in riparian zones to meet wildland fire management needs?

Fire Management/Fire Suppression Variables (needed to quantify water/riparian functions necessary for fire control needs)

Some relevant comments here include:

- Need is a subjective descriptor--will vary by situation and who is making the assessment
- Water is not as important as the drip torch in terms of fire fighting
- We can fight fire without water, in many of the fuel types we encounter the lack of water significantly increases the cost time required to control a fire.
- **I have not been on a fire in the last 20 years where there was not a significant use of water in the effort.** Especially with the use of type 1 helicopters the use and reliance on water has increased dramatically.
- If water is readily available fires can be contained at small size or at least kept from going another burning period, whether suppressing a fire in a short amount of time is ecologically sound is another matter but when you are chasing fires through a carelessly planned sub-division water is very handy.

Fire Management Variables listed

1. Firefighting needs of water in outlier years
2. Firefighting needs of water in typical years
3. Existing fuel conditions
4. Future fuel conditions
5. Width of stream and type of fire it is effective in halting
6. Water needed and timing of flows to maintain the width of wet vegetation types
7. Slope of stream

8. What is the current condition of the riparian area in comparison with the upland.
9. Sufficient water to maintain a "green line" of vegetation adjacent to the channel
10. Slope of adjacent side slopes – topography of the landscape
11. Water necessary to suppress fires under various percentile weather conditions (i.e., 90-97-percentile)
12. The cross section nature of the riparian - broad and flat vs. narrow and steep
13. Houses, improvements in or near the riparian area
14. Amount of water available locally vs. fire management needs (not always an issue)
15. Proportion of suppression effort that relies on water vs. other mechanisms
16. The actual difference in fuel moisture and RH between the riparian and the uplands
17. Sufficient water for meeting suppression demands without adversely affecting aquatic species (i.e., the water is available for use)
18. Historic pre-attack guidelines evaluated tanker fills by the average rate of inflow to a pool area that was accessible for drafting. This was done on a site by site basis.

19. Fire records and trends, climatology (drought, forecast probabilities of % streamflow

Geomorphology and Hydrology Variables (needed to quantify water/riparian functions necessary for fire control needs)

1. Ratio of base flow to median flow (relative measure of low flow, water limitations)
2. Peak flow
3. Base flow
4. Horizontal extent of zone of vertical flow exchange (< 1 year turnover) and near-surface groundwater (a.k.a, hyporrheic zone)
5. Re pools: What is the natural/potential bed morphology of the reach, given valley gradient and bed material? What peak flows are needed to maintain this med morphology?
6. Stream maintenance:
7. Sediment regime
8. Re 7: Bed material is clearly important for pools, stability/incision, etc. Suspended sediment transport regime may also be important in some systems, for specific purposes (bar and bank accretion, substrate for some organisms, etc). Need to identify and quantify these suspended sediment needs.
9. Size/class of stream
10. Flooding regime
11. Movement and deposition of organic matter in system
12. Maintain the long-term frequency of hydrologic events (floods, droughts)
13. Topography
14. Flows necessary to recruit and transport LWD
15. Nutrient cycles
16. Residual pool depth (measure of depth relative to average)
17. Sediment regime - maintains fluvial morphology - geomorphic surfaces that are the base for different riparian habitats
18. Sediment regime - also important to supply fresh material for establishment of plant species

19. The relationship of the channel to the floodplain is critical to whether or not riparian has a wetland character. The valley width is important to the effectiveness of the riparian area in influencing fire behavior. Narrow v shaped channel valley complexes likely have little influence.
20. Flooding regime - important for vascular and non-vascular plants - also for animals dependent upon water supply and food in particular bodies of water that may be temporary
21. Valley width is an important constraint on potential width of the "green zone" or riparian, but for a given valley configuration , the expressed width could vary by an order of magnitude based on shorter-term channel and floodplain and hydro dynamics
22. Large wood might be important in creating pools and creating features that retain water as well as increase the interaction between channel flows and flood plains.
23. Addendum to #11: this frequency includes both high frequency events (annual and monthly flows) and low frequency (decadal and longer). The high frequency events maintain the riparian system, whereas the low frequency events provide for resetting the system for renewed succession, delivery of structure (substrate, LWD, etc).
24. Upslope land use management that maintains natural hydro/geomorphic disturbance regimes impacting streams & riparian systems.
25. The basic flow regime...hydro-period what flows occur with what frequency and magnitude.
26. Sediment regime - size of material key to establishing/maintaining particular type of plants/communities
27. .Bed material character is also critical in determining vertical flow exchange, which then determines hyporrheic function etc ad nauseum
28. Residual pool depth (topographic)
29. Every time we base something on a "typical year" we get into trouble. Better to use a worst case scenario – this would be the drought years.
30. Ecological/hydrological influences of beavers Remember nature's engineers

Biotic/ Microclimatic Variables (needed to quantify water/riparian functions necessary for fire control needs)

1. ***Plant available water (to maintain the riparian vegetation)***
2. Soil texture (as it influences plant available water in unsaturated zone--capillary fringe)
3. Soil moisture
4. Base flow necessary for biotic needs
5. The natural hydrologic and sediment regimes
6. Peak flows to create surfaces, recharge soils water, seed dispersal etc
7. Flows needed to maintain system connectivity
8. Base flows for water table maintenance where adapted vegetation can exist
9. Moisture in plant materials as they effect fire spread/combustibility
10. Periodic extreme floods
11. A "natural" falling limb where seedlings can survive (as opposed to diversion effects)
12. Flow regimes necessary to support invertebrates and fisheries
13. Flows needed for wood and sediment transport

14. Water temperature (need to maintain certain biota)
15. Flow variance is an important component of stream systems-- claiming average flows would contribute to riparian degradation
16. Directionality of water interchange between stream and riparian.
17. (a) physiologic needs of the riparian veg (i.e. relation between water, open stoma, photosynthesis)--by season; (b) depth of rooting, and degree to which shallow rooters are supported via hydraulic lift from deeper rooting; (c) both amounts of water in the hyporrheic zone and its horizontal and vertical distribution (depth to water table--esp. important in streams that are cutting down for one reason or another.
18. We often think flows, but riparian vegetation typically responds to changes in "water level". These are more difficult to model for reaches.
19. Structural layers of vegetation - habitat for other plants as well as for animals, microbes, etc. Also important in terms of fuel arrangement and crown out potential.
20. Flows required for substratum maintenance and diversity.
21. Structural layers of vegetation - maintains relative humidity and modulates wind movement through valley bottom - fire management and movement
22. Flows to maintain depositional features for germination of willows, cottonwoods etc...
23. Woody debris production and sizes
24. Pool riffle ratio: Natural pool riffle ratio varies widely among different stream types. The organisms were adapted to what that stream type naturally provided, not some ideal 50-50 ratio.
25. Seasonal high flow for movement of sediment for recruitment substrate for disturbance species: willows, alders, and cottonwoods. Each species has a different particle size and water potential relationship that must be maintained during germination through early plant development.

IV. Fire Behavior Models and Riparian Zones (Topic Commenter)

1Va. Current fire behavior/suppression models adequately consider riparian zones (Agree/Disagree?)

FARSITE can do it, but need better fuel models for variation in riparian ecosystems {#4}

Fire behavior models (e.g., BEHAVE) use physical inputs such as fuel loading by size class, fuel moisture content, slope, and weather conditions such as wind speed and direction, and relative humidity. It only distinguishes among fuel types, etc., insofar as the differences are reflected in the physical inputs. There are 13 physical fuel "models" (3 in which grass is the primary fire carrier, 4 for shrubs, 3 timber, and 3 slash). That is, there is no separate fire behavior model for "riparian." Riparian zones can be modeled separately, however, but this rarely happens because riparian zones typically constitute a very small proportion of any given fire (Everglades National Park and a few other land management units are exceptions.) {#5}

Re:5 Roger Ottmar at PNW has been working on expanding the 13 fuel models; I'm not sure if he has incorporated riparian zones into this effort, but it may well be possible. {#6}

This can be done but only crudely. {#7}

Re: #6. Roger is actually designing "Fuel Condition Classes" rather than new models. Currently, the FCCs will not link to any of the other models. However, one module in the BEHAVE package is NEWMODEL which allows you to customize your own physical "fuel" model. After development, you can test it via "TESTMODEL." Takes some data to develop the custom model. That is a place where scientists and Fire Behavior Analysts could get together and build some "riparian" models. {#8}

Agree. spotting is the problematic fire behavior component that crosses riparian zones rapidly. occasionally enough woody material and/or grass thatch exists to carry a fire through and that spread is adequately predicted by existing models. the fire will often spot over the riparian area before it burns through in these cases. {#9}

No, not adequately, at this time. {#10}

Assumed independence between pixels may under predict "neighborhood" effects of higher fire intensities, particularly for thin riparian "strips" running through forested landscapes. {#11}

The key to this question is "adequately"--depends on the user and the disparity between |observations-predictions| that the user can tolerate. {#15}

Based on the discussion, it looks like we can , but outcomes will be crude. Looks to me like this is something that needs some follow up to see how they can be refined to address the questions posed by Boone - that is, we need a model that will predict the effect of diversions on the ability to meet fire mgmt responsibilities. {#18}

Current models have some basic limitations that might make predictability even less in riparian areas with decomposed large woody debris. BEHAVE treats decomposed LWD as a large solid fuel when it actually acts more like fine fuels due to the extensive surface area developed in the decay process. The model user has to account for this with some tweaking and guessing. {#19}

Looking in at this discipline from outside, I think we have a problem in that these models are inordinately driven by fuels. Fuels are easy to measure and they can be messed with in the lab easily, so that's what we've focused on traditionally. Sure fuels are necessary for fire to occur, but meso-scale phenomena such as microsite wind behavior (turbulent dynamics not linear!) and convection and radiation effects mediated by canopy structure appear to be really important (to explain field observations of fire behavior) and are NOT accounted for in fuels-based or height-to-canopy-based models. These things are very

sensitive to riparian conditions and management, at least as sensitive as fuels are. I think we have a lot of misconceptions about riparian management for fire purposes that are WRONG because they are based on a view that suffers from an inordinate focus on fuels and a neglect of what we (perhaps natively) refer to as "microclimate" considerations. {#20}

No, there is the possibility at least to incorporate the concerns you mention {#84}

Re 20: Agree {#42}

Re #21. Yes, I agree that Berni and Gene have invaluable knowledge. The key is to improve models like FARSITE enough so that the models do as well. {#49}

One can define in FARSITE a pixel size small enough that the riparian zone might be 4-5 pixels wide, even on small riparian zones. Under less than catastrophic weather conditions, one could simulate the contrast between riparian and upland burning, but in reality for a site-specific real landscape, I would rather have Berni and Gene at my side with their best guesses rather than FARSITE. {#21}

Amen, there's no substitute for experience ("Droids is one thing, kids. Human is something else.) {#105}

The key is the resolution (pixel size and accuracy) of input information and how it is used to characterize fire behavior. This could easily become a garbage in garbage out exercise. If the topography is characterized by 30 m DEM and veg from LANDSAT, then the riparian zone will disappear, unless it is exceedingly wide (only perennial 4th order or larger rivers). {#23}

"V" canyons vs. "U" canyons can define the width of the riparian zone, the bottom line to fire crossing or not crossing the riparian zone is width, that can be observed first-hand. {#27}

Maybe we are talking about two different kinds of models, one more detailed for experimentation to develop general ideas about managing fires in the specific landscape, and one perhaps less detailed for operational use. {#52}

Agree, to the point that we have the ability to explore, certain scenarios. The fire behavior model inputs are user defined, that is if build into the landscape, you can assign custom fuel models to account for different vegetation and how they might burn. Weather conditions can be varied on the landscape to improve how fire spreads on the across that landscape. But, ultimately the interpretation of the outputs must carefully disclose all the user assumptions and clearly state the range of outputs based on the assumptions and limitations of the model. {#28}

Re #5: Would need 2-5 or more fuel model for any given riparian zone - can these models handle this kind of complexity on the scale in which they currently work?? {#29}

Re 8: Even in NEWMDL/TSTMDL the user must provide hard-to-measure estimates of surface area/volume, heat content, moisture of extinction, etc. Essentially these can be tweaked to produce a wide range of fire behaviors. {#31}

To what extent can FARSITE or a similar model incorporate the kinds of needs that Jim Agee suggested? In concept, this can happen. There are sophisticated terrain-based windflow models, and transfer of heat is understood well enough to approximate it in models. The problem at this point is a computer and knowledge limit. The windflow models are too computationally complex to intersect them with FARSITE in real time. The heat flux modeling however, may be more tractable. But, to what extent does preheating of fuels in front of the advancing flame front change the fuel model data--that's more difficult. Can model improvements make it possible to address the kinds of questions that need answering? Sure, in concept. But, Bob Clark is probably right that it may never be better than a factor of two accuracy. Is that enough for planning? {#32}

Re #27 - There are more valley shapes than just V vs. U canyons {#34}

Again re #27 - And these valley shapes do not correlate very well with valley width. {#37}

It sounds like the available fire models are somewhat crude; however, there is uncertainty in any modeling exercise. Given we accept this, for planning purposes or exploratory work one could take a given weather condition for a watershed and do a Monte Carlo run to get a probability output based on varying one variable--say vegetation moisture or riparian width. Then take the same watershed and a different weather condition and vary the same variable as before. Thus you get a series of probabilistic outputs for different weather conditions (which we have all heard is the driver). Basically this gives you a look at the sensitivity of the model to the variables that riparian systems could affect. It would give some insight into the process we are interested in--influence of riparian on fire behavior and the sensitivity of the current model(s). {#38}

The biggest difference between riparian and upland fuel models is fuel moisture - most are going to be a NFFL 10 (and unfortunately that's what most of the uplands have evolved to as well) - but the dead and live fuel moisture differences are key to understanding different fire behavior (OK, given that we can't do a very accurate job at wind).

These conditions are going change over the season - so that early on, the riparian zone may be less flammable than the upland, but in headwaters may be more flammable of the rz dries out late in the season. FARSITE can account for these types of differences - its the lack of site-level winds and the independence of pixels that create problems for the rz simulated fire behaviors. {#43}

Re#32: Is there really a need for "real time modeling? Or can these more complex models be used to examine the nature of landscapes, the role of riparian zones within them, and how all this might influence fire behavior under different land management scenarios? {#45}

Re #45. Yes, you're right about the primary value of these models. But, eventually these models will be sufficiently sophisticated to look in real time at what may happen when that rapidly moving cold front hits and winds blow up a canyon. That would be useful too, in situations like South Canyon. {#65}

Agree with #38. {#46}

It sounds to me like current fire models were specifically designed to provide information to assist with fire suppression (i.e., rate of spread, etc.) and that ecological questions about what happens to riparian areas are ignored because (1) that was not the purpose for their development, and (2) the scale of analysis of the fire models is so large that it cannot realistically be applied to narrow riparian zones. It also sounds like riparian analysis, except for large streams, is totally irrelevant because the process is driven by large scale thermodynamic processes. {#47}

Re. #19. In moist systems CWD may hold huge amounts of water. In one high elevation stand (approx. 5000 ft) completely destroyed during the silver fires, old class 3-4 logs averaged 150% moisture (measure within a couple of weeks after the fire--before the Fall rains). In some you could actually wring water out with your hands. {#48}

#50 the 97%/3% phenomenon has implications that cut the other way too, and this question gets to that. If riparian zones keep a certain proportion of small or moderate size fires from becoming big fires, they may be having a huge effect on keeping the total acres burned down...and shifting fire pattern away from large contiguous burns and toward smaller, patchier burns....seems like in many landscapes it is this burn pattern we want? The main point is that you have to pay attention to what riparian firebreaks may KEEP from happening , not simply whether they stop big fires once they start rolling. {#94}

#76, 54 There are some places where large fuel buildups occur in riparian zones (e.g. beetle killed spruce stands in the Blue Mtns) ..but it's like such accumulations occurred, patchily at least, as a natural feature of the riparian mosaic and are not necessarily a "crisis" that we need to manage our way out of with chainsaws. {#108}

Re 108 Agreed. We need to be really careful using "fuel reduction" as a management goal in riparian system. Large wood in riparian zones is incredibly important from an ecological perspective. This would indicate a heavy burden of proof is on those managers to justify fuel load reductions in riparian systems. {#118}

Re 118 this is an overgeneralization; CWD is not important in all riparian zones or all forests! For example it is not prevalent in meadows, ponderosa forests, willows, etc. We do not know the role of CWD in dry forest riparian zones.

Re #103 Great opportunity for someone to do research to address this question. If thinning is ecologically beneficial or not, it needs to be figured out soon. {#110}

#54 Well for many purposes, proposed thinning activities in riparian areas are tantamount to "trashing" in a biotic sense. This is NOT paranoia...believe me we have "trashed" countless thousands of miles of riparian zones in the past through similar thinning activities. The FS has a long way to go to convince me that proposed thinning practices are dramatically different in their consequences than the past 60 years of riparian timber mgmt. {#103}

I have a question re the 97% 3% breakdown. While this is true today if we are able to more effectively bring landscapes into a reasonable natural fire regime will that ratio change. And if it changes will the role of riparian as of the natural bounds and limits be more important? I recognize catastrophic conditions will be little influenced. {#50}

Oral comments indicated that current models have some real limitations. Hope those comments get recorded here for us non-modeling folks as they were very helpful in trying to understand the potential utility of models for assessing riparian effects. {#51}

#9 this observation that fire spread typically occurs through spotting and that riparian areas often burn secondarily to the spread of the fire front accords with my field observations over the years.

One thing it implies to me is that we need to be focused on what remains behind when riparian areas burn, for purposes of their overall ecological and cultural value and function; it's not okay to trash riparian areas (or "manage them" e.g. for fuels reduction programs, which often propose to manage riparian areas as if they were bad concentrations of nasty fuels that need to be reduced)) simply because they don't stop big fires. {#54}

We haven't really talked about fire effects, but the spectrum of reliability from fuels, weather and topography to fire behavior is pretty good compared to the next step: predicting effects on biota: a classic case of the good, the bad, and the ugly. {#64}

Can fire models be used to help define let burn areas or to define larger prescribed fire on the landscape? Maybe part of the discussion needs to be focused on how to reincorporate more natural fire regimes. {#71}

Re#48. Wet CWD is a character in moist forests, but in dry forests its more like 40%, and a lot of CWD burns with wildfire or prescribed fire - in dry systems we either have to

accept the fact that CWD is limited or simply not burn - can't burn AND preserve high levels of CWD {#74}

Agree with #54 - Having tromped through thousands of miles of stream, I'm not sure where the idea that there are horrendous fuel build-ups comes from. {#76}

Re:54 In my view there is an important argument for thinning riparian zones for ecological restoration, not to produce timber or fuel management per se. Many RZs are in a state of advanced succession (that has probably occurred because of fire suppression/flood control) - the vegetation is extremely dense and in a state of structural complexity and physiological stress - rendering them more susceptible to insect/pathogen infestation and catastrophic fire - besides loss of important vegetation types and habitats for wildlife indigenous to riparian zones. {#77}

In response to #50 about the 3vs97% this is generally the ratio we use to express the number of fires that exceed initial attack and go into additional burning periods. this where the greatest acreage is involved. A more desired ratio would be what is the intensity level of the acres burned this would change the role of riparian areas when we go to looking at fires on not whether we succeed at initial attack but we have fires that do good from an ecological standpoint or not. {#79}

The width of the riparian may be less that the pixel size so it cannot really be used to evaluate fire spread in riparian zones. The BEHAVE (FARSITE) models homogenize the fuel bed and distribute all the various fuel input through the "fuel bed depth" chosen by the user so stand structure has no direct effect on the outcome. There is not one single peer reviewed "validation" paper concerning the outputs of the FARSITE Model. It is "fuel model dependent" and large areas are assumed to be uniform with the same fuel characteristics and moisture content. The is no interaction of terrain with wind . It would be better to use BEHAVE to compare outputs from upland fuel and microclimatic conditions versus the adjacent riparian zone fuel and microclimatic conditions. The crown fire modeling in FARSITE is ever worse. You have to assume all fuels are Ponderosa. pine regardless of what the fuels really are and multiply the ROS output by 3! The pub is based on ROS data from 5 or 6 fires and overestimates ROS of crown fires by 1/3 when compared to prescribed crown fires lit in NW Territories and compared to the wildfire data base of the Canadian Forest Service. {#82}

Re # 54. I haven't picked up anyone looking at trashing a riparian area (sounds like a phobia). Again, these areas are important for many things, the focus here is how they are used for fire mgmt. They, like anything else, will not stop a major fire run with weather not in your favor, but, when it moderates, they are routinely used for a variety of purposes in the suppression effort. {#83}

Re 77 - and many more riparian zones are not in a state of advanced succession - in fact that's fairly counterintuitive to the disturbance regime of riparian zones {#86}

Re:74. Fires can produce new CWD, not just consume it. {#87}

Most riparian areas are probably not significant in the overall mgmt of a ripping wind driven head fire in steep terrain. They maybe significant in stopping at least portions of a backing fire in gentle terrain. This can be significant in trying to determine the acceptable boundaries of a fire being managed under what used to be called a confine strategy. {#88}

Re #71 - FARSITE was initially developed to specifically address the "let-burn" situation in national parks - if we let this fire go today, where will it be in 40 days given a predicted weather stream - and I think it can work in fuel-limited systems like the backcountry of Sequoia - but not very well in Yellowstone where extreme weather drives the fire system. {#91}

Re 77 - Riparian zones inherently have lots of structural diversity and that's when they are in excellent ecological condition {#95}

Strongly agree with #20 {#96}

Re. #48, so are rz's in dry forest types moist systems or dry systems? {#98}

Re:86 But the point is that disturbance regimes in many riparian zones have been interrupted. {#99}

Re: 95: But in advanced succesional states there is structural homogeneity not diversity. {#101}

Re 99 - The largest disturbance regimes are not necessarily fire - water and sediment play a huge role in what goes on in riparian areas. In addition we have added other disturbance agents - livestock, logging, roads, culverts, camping, etc. etc. etc. {#102}

Re 101 - Not necessarily - in fact, generally not true in riparian areas {#104}

#114 Advanced successional stages in riparian areas are NOT homogenous in any sense! Certain intermediate succession stages may be. {#116}

The following comment (#``3) pertains to #83 and 54 {#115}

This needs to be considered in the context of the thousands of miles of riparian that have been disturbed and impaired for the long term as a result of past timber mgmt and grazing. These "decadent" riparian patches may be the last refuges for sensitive species...they may not appear "healthy" in a narrow view, in the context of the landscape as a whole the biota may be telling us they are the healthiest places out there. If you can show me that mgmt can preserve the biotic values of these stands while reducing their

vulnerability to obliteration thru fire, I could see a need for some mgmt. But I am not at all convinced so far that you have the silviculture to do this! {#113}

Strongly agree with #104. Structural heterogeneity may be arrayed differently between early and late succession, but to say advanced successional stages are homogeneous is too big a generalization in my opinion. {#114}

IVb. Can they be used to determine how land/water use in riparian zones may affect fire in western landscapes?

We need to now if we have fire models that can adequately predict the functional role of riparian zones as they may influence fire on the landscape? Are they sufficient to begin to predict their values for fire management? {#26}

It looks like they may be adapted to give some crude answers, which is better than nothing! {#39}

The main use of these models would be either in long range planning on incidents or complexes of incidents or in landscape modeling for fuels reduction or fire use. They need well trained fire behaviorists who are very familiar with the model (not easy to find) and computing power-which on a going incident is also not easy to find.
Even on small projects such as a timber sale modeling the post harvest effects is not precise but the best use of current models is showing effects over time with changes in vegetation and how this effects fire intensity and spread. {#41}

#39 Maybe; depends on who's doing the interpretation... {#57}

Assuming we want to model this, do we actually have any research information on which to build any of these models? {#58}

Only to the extent that users are willing to tolerate wide "error bands". The models will grow fires (almost unmercifully) but accuracy will be affected by propagation of errors, e.g., from fire behavior to fire effects (as tempered by riparian zones) to landscapes. Still the models are useful from a planning standpoint, where the stakes are relatively low compared to the values-at-risk on an ongoing wildfire. {#59}

It seems that long range planning goals may be adequate, given the feeling among most fire people that catastrophic fires and their suppression are not significantly influenced by riparian areas. I think we can all concede that in the smaller fires, riparian areas are an influence in suppressing or herding the fires away from areas that need protection from fire. {#62}

They are tools that are helpful in the landscape exploration of this issue. It will require careful work that discloses all the assumptions and limitations of the tools. {#63}

Re #39: It is only better than nothing if the output is better than nothing. If the predictions are the opposite than the observed, nothing is clearly better. If the resolution of the model prediction is such that the riparian zone effectively disappears, then the prediction would say that the riparian zone is unimportant. This may simply be an issue of resolution, not fire behavior. Believing model predictions to make management decisions without fully understanding the limitations is not necessarily better than nothing! {#67}

Yes, eventually they can, but at the moment perhaps only at the factor of two level. {#72}

Structures and urban-encroachment have an effect on fire suppression. {#119}

3. If you do not know fire models, what parameters would you suggest are necessary to predict how riparian/stream ecosystems affect fire properties?

Spatial dimensions of the riparian zone, physical characteristics, including humidity, fuel loads and characteristics (vegetation water content). {#12}

The spatial scale of the models must be adjusted to the smaller scale of riparian zones compared to the uplands. I hear people saying that models are based on spatial imagery with 30m pixel size. These are too large for many riparian zone widths and beyond that, riparian zones contain a variety of different systems and corresponding vegetation with different fuel loads, humidity's, etc. that are also much generally much smaller than 30 meters. It's difficult to average these different systems together - and would be pointless to use in a predictive model. {#13}

Width/area of stream, width of green area, floodplain, flow regime, veg type (meadow willow community) {#14}

We are working with ecosystems that have experienced the effects of management (e.g., harvesting, roads, grazing) for multiple decades. All of these practices have impacted the character of riparian systems such that the departure from "natural" or pre EuroAmerican influence is often severe. In addition, beaver have been extirpated across many stream systems in the west. Thus, while we may be focusing on how existing riparian systems function with regard to fire properties someone needs to give some thought and effort to thinking about the potential for these systems to function if future riparian restoration efforts are successful. {#16}

Vegetation cover, structure (layers and size class distribution), live fuel moisture, valley bottom width and gradient, adjacent vegetation characteristics {#17}

How about adding a probabilistic capability to the models? This might account for changing conditions and provide feedback/interaction (negative and positive) between adjacent cells. {#22}

Total RZ width, relative humidity, vegetation fuel moisture, vegetation type, height and density (spacing), continuity of riparian zone and/or vegetation types. {#24}

Better ability to identify riparian areas in GIS systems. Thirty meter may or may not be adequate to identify and characterize areas significant to fire. {#25}

Stream network coverage, by reach, with info for each reach on valley characteristics (valley width, valley depth, maybe side slope gradient), channel characteristics (wetted width [could be specific by season or month], bank full width, incision, water depth), and riparian characteristics (riparian veg. riparian fuel, presence of sensitive species, etc.). {#30}

#16. I like the idea of predictive models (possibly conceptual) of potential fire effects within riparian ecosystems (and effects of riparian systems on uplands when possible) and how these differ for intact vs. degradation states. {#33}

Re 25--There are valley bottom aml's that delineate rip areas at a finer resolution, using 10 m DEMs. So there may still be a way to get these areas delineated. {#35}

Discussion comments indicated that the spatial distribution of riparian systems is a key factor in their capability to alter fire properties. Most stream systems are comprised of 1st and 2nd order streams. It seems, based on discussion, that these are the most prone to burn, and burn well, because of their topographic location (steeper drainages). However, lower down in the drainage, where riparian systems may be wider, may have flood plains, are lower gradient, and adjacent hillslopes of less steepness, relatively intact riparian systems may have a role in influencing low and moderate severity fires. Is this a reasonable recapitulation of some of the commentary? {#36}

The key is the resolution (pixel size and accuracy) of input information and how it is used to characterize fire behavior. This could easily become a garbage in garbage out exercise. If the topography is characterized by 30 m DEM and veg from LANDSAT, then the riparian zone will disappear, unless it is exceedingly wide (only perennial 4th order or larger rivers). In addition, how is leaf moisture, humidity, etc characterized for each pixel? Based on what input data? Can the fire behavior characteristics of an intermittent stream riparian zone be distinguished from a permanently wet one based on model resolution and input information? Probably not. {#40}

Re 36--Yes. that's why it's important to describe rip zones using the parameters you listed, to differentiate fire effects etc... {#44}

Re 40--The 10 m DEMs and the valley bottom AML (see 35) hopefully may solve this problem. {#53}

Valley slope and orientation, valley width, proximity to forest, grass, or bare ground, surrounding topography, size of fire and weather conditions immediately preceding and accompanying it. {#55}

I agree with 30. I think vb side slope steepness is an important variable. {#56}

In addition to vegetation characteristics, it seems that the models would need to represent climate and weather conditions at small spatial and temporal scales. I could imagine that this would be relatively complex. For example, supposing relative humidity is an important variable, the question is: how well can we model changes in relative humidity over forested surfaces? in complex terrain? with limited meteorological data? The answer is not too well! {#60}

What are the key components used to develop models of how surface fires move through a given area? besides fuels, that is {#61}

Re 61 - I don't know but I think I heard from the discussion that riparian characteristics are not part of the current modeling process. {#73}

Looks like we need to get the fire modelers and the riparian ecologists in a room and talking to each other about mutual capabilities. {#80}

Location of the fire with respect to valley bottom and mouth. {#66}

Will need to develop models than do some validation using field and aerial/remote sensing data from recent past fires that are well documented. {#68}

Northern region, Forest Service uses land type association spatial coverage to characterize parent geology, geomorphic features, drainage density, dissection spacing, potential veg types etc. It's been useful when intersected with existing veg land cover (TM imagery) as context for the riparian. We also use aspect, slope, elevation rule sets in conjunction with or instead of LTAs (where they are unavailable). This is useful for multi-forest landscape assessments (pre-Forest plan). {#70}

The stream systems for most watersheds are comprised of 1st and 2nd order streams. To what extent do these alter fire behavior (increase fire severity or decrease fire severity) because of their topographic locations? that is, they tend to occupy the steeper portions of the stream system and normally have steeper side slopes. {#75}

If you do not know fire models, look at spatial coverage of riparian zones relative to the entire landscape. Consider relative flammability of upland vs. riparian zones under various weather scenarios. Then consult with someone who knows the strengths and limitations of existing models. {#78}

There is a current "national" fuels mapping effort getting started. Wall-to-wall 30m maps. But even that scale is often too crude (for example, "shrubs" is a pretty inclusive category). Some folks in Alaska are working with a sub-pixel program in an attempt to distinguish between different species. This is important because some shrubs are much more flammable than others. Point here is that current tools are pretty crude, but there is work underway to improve the situation. {#81}

{#97}

Re 40 & 53: 10 m DEMs may simply improve resolution of the topography. Unless the resolution of the veg and climatic predictions are also improved, then the overall model performance is no better. {#85}

Need to know moisture conditions and how width of areas are affected by incision and diversion. Also how does denial of water to riparian in winter affect the plant health and moisture condition {#89}

Re 61 There is a factor of the propagating heat flux from a flaming front to the next fuel particle. {#90}

Re 70: Some of these characteristics -- drainage density, dissection, etc. -- can be better determined from the DEMs than from some generalization from land type associations. Don't try to hang everything on land types, they may not all correlate. {#92}

One issue that has not been addressed is the lack of our ability to develop good predictive models for potential riparian vegetation in the interior west for non-forested riparian zones (shrub and graminoid dominated systems). If we can tackle the parameters that drive potential types on a spatial and temporal scale we can be of assistance to fire science and management folks. {#93}

Re 92--You're right. DEMs can be used too. there are many tools out there! {#100}

Most riparian systems in the west have been impacted by land use (harvest, grazing, roads) in addition to the loss of beaver. Are we thinking about riparian systems as they now exist (a degraded state) or how they might be down the road if restoration becomes successful? to me this is an important issue. {#106}

Re 93--I strongly agree! Hope someone works on this! {#107}

Re: 107-- I think Elizabeth ? is doing this? {#109}

Re: 109 No, I think it is Mary Manning working on model. {#111}

Re 111--This is Mary. I am working on non-forested types for example and we do have 3 rip types, but it's not directly for fire related modeling per se. {#112}

Re 93 - We've been doing this since the first riparian classifications came out in the mid 1980s - We have classifications for most of the National Forest lands in the inland west (eastern Washington, eastern Oregon, Idaho, Montana, Nevada, the eastern Sierra in California, northeastern California, Utah, western Wyoming, the Bighorn Mountains and other places I don't know about. {#117}

Also re 93 - And there's a combined effort for all of the Columbia River basin - done by all of these {#120}

Done by all of the people who wrote {#121}

Effects of Land and Water Management (Topic Commenter)

1. What are the effects of land and water management on efficiency and capability of fire suppression and management?

Huge! {#2}

Roads, Roads, Roads, Roads {#3}

Re #3: Roads are good for fire fighting but often bad for a variety of ecological reasons. {#9}

Forest /Urban interfaces creates larger zones of high-risk fire behavior. Same people don't want smoke/haze from prescribed burning. {#5}

Roads - presence adds to fire starts, also decreases response time - generally fire stats support more fires on roaded landscapes (because of more human ignitions) but smaller fire sizes. {#6}

I think you should also consider societal attitudes and the need for public education as also having a big influence on our ability to manage fire events. Or you could say inability to perform preventative maintenance vs. fire suppression. {#7}

Actually, the answer depends on the quality of management--poor planning/management can tie the hands of managers (e.g., urban interface). {#8}

I agree with Jim Agee's suggestion (I think this is part of what he meant) that management of the uplands surrounding riparian areas has constrained what we can expect riparian areas to accomplish re fire mgmt. {#10}

Through fire exclusion, riparian vegetation (especially shade intolerant riparian shrubs) have been shaded out by conifers that typically would be kept out of the rip zone through frequent fires. As a result, the composition and structure have been altered, with more

flammable fuels, ladder fuels etc... The fire behavior would be different. The area may not function as a safety zone. {#11}

The urban interface has made it difficult to manage fires strategically. The tactical approach has move us away from using some of the natural landscape features as strategic control points. Riparian might be one of these features especially in terms of backfire type actions. {#12}

More multi-layered forest in unharvested areas. Average tree size much smaller than historically in harvested areas. so we have screwed the landscape in both harvested and unharvested areas.. {#13}

Untreated logging debris has abnormally increased both fire size and intensity, now we see the same problem with unlogged areas that have had fire excluded {#14}

I suppose that , in this context, roadless and wilderness designations could be seen as adversely affecting the capability of fire suppression. On the other hand, by excluding habitation, etc. It should simplify management. {#15}

I started my fire career in the northern Sierra Nevada. in several locations that were open, sugar pine stands are now currently choked with incense cedar and fir. where fire spread in needles on the ground historically, any fire during the summer months will have far more severe impacts. the ability to stop fires in the needles was very high, the potential to stop a fire in the current vegetation is often quite low. {#16}

#16 I agree that successional changes in veg often reduce attack potential and the ability to keep small fires small. This is important for protecting people and property. But what effect does this have on overall fire pattern or regime across a region? Is it consequential? We still have a scale problem to address in making that leap. I am guessing that the major landscape-scale threshold of effect is determined by the factors that keep medium size fires from becoming large fires..i.e., mainly the weather..but also perhaps the mosaic of prior burns and of vegetation patchiness at a scale of square kilometers. {#33}

Grazing impacts more acres in the west than any other land use. And grazing removes fine feels which essentially eliminates the capability of fire from occurring in areas experiencing season-long grazing (the traditional west-wide grazing strategy). {#17}

All the processes that have dried out riparian zones (discussed yesterday) have made the RZs less effective in fire operations. {#18}

Landuse changes to urbanization has focused suppression efforts in to structure protection. Fighting fire in the interface allows what would be easy to handle fires to become more catastrophic. Concern for structures is driving the allocation of fuels mgt. projects to the urban -interface (Sierra Nevada Framework). Relocation of water

resources to provide human habitat is reducing instream flows which reduces ability to draft, dip,etc... {#19}

I agree with #11, but want to know more, is it common in our western forests? {#20}

Diminished riparian width, flow in late season and general decline in wetland character and extent make riparian less strategically valuable than in the past in terms of fire management.. {#21}

Timber sales (old ones of course) have changed the fuel loading and arrangement of the fuels to where any positive effect a riparian area might have is negated by the high intensities generated by the accumulated slash (Stormy Fire Sequoia NF). {#22}

There is a lot of potential for more effective management of riparian zones that would enhance their integrity and their value for fire management. 1) Improving ecological condition with efforts focused on water retention in the system 2) Reincorporating more natural fire regimes into valley bottoms - not all or none but a mosaic designed to maintain integrity, etc. {#23}

Loss of beavers has had a large impact on many riparian zones throughout much of the west. Whether this translates to altered capability to affect suppression and management of fires is beyond me. {#24}

#24 I agree, loss of beaver and other wetlands generally has totally changed bottomland ecology on many if not most intermountain valleys... a lot of the successional incursion of conifers that is commonly attributed to fire exclusion is more likely a result of changing moisture regimes and edaphic conditions in bottomland soils! {#51}

#24 51` and grazing plays a role in this loop too {#54}

Assuming fire suppression has lead to increased density of trees, this could increase evapotranspiration, resulting in less runoff and water available to fight fires... effective 1-2 punch. {#25}

Also think comment #11 is an interesting point of discuss. Also, curious why it is ok to manage fuels in the uplands and not in the riparian zones? Are they sacred? As an ecologist, I just don't see the difference. {#26}

Livestock grazing is perceived as reducing fuels and improving accessibility and thereby aiding fire suppression and management. Is this true, is it effective in this regard? {#27}

Re 17 BUT AS Grazing Changed STRUCTURE from a grass-dominated systems to a shrub dominated systems; couldn’t that also influence the inevitable fire that will occur on the site {#29}

I have a hard time answering this questions since we do "fire management" to support land and resource management objectives. T.S. The tail shouldn't shake the dog. Our business is growing trees, not just putting out fires. As fire management becomes more professional then someone will be at the ID team table, instead of sitting outside the circle and asking, "Tell me what you want me to do?" {#30}

Re #11. I don't think there is scientific evidence to support this view at all. Most western riparian ecosystems are driven much more by floods than fires. {#31}

See yesterdays discussion! This was bantered about yesterday. We know that our management, together with the variability associated with changing climate, has created a situation where we are experiencing more large fires than we have had in the past (with the exception of a few notable years). The changes in riparian condition in some instances has exacerbated the effect and decreased some options from a fire mgmt/suppression perspective. The urban interface has created a huge challenge that was basically isolated instances just a few years back. {#32}

Smoke management issues are still a major source of roadblock in efforts to return fire to the ecosystem with or without a physical or mechanical treatment of stocking level....which generates another roadblock to such efforts...the social aspects of "anti-logging" philosophy that preclude the return to a more historical state of basal area, stocking level and species composition that would more adequately support a natural fire return interval {#34}

Diversions of flows along with regulation of flows by dams has diminished the width of streams (see Williams and Wolman) This makes streams and riparian less of a factor. {#35}

Many issues here. Some of them are:
1. Development (houses, etc.) against or into wildlands.
2. Roads are a double edged sward. Downside (from a fire management perspective) is that currently, roadless areas are a sink for certain fire management resources (shot crews, airtankers, Incident Management Teams, etc.)
3. Poor cultural practices (improper timber harvest, overgrazing, ORV management, etc.) both enhance and dampen fire management options. Another "depends" issue.
4. Political reality (protecting structures rather than managing fire).
5. Water diversion from wildland sources. May lower water table resulting in vegetation shifts and drier fuels, less water available for everything we talked about yesterday. {#36}

When I look at some of the comments, I see a difference in opinion as to what the management goals should be - are they to be managed for use (recreation by all, products (timber, minerals, natural gas)) or are they to be restored to a pristine condition to act as preserves were use is excluded? {#37}

More potential for extreme fire behavior and resultant less direct attack and more indirect attack. In dry forests of the West, the early USGS timber reports in low elevation forests report almost NO stand-replacement fires - these are the areas where fire scar analysis shows fire return intervals less than 10-15 yr average. USDA Bull 418: rangers put out fires by tying pine branches to their horses' tails and walking them alongside the fire (probably not under 97 percentile fire weather, but why they were so easy to put out). the whole problem is that we thought trees were good, and therefore more trees had to be better. {#38}

Not true in the Black Hills! {#59}

I'm pretty ignorant about fire suppression, but it would seem that more flammable stands across the landscape, the more potential for fires to build in severity, and the harder it is to stop them. During the 20th century management replaced relatively fire resistant (to crown fire) with relatively crown-fire prone stands--either because of invasion of firs etc into older stands or by significantly lowering height to live crown and increasing crown bulk density via densely stocked young plantations. {#39}

Conversion of aspen stands to conifer stands would seemingly have a big effect. because of the difference in fuel loadings, microclimate, fuel chemistry and susceptibility to burn, etc.? There is documentation that the aspen type is on the way out for many locations in the rocky mountain west (due to multiple factors such as over grazing and succession to conifers). {#40}

Encroachment on and into wildlands has an adverse effect. {#41}

I am positive (I wrote the damn things) that the FEMAT S&Gs, and I believe the present PACFISH S&Gs, allow management within the riparian buffers IF that management is justified to improve the riparian zone for fish and related riparian and aquatic dependent critters. Certainly veg management is not only allowed but encouraged to move the riparian toward late successional stands, and, I expect that a strong case could be made that veg management for fire within riparian zones is desirable IF it could also be shown to improve habitat conditions for fish and related riparian and aquatic dependent critters, but not simply to reduce the chance of fire spread to the uplands. The burden of proof is that it must not detract from the purpose of the reserve. {#42}

Re: 8 Right on! We think Federal land managers are poor at planning! Many of the adjacent landowners in western counties need to be forced to evaluate the long term consequences and ecologic consequences of their short term idiotic planning and greed. Of course they'll blame the government for their screw ups! {#43}

The historic mission of the Forest Service as a land and resource management agency has been multiple use and protection of the resources. We fight fires is to protect lives, property, and resources. Land management has everything to do with our capability. {#45}

#31 Intact western riparian systems may respond to floods and fires (and do) differently than degraded ones or ones with significant woody encroachment. {#46}

Creation of water diversions and access to water have increased the human impacts on riparian areas either through sheer numbers, escaped campfires, the diversion of firefighting resources to protect "improvements, the change in the nature of the riparian area to meet human perceptions of what a water based recreation experience ought to be like. {#47}

Re #40. Much of the aspen "loss" in my opinion is simply return of conifers to sites where they dominated prior to human-caused fires (e.g., miners, early settlers). This is not a problem at all. {#48}

Re 40 and 48. Given our understanding of aspen reproduction your opinion is wrong and dangerous! The loss of aspen is an important environmental problem associated with land use. Many of the clones may be >10,000 years old and we are losing them due to short-sited land management. I cannot imagine where you got the ideas that mining increased aspen.

Roads in riparian have often resulted in incision and drying of wetland /riparian. Also late season flows are diminished in incised systems. {#49}

Reply to #42 -The intent was to allow mgt, but the political reality is that has never been allowed to happen because the reality is that the wide buffers, which were to be starting point, turned out to be the end point - mgrs got stuck and could not decrease them regardless of watershed analysis results. {#50}

Safety is compromised anytime the resource is changed from wildlands to human habitation or use. Priority goes to life and property no matter how insane the land use decisions are. {#52}

I disagree with #17. I don't like grazing but it gets over used as a probable cause of degraded systems. {#55}

I disagree with 55. Grazing is a sacred cow. It has caused more damage than any other land use and political muscle has prevailed over common sense management where destruction continues for the benefit of a few.

Safety and suppression issues??? {#57}

VI. Examples of Wildfire Spread Ending at the Stream/Riparian Zone Edge

Can we find/cite specific examples of where riparian zones and streams have been used in fire management? (i.e., halting the fire or functioning as a fuel break)? These can be actual observations, evidence from forest structure, species composition, fire scars, etc.

> Fire burned through a moderate width (approx. 200'), flat valley bottom near Missoula, MT (Valley complex fire). Veg was tall willow (booths, geyers) and graminoid undergrowth. This is based on postfire observation only. (And prefire observation of species composition). {#2}

NOTE: If the riparian zone SLOWS DOWN the fire spread, it may still have a significant effect on fire size....even if the actual fire perimeter ends at some distance beyond the riparian area, such a delay in rate of spread may have kept the fire small before weather ended the burn. So.....do riparian areas slow the rate of spread in some cases? especially on medium-size or small fires? (keeping them from getting big?) {#3}

Kate's Basin, Wyoming, 2000, Wind River used as a control line and a line for burnout operations to contain the fire from advancing to the west. {#7}

Where and how do riparian areas stop fires? I agree with the comment that this often happens but is generally undocumented. {#11}

There is a place to look for some evidence of this. In fire history work in Jemez Mts. I believe Craig Allen drew (or could draw) some boundary lines for historic fires in any given year. Those lines may or may not fall along riparian zones.. {#12}

#11 Yep, and what bothers me is this is not a new question and it has always been important, for a lot of reasons. And the research would not be tricky especially, very straightforward. So why has it not been done (with a handful of very small-scale exceptions)? {#20}

I don't get it. Why such strong resistance to any attempt to quantify the proportion and conditions under which riparian areas might stop or slow the spread of fire, or change the nature of fire within the landscape. "BUT STREAMS DON'T SURROUND FIRES". So what. What proportion of the fire perimeter stopped at a riparian zone, under what conditions? These are quantifiable things.

From much of the discussion, it seems to me that each summer every bit of contiguous forest in the western US must burn up, entirely, and every fire will spread to the limits of available fuel. Thank god we don't have forests coast to coast! {#13}

#13 Right on.....take the assumptions to their logical conclusion and we would not have any forests from coast to coast..only shrubs and grass and a lot of bare ground/ {#32}

I've seen a lot of evidence of riparian zones influencing fire pattern in ways that I believe most people desire. I am frustrated endlessly by the lack of science to nail it down, and of resources to do that science...which wouldn't be difficult at all and is important. {#47}

Re 13 -- Agree with your concern. {#25}

The larger the stream and associated riparian zone, and the more moderate the fire weather, the higher the probability that the riparian zone will slow-stop the fire. Western Olympics of Washington (19th-20th century fires) almost always stop at the major rivers (Hoh, Queets, etc.). but small streams/extreme fire weather, forget it in most areas. so it depends on where you are in a 2-dimensional (simplified) matrix with one axis size of stream and the other fire weather. {#14}

#24 hear, hear {#27}

Yes, on the Middle Fork Salmon River near Flying B Ranch and in non-fire storm situations in Yellowstone in 1988 . In some cases, on Big Creek ID in 2000 generally in the case of secondary fires following initial firestorms. GWM {#16}

In Sierra National Forest, we have pictures where prescribed fire in Ponderosa pine (understory was bear clover, small cedar) has stopped at the edge of small streams. This would illustrate their possible function for helping control prescribed fire even though there was not the need in this case.
Carolyn Hunsaker {#17}

Doing fire history work in crown fire ecosystems, I commonly find higher fire-scar densities in wetter areas, including areas adjoining wetlands, streams, swales etc. These appear to be places where crown fires may have a higher probability of becoming surface fires or going out (Bill Baker, Univ. of Wyoming). {#18}

Simnasho Fire, Warm Springs reservation, Deschutes River used to contain the fire from spreading to the east. {#21}

Would it be possible to go the past fire maps and other documentation and see how much of the perimeter ended along stream coarse (i.e., riparian areas) as a first approximation of riparian areas significance to fire suppression? {#22}

Even where the fire stopped at the riparian area, don't we also need to know the conditions/factors that caused this to happen? For example, stopping because it was a small back fire is different from stopping an active expanding fire. we probably don't have the information on this aspect. {#31}

The Buffalo Creek fire stopped at the South Platte River, only because the winds stopped (and humidity recovered). Otherwise, it might have spotted across the river--i.e.,

sometimes a variety of factors contribute to stopping a fire. Documentation of explicit instances is scant. {#23}

I'm hearing two opposing statements from experienced firefighters here: yes, riparian areas stop fires and can serve as a portion of a fire line; and no, riparian areas never stop fires. Which is it? Sounds like both and if so, just say that under certain fire conditions, riparian areas are effective and under others, they aren't. {#24}

Re #24. Well, but it is really a matter of probabilities, not absolutes, that's why there are competing stories. The question is how many of each kind of story... {#30}

Heinselman showed that in the Boundary Waters Canoe Area in Minnesota there was a higher probability of older forests downwind of lakes and wetlands, as these areas served as fire breaks to some extent. Same with David Foster's work in eastern Canada. There is a reasonable body of scientific literature suggesting that wet areas serve to decrease the probability of fire spread. {#37}

#13 Don't think that history (data) supports you. Its not just contiguous forest... {#26}

Use GIS coverage for fire boundaries to get some idea of percentage of fire boundaries along wet areas. Would then need to look at what suppression techniques were used in each case. {#28}

Coyote Fire, Fremont NF, the Sycan Marsh used as part of the control line. {#29}

South Fork Complex, 1995, Fire held on one flank by using the So. Fk. John Day River. {#33}

For research purposes, PSW and the District are building a spatial fire history from 1900 to present with what is available on the Kings River District of the Sierra National Forest. Once it is done I could make it available if it would be useful to anyone. We have not had a lot of large fires.
C. Hunsaker {#35}

The bottom line is that it appears that the efficacy of the riparian zone ranges as having no effect to actually stopping the fire. The data seems to be quite sparse where riparian zones actually enhance fire spread and intensity. So the range is usually from 0 to curtail, with very little evidence that it ranges from 0 to enhance. That at least demonstrates a positive influence, the magnitude of which depends on conditions and circumstances. {#36}

#36 response - agree in general, w/ some evidence that enhancement can occur - Agee's slide of the burned over rz. {#40}

In 1992, I had 6,200 acres of wilderness prescribed fire bounded on two sides with riparian areas. Fire intensities were generally low, with crown fires typically blowing holes of 1 to 10 acres in a scattered mosaic. We only lost about 50 acres where it blew over the creek, and picked those up within a burn period. As an aside - the permittee's only complaint was that they had to ride the hill sides to find their cows after the fire, where as before the fire the cows could easily be found only in the stream bottoms because that was the only place growing grass. {#38}

Sounds like some good opportunities to examine the effects of the recent fires. What role did riparian corridors play within the matrix of some to the past year's larger scale fires. What geomorphic positions/stream orders/riparian widths (etc.) had an effect if any? This could be stratified based on fire severity on the landscape. Let's get some data! {#39}

Yes, need some funding from JFSP for this kind of work! {#45}

Re 39--I think Mick Harrington is going to be looking at the fire effects on rip zones in MT. I'll check into it--MM {#41}

One way to consider this issue, is to overlay a fire areas with a riparian layer and see where there is correlation. This could provide some insight on how many fire over time (and not just the big ones) used a riparian feature to contain the fire. (in region 5 CA forests usually map all fires over 5 acres with a GPS) {#43}

I have used riparian zones ranging from creeks to large river drainages to establish control lines for wildfires. These locations represented only a portion of the final perimeter, but were valuable in the success of the operation. Roads are just as important, if not more often used. {#44}

The riparian zone combined with large scale aerial burnout operations are regularly used by Alberta Forest Service and NW Territories as suppression actions. I had also seen the presence of spruce trees on the edges of the riparian zones negate all burnouts by spotting 100 meters across burned out meadows under August, 1983 conditions in Glacier Park. Wakimoto {#46}

I agree that it is mainly on larger stream >3rd order, where they are effective fire breaks. {#48}

Re 24: Your point illustrates how it all depends. A variety of factors contribute to stopping a fire (riparian zones rarely stop the fire) {#49}

Fires with "management teams" (in this context, everything except initial attack) develop one or more strategies and a bunch of tactics when answering the basic question: Where and how can we contain this fire? Natural breaks (ridge tops, talus slopes, riparian areas,

barren areas, are all considered). My point is that riparian areas are often included in the strategy but the inclusion of riparian areas may or may not be documented. i.e., any estimate here will almost certainly underestimate the value and consideration of riparian areas. {#51}

Re #30 - true, all of natural resource management is a matter of probabilities. We all end up having to give answers that are more hard and fast than we are comfortable with - the fire people are going to have to do the same - otherwise we will never move forward with what we know needs to be done. {#52}

Certainly we can find examples of where riparian areas have been utilized to halt the fire size but it depends on fire behavior and where the fire lays on the land in respect to the wind and topography.
Last year we used a wet area on a north facing slope to halt the west slope of a very large spotfire, however the fire spotted over a major river to ignite that area in the first place. Generally fires use windows of opportunity to where they burn so you will find areas where the riparian areas stopped the fire and others where the fire blew right through it. on the Flat fire the fire stayed for the most part on the north side of the Kern River but when it reached a bend in the river it spotted to the South side and followed the river corridor on both sides. incidentally the fire camp was located in a meadow next to the river (camp is used loosely since there were no facilities to speak of) and it burned up. Same scenario with slope fire burned up a riparian corridor i.e.. chimney on the Stormy fire where the fire camp was inconveniently located in a meadow at the top of the chimney-that meadow didn't burn too well but everything else did.
I have used riparian areas as lines on both wildfire and rx burns depends on the weather and topography whether it works or not {#53}

Re: the Nobel Prize Winner #13. I think we have come against the "comfort wall". There certainly seems to be resistance from the fire management folks re: the relevancy of modeling riparian areas for fire suppression activities. A comment was made that the 97% ignition and resulting small fires were not were ecologically significant. However, the resulting impacts suppression are far greater on the ecosystem are far greater than the 3% large fires. This gives up the spatial variation we see in the landscape. {#54}

VII. Fire Suppression and Water Diversion

VIIa. What are the effects of water diversion on fire suppression?

Less water {#3}

If it's not there we won't use it. {#4}

Reduces wetted width and depth {#5}

Water diversion resulted in death of cottonwoods and increased dead wood fuel loading. {#6}

Shift in veg composition to upland species with lower foliar moisture {#7}

If diversion is used locally, within the reach for floodplain irrigation, it might increase the width of the moist zone, particularly in late summer. {#8}

Agree with #8 to the extent that it happens as in the case of the Big Hole Valley in Montana where the irrigation practices have created extensive wet hay meadows that would have otherwise been sage brush areas. This certainly has some influence on fire behavior. {#30}

Depends on the timing and amount of the diversion; diversions occurring at peak flow in spring may have no effect on ability to suppress fires that occur in late summer. {#9}

Often it's water diversion that creates the water source(s) we use in fire suppression {#10}

#7 agree {#11}

Agree with #4. We have to play the cards we are dealt. {#12}

Will reduce pool volume - less bucket chances, less availability from a drafting perspective, fewer chances for use as a safety zone/escape routes. {#13}

Water diversions have resulted in stream narrowing and in some cases vegetation ingrowth into the channel rendering them largely ineffective as a fuel break. {#14}

The other side of the coin is that water diversion that results in storage in reservoirs actually helps fire suppression activities. {#35}

Extended water diversion can be expected to reduce channel width in most instances reducing the effectiveness of the channel as a vehicle for stopping fires. {#20}

Loss of water = conversion of vegetation from more mesic to more xeric. Xeric plants are more flammable, generally, than mesic plants. {#15}

More standing dead (willow carcasses!) {#16}

Intuitively, would be hard to measure--i.e., no controls for comparison. {#17}

Effectiveness of diversion to alter channels and riparian systems (which may or may not be important to fire management) would depend on the frequency, magnitude, and timing

of those withdrawls. Also important is whether the diversion significantly affects sediment yields to downstream reaches. {#18}

I know of no fire that water diversion generated a significant problem {#19}

Re 19: How would you know? How would I know what the streamflow and riparian conditions would have been without the diversion? {#22}

Biotic. Diversion usually = decreased water tables = more xeric vegetation and narrower riparian zones. Can adversely impact geomorphology and stream system dynamics. Possible erosion or aggradation and further vegetation changes. {#21}

Water diversions typically take water off the peak flow during snowmelt; loss of peak flow eventually narrows the channel and decreases braiding and meandering that contribute to the functional value of riparian areas as fire breaks {#23}

Not only diversions but dams - affect scour of downstream riparian vegetation - taller older, more dense willow/cottonwood/alder where there were more gravel bars historically - these are not terribly flammable but more so that the wider/more open channel that occurred before dam construction. {#24}

Depends on where you are. Water diverted from Northern California shows up in hydrants on the Angeles which enhances your ability to suppress the fire. This also goes for reservoirs where large bodies of water make excellent dip sites for helicopters rather than the trickle of water that would normally be there. This is true in almost all the low to mid-elevations in California during the summer time. {#25}

In my experience, most water diversion is on private land and the water is then used to irrigate fields and thereby increase the size of the green buffer. {#26}

Re #26: That's probably true, but we are interested in the effects water diversion has if it occurs on National Forests. While diversion may not be happening now, as population increases we can expect to see requests for additional withdrawals in the future. {#49}

Lack of good research that has addressed the topic--- "If I take X amount of water out of the creek at these times and frequency, what will be the effect on riparian systems and channels"? {#27}

Re 4--- But if it had been there; would it have been used? How would the presence of surface water in a drainage (usable for suppression) affect tactics compared to if it was all diverted? give details {#28}

Mop-up operations were enhanced and time-effort shortened by the diversion. Water was pumped by a stationary volume pump in to engines quickly because the diversion backed up an adequate volume of water. {#29}

Water diversions sometimes require an impoundment at the point of diversion (a dam, a pond). In this case, and at this point, water is more available for extraction or filling bags. If the purpose of the diversion impoundment is to store water for later release, then a larger body of water may be available later into the season. This might also be the case for stock ponds, where water is retained behind a small dam in a normally intermittent stream. {#31}

Agree with 19, 22,4, and 12 {#32}

If you have ever tried to draft from a steam that has a water diversion you quickly learn there are fewer sites that you can get your engines or tenders into and sometimes shallow sites may meaning sucking up silts and sands that ruin your fire fighting equipment. {#33}

Re #33 Are their technological fixes to this concern that would be reasonable and effective? {#44}

Re: #44: There's always an engineering solution to everything (provided you are willing to pay the price). {#55}

re #26. That's the downstream impact on private lands, but the upstream impact on public lands is to diminish the riparian zone {#34}

I would expect both a reduction in the riparian zone and a reduction in water availability. Thus, it would not be as useful from a fire mgmt perspective, which would lead to looking for alternatives for management, that would likely lead to increase in cost and acres. {#36}

Ditto to 26 the orange groves in Ojai were excellent buffers to keeping the fire from going into down thus keeping the firefighters from having to do structure protection. {#37}

On the Wenatchee, irrigated apple orchards are where the fires stop, so diversions (not clear whether the water source is well or diverted surface water) can help suppression operations - rarely scorch more than 1-2 rows of trees into the orchard. {#38}

#22..I have no memory of a fire we needed water on that we didn't get it somewhere. potable water is more difficult to get than water. {#39}

But what about in areas where the snow melt flows are not diverted, where the irrigation season starts in late June and goes through mid Sept. This is the case in most western ag areas. {#40}

It really depends on how much water is diverted, for what purpose, how far distant from the point of diversion the water is used, and when. {#41}

Re: 13. This does become a safety issue as more time is spent locating appropriate sites that have significant water and access. {#45}

Re #46 This would be a worthy effort for someone to do. {#56}

There has been a considerable amount of research on the effects of water diversion and dams on flow regimes and system geomorphic properties and riparian vegetation. Many generalities exist and these could easily be extracted from a good literature review. {#46}

I can see numerous comments where diversion helped ff efforts. Interesting reversal of the theme?! {#47}

Temporally variable, I would guess, but in general, water diversion would probably increase xeric conditions in the channel from which water is withdrawn and lead to increased probability of burning. In the long term, natural vegetation types may be altered and potential for burning would increase. The period of time during the year that an individual riparian zone was susceptible to burning would increase. {#48}

So are diversions in large measure a good thing or a bad thing in terms of fire management??? {#50}

Water has been brought to areas like southern ca. and has been used in suppression. The Owens Valley on the east side of the Sierra and been greatly affected by water diversions, in some places making water available where it wasn't in others taking it away. {#51}

Incised streams often drain ground water that would otherwise be available to sustain a larger riparian width and wetter conditions. Also significantly late season flows are less available in these systems. The converse is often true with restoration of these incised channels and improved watershed conditions, {#52}

Perhaps the proximity to water affects the cost of suppression, rather than simply whether it happens or not. {#53}

In the southwest, the diversion of water from runoff into reservoirs and stock tanks frequently provides the main water sources available during fire season. Ski area snowmaking (the compacted snow typically melts more slowly than natural snow fields) increases runoff in live streams later in the season than they would typically run, which also helps sustain increased fuel moisture in those affected riparian areas.

On the other hand, diversions that dry up the Bosque forest types increase the flammability of them, increase incidence of invasive species, and decrease the ability of

native vegetation to reproduce. What's perhaps OK for the uplands ultimately causes grave problems on a broad scale downstream. {#57}

Diversion impacts on suppression depend on when and where - if they conserve water for later use (reservoir) it might work to our benefit - and if applied in areas where fires are going to be a factor and the diversion resulted in the fire slowing/stopping, then OK. Otherwise hard to defend. {#59}

Re. 26 and 37, From a fire buffer standpoint, do irrigated orchards function like riparian zones? Sounds like more examples of how relatively moist areas can stop fires. {#61}

Again, diversions do not always reduce the volume of flows from ALL streams, unless it is conveyed through a pipe. In many cases water is diverted from one stream to another, in which the stream is the conveyance of the water, not a pipe. Consequently, on a landscape scale, the streams where water is diverted INTO can have more water, and later into the summer, than might be normally available without diversions. While other streams will have substantially less. {#62}

I had the unfortunate experience of having over 80 water wells in montane meadow that was downstream from a designated draft zone. Even though this was a Forest Service funded project the fire folks did not know what we were doing and we didn't realize their impacts until our wells went dry even though there was water just down stream from our study site...but it was unavailable to the fire engines. {#64}

Ground water abstraction can do the same as diversions! {#65}

Diversion could adversely affect fire suppression, e.g., salt cedar growing along canals in wildlife refuges. {#67}

Re 65, A few years ago there was considerable concern in this area that wells to support planned housing developments were going to lower the flow of the san Pedro and impact the RZ (a major migration route for neotropical birds) {#68}

2. Are there any real world examples where diversions have affected the efficiency or safety of fire suppression crews?

Apparently not! {#43}

As with other questions, isolating the effects strictly to the diversion or impoundment would be difficult to document. {#54}

I can't think of any, but that doesn't mean they aren't there. When we take responsibility for a fire, we aren't really in the business of looking for diversions, our intelligence would simply run along the lines of whether or not the stream/river presented an opportunity as a strategy to facilitate controlling the fire. If a diversion had created a situation where it wasn't feasible, it would be discarded. {#60}

I have gone into wet areas and meadows rather than shelter -up a number of times. They provide excellent safety zones. When planning operations those are areas where crews can go into rapidly without much preparation. I don't recall in 31 years of needing to get to water and it wasn't there that it would compromise safety. I did almost get burned up in a riparian area once when the fire decided to crown through it and we thought it would be more safe than it was (Cottonwood Fire) {#63}

Last year the Springer Memorial Area was protected in the Bitterroot by a sprinkler and diversion. This was in standing lodgepole pine. {#66}

X. Group Presentations (Topic Commenter)

Key question:
How do riparian zones and streams influence the rate and extent of fire spread?

VIIIa. Hydrologists/Geomorphologists

Recommendations:

- Multidisciplinary team to formulate models and hypotheses, gather data and test hypotheses on influences of riparian zones and streams of fire spread and behavior.

Some preliminary models we propose:

- Effectiveness vs. stream order (or other characteristics)
- Fire properties (increases fire spread or retards behavior) in relation to stream order

Potential control variables to consider in models and hypotheses above:

- Stream order
- Valley shape, width
- Orientation of streams (relative to typical direction of fire spread)
- Channel (wetted) width
- Channel depth (wetted depth, residual pool depth)
- Braided vs. single-thread
- Ecoregion
- Riparian vegetation type
- Beavers
- Hydrologic regime (rain vs. snow, or elevation within ecoregion)
- Flow regime/flow variance (baseflow:median flow)
- Season of fire occurrence

And the more complex ones:

- Disturbance history (or regime)

- Drought regime
- Flood regime
- Channel floodplain interaction/connectivity, hyporheic
- Land use (current and historic) and human perturbations (logging, grazing, diversion, etc.)
- Pebble counts

2. Comments on Hydro/Geo presentation

Regarding "What do fires do for riparian systems?" I would agree that fires can be a major factor affecting the ecological processes and functions of riparian zones. However, on a year-in and year-out basis, the hydrologic disturbance regime provides the fundamental role of maintaining the predominant features of most riparian systems. Thus, if the hydrology is intact and management has not greatly altered the integrity of the riparian system....then fire could be a reset mechanism that had important ecological benefits. But if the hydrologic disturbance regime is a mess (e.g., major diversions) or increased peak flows and sediment yields from upslope areas to riparian system, then I would argue fire may not be an ecological benefit but may simple add to the degradation of the system. {#134}

Seems like social scientists should be included in the interdisciplinary mix from the get-go. {#133}

Re 133: Yes, particularly a historian. {#147}

I like the two models you propose. This is a more sophisticated and precise articulation of what a lot of us have said over the last two days. {#87}

Comment on Conceptual Model 2: low stream orders at or burning under extreme conditions influence fire because of topographic shape, and orientation to the wind. {#88}

Another control variable is stream density (#/area). Going to smaller order makes smaller fire breaks, but more of them. {#92}

The graphs is an interesting way to conceptualize the anecdotes and intuitive comments {#96}

I like the last idea about whether fire effects riparian zones. Again, nature seems to have let them burn in the far past, so why would we consider them sacred and asbestos now? {#98}

Your model/graphs would be good in deciding whether even to put effort into making instream fire claims in an adjudication. I can't wait to see them... {#104}

The conceptual curves are a good way to focus the questions we have been dealing with. The ideas are similar to what the fire ecology group came up with just expressed in a somewhat different diagram. {#105}

Is there a use for the Rosgen? scale for characterizing the riparian? {#106}

Re 106: I would not start with a Rosgen classification -- start with the underlying variable (used in Rosgen) that determine stream size and function. The Rosgen classification itself is reduced data. {#124}

106. What is the Rosgen? {#109}

Some data requested by other groups might be shared, if there is initial planning so data is collected right to work for other groups. {#118}

Good conceptual models and control variables list--we need funding mechanisms to start collecting and collating data points {#110}

#98 comment is good -in areas that we think of as asbestos we not thinking in terms of the fire regime in a given area-it all burns sometime. {#111}

The second question may have connections to the first. Some of the riparian/channel characteristics that influence RZ effectiveness in fire spread may be partially created by the fire disturbance processes. {#112}

Yes, that's a good point. Within an ecoregion or subregion there may be significant variation (likely due to how much topography controls wind direction). {#138}

If there is a "typical direction of fire spread," isn't the fire that displays an atypical direction of spread likely to have the most influence over changing landscape pattern? Fire guys? {#113}

Is there a use for Rosgen? {#115}

Re #106: Absolutely, and we talked about subdividing stream order by some valley-floor/stream type categorization rather than, or instead of, stream order. {#116}

I don't think anyone has said that riparian areas are sacred and asbestos. The question has simply been posed as to whether riparian areas act as fire breaks to slow or stop fire. {#117}

#106 If you have found a good use for Rosgen, you should be up for a merit award. {#119}

I agree with #87 Good start on a useful conceptual model and stratifying by ecosystem a good notion as well. Good work! {#120}

Re: 98 What ever gave you the idea that we were considering them sacred or asbestos? Riparian areas are quite variable. There are some that only burn under the most extreme conditions. All you have to do is look at the fires in the Bitteroot Valley to see that. Some toasted, others only scorched, and still others had no effect. {#121}

No need to Rosgenize.... traditional measures of watershed/channel characteristics will do just fine, especially with present digital data and GIS capability {#122}

#119 - Rosgen's classification has been extremely useful in allowing people from different disciplines to talk about streams.

Re: #119 I have found Rosgen to be much more beneficial than any other classification system to come out! {#128}

#113: To abuse the cliché..."it depends". there isn't probably a typical direction of spread on any drainage. Lightning ignitions tend to occur on ridges, then back down, then make upslope runs and repeat until weather or barriers stop the process. {#130}

Clearly there needs to be a post hoc review of the fire severity of riparian areas to determine just how much fire carried in the riparian zones last summer. {#131}

Instead of counting pebbles let's count Harlequin ducks (breeding pairs) as an indicator of riparian effects on fire! {#132}

Glad to hear some good comments on Rosgen...I think the variables he uses to describe stream types are still valuable. {#135}

Re 135: But I object to the way he puts them together. {#146}

Re #127, Thought that's what we did with the fire claim! {#137}

#113 A fires direction is typical in the sense that it responds to weather, patterns, slope, aspect, vegetation etc... which may seem atypical. What would be atypical is when fire burns through riparian areas that are wet or moves rapidly downhill or burns things that usually are impervious to burning. {#140}

Re: 113. Despite prevailing wind patterns, not sure there is a "typical" direction of fire spread. Many fires spread with the passage of fronts (i.e., wind directions constantly changing). Other (large) fires begin creating their own weather. Finally, to many variables in 3-dimensional terrain (upslope/up valley, downslope/down valley, and eddy effects). {#141}

#130 I think there are some areas where stand history does show preponderances in the direction of fire spread relative to ignitions...but the point is that a single large event that reverses the pattern may recast the system. {#143}

Yes disturbance does have the last laugh. Unfortunately we have been taught to think of disturbance as sometime is wrong...like a mentally disturbed individual. But it is disturbances that govern the function and processes within these systems.

Agree with 135 {#145}

Re:113 & 130 - There are areas with strong prevailing predictable winds during fire season where the general spread of the fire can be expected. Other areas are variable and unpredictable from year to year or fire to fire. {#148}

146 Rosgen is useful if you don't know much about streams, if you do, it is not....that's what scares me. {#149}

Re 149--What do you propose? do you think a classification system has merit as a communication tool? most hydros I know do see a benefit to using his system. {#151}

Re 151: I'm not 149, but here's my 2 cents. A classification system has merits, but Rosgen's is untested and conceptually weak. Montgomery-Buffington is much better conceptually and has been tested more. It (M-B) needs further development, {#155}

I have found that stream order is a poor way to think of or classify riparian systems. A riparian system (with its associated vegetation, soils and geomorphology) can occur along a variety of stream orders. {#160}

#151 It is somewhat useful and also highly prone to abuse. So as a communications tool it is limited...I agree Rosgen is better than nothing, but it is not useful for all it is commonly claimed to be. The claims made for Rosgen and its uncritical application have prevented other classification approaches (e.g., Tongass NF approach, or adaptations of Montgomery and Buffington) from being more widely explored. {#168}

3. Aquatic and Plant Ecologists

Identify research needs and information gaps ….

1) Effects of water removal for fire suppression on riparian zones

a. Water tables => riparian vegetation (which species are acting as "water pumps" - "keystone pumpers") – ecophysiology and relationships with fuel moisture.

b. Relationships between plant community distributions and water tables/soil texture distributions - ecophysiology

c. Short term effects of rapid withdrawal of water for fire suppression

i. Rapid dewatering

ii. Sediment disruption

2) Effects of thinning on riparian zones

3) Effects of prescribed fire the riparian biota

a. Timing of fires -- a natural regime vs. fire at other seasons for fuel management

4) Historical fire regimes in riparian area & their associated upland ecosystem 5) Role of fire disturbance vs. flood disturbance

a Interactions and sequencing

b. Landscape context - spatial patterns

c. Sequence - severity, frequency

d. Effects on nutrient dynamics

i. Import (nutrients and sediments after burns) and effects on anadromous fish

6) Role of riparian areas as "fire breaks"

a. Effects of past fires - landscape matrix approach - G.I.S. coverage for specific types w/fire weather/severity data

b. Density of drainage and dissection spacing

i. Stratify by elev/climate/veg type - is there a repeatable pattern of fire on the landscape that corresponds with a repeated pattern stream type e.g., patchy fires in middle zone, more intense fires in headwaters, all bets are off in the lower zone because of human based disturbance

ii. And how does this vary by ecoregions

7) Role of fires suppression on fire extent

a. e.g. go back to early season suppressed fire locations, use fire models to estimate the potential fire spread; would they have gone out or blown up? Can "let burn" (wildland fire use) zones be established

8) Role of riparian zones in managing fire - may slow down fires if not stop them - such a delay In rate of spread may have kept the fire small before weather ended the burn - especially relating to small and medium-sized fire

9) How characteristics of riparian areas (veg) affect fire properties

10) How current conditions vs. restored condition affects fire properties

Comments on Aquatic and Plant Ecologists presentation

What about flooding following fires- is this more destructive due to the degradation of the riparian zone? {#165}

Flooding is restorative if you are interested in disturbance species like willows and cottonwoods! We need to accept that from an ecosystems perspective, disturbance is good. {#169}

Good points re culverts, fire camps. When is someone going to blow the whistle on BAER team activities which are especially undesirable {#186}

Re: Going back to early season fires: Current fire models are very poor at predicting extinction of fires or behavior under marginal burning conditions (often expected in early season riparian zone fires. {#170}

170: It's time for some new fire models {#177}

Question 4 could use more elaboration. What is the research question? {#191}

The term is now "wildland fire use for resource benefit." "Let burn" was an NPS term published as a map label by Kilgore and Briggs in 1970. From 1978-1994 is was Prescribe Natural Fire. Only lightning caused fires can qualify. {#205}

I believe that riparian zones burn (carry fire) after large diameter fuels (1000 hr) burn out and dry out the herbaceous fuels, just as the do in planted clear cuts. They smoke and smolder for long periods of time and then in the late afternoon the fire moves with convective up slope and up valley winds! {#231}

Moderate severity fire regimes were great providers of periodic CWD pulses. {#97}

Re #108: It's interesting that the hydros/geomorphs and plant people had similar ideas but expressed them differently. Hydros used a graph; plant people used a descriptive diagram. {#183}

What about flooding following fires- is this more destructive due to the degradation of the riparian zone? {#166}

Re #165 - What is your definition of destructive? and more destructive than....? {#167}

Re: 167 - It' s all a matter of perspective. One person's destructive event is another desirable disturbance regime. {#194}

Re #166: Destructive to what? the riparian zone or downstream infrastructure? If infrastructure, the damage may be less in a "degraded " riparian zone, because much of the bulking effect of riparian veg has been removed. On the other hand, a fully developed riparian stand might capture debris moving downstream. {#172}

Re: Research topic #5 is an important question. However instead of evaluating the relative roles of fire VERSUS hydrologic disturbance regimes, perhaps hydrologic AND

fire disturbance regimes is more appropriate. This general topic is an important ecological question that needs more research. {#174}

Besides, flooding following fires is inevitable...what are you going to do to stop it? {#175}

The fire , flood , insurance, construction cycle. {#178}

#174 That's what we meant to say--we need to explore the interactions between fire and flood disturbance in riparian areas. {#179}

Re question 5 in your report: This is an important question. There may be some riparian zones shaped more by fire than by flood. Particularly if fire makes floods more effective in that region. Maybe S. Cal. mountains? debris flows are the big events, but they are triggered by fires predominately. {#180}

Re 174--right. miscommunication. you got clarification I assume. {#181}

Lets' remember that its the kind of fire that affects floods - not historically every fire, not even now every fire. {#182}

Re: 174 & 175 -- note, the interactions of fire & flood are the first subheading under topic 5 {#184}

I tend to think of floods following fires as being more productive - at least in terms of providing new - OK I was going to say establishment sites for riparian plant communities and everything that goes with them {#185}

Seems like we must have had fires, flooding, erosion, etc, for a long time. i.e., "natural" processes. But now we seem to be putting value judgments on these processes. Question: How do we distinguish between "good" and "bad?" {#187}

Thinning used as a restoration tool or "surrogate" for fire is quite an issue today. Many factors must be accounted for, it likely to work better is some place than others, e.g. where fires were frequent and of low intensity and have been successfully removed some given period: removal of the right trees can restore some of structural conditions that fire may have created on a very specific landscape. Other fire regimes may use thinning to reflect other types of disturbances like insects. {#188}

#175 - we spent enough on Cerro Grande to find out if there is any way to stop the flooding. Fortunately, there are some plots etc installed and at least one graduate student and a full time FS employee attempting to follow up on the investments. {#189}

It is refreshing to hear more understanding of the disturbance dynamics of post-fire watershed disturbance....maybe we have made some progress in that arena {#192}

When we talk about floods/fires and sediment/wood delivery, lets not forget about maintaining the ability of a system to route these important habitat components throughout the stream network (i.e., passage through culverts, bridges). {#193}

One fire may create debris that helps capture debris from the next fire. {#195}

AND, the fire/flood sequence is very regionally specific and depends on the timing and magnitude of large storms. {#196}

Question 4 could use more elaboration. What is the research question? {#197}

187--Good and bad should be replaced perhaps w/terms like "w/in the range..." or not. but even that is still debated. pulse versus press events....etc...lots of dialogue on this. {#198}

Re#187: We have had them occurring for a long time. The major question is whether they are now occurring at a frequency, timing, and magnitude that is significantly different than previously. {#199}

There are some quite complex questions you bring up in terms of restoration--- it might be difficult to accept fire effects on the fish populations if it results in local extirpations of an T and E species. While the fish evolved with disturbance such as fire, their numbers may be too low to recover form a "natural" disturbance, {#203}

I don't think I agree. Species are often more resilient than we give them credit for and evolution needs to go on. "Nature finds a way." {#225}

#225 Tell that to the trilobites. {#246}

Re: 188 -- Not sure if thinning and fire is an "or" -- thinning can be very useful as a restoration tool, to get the system back into "desired" structural characteristics before fire is applied. Thinning does not surrogate for all fire effects. {#204}

Re 203--Good point also. we don't have the "wiggle room" we used to...esp. when the strongholds are fewer and farther between. {#208}

Re:212 -- I think characterizing fire sizes on with time (maybe ecoregion by ecoregion or smaller scale) is a good research question in itself. {#223}

Re #199 - Good question and I definitely think that it is NOT all different than it was in the past. The fires today are NOT all bigger than they were in the past - nor is the fuel load higher everywhere. {#212}

#203 Work to restore connectivity and healthy stream "networks"; accepting major fires is not an option... {#213}

Question for historical fire could be quite simple regimes: How have fire regimes changed over time, and are these changes similar to those observed in associated upland ecosystems.. {#214}

Re 204...Absolutely right on ! both are useful and thinning cannot substitute for fire. {#215}

Flooding after fires is a common, but NOT ubiquitous, phenomena. Debris flows following fires are also much less common than we have been led to believe. Look for a paper by Sue Cannon (USGS- Golden), which should be appearing in GSA Bulletin soon; this paper demonstrates that the frequency of debris flows following fires in So. Calif, New Mex., and Colo. was surprisingly low. {#217}

Re 213--I think you are right. It's a tough situation for fish right now. {#219}

#214 - I disagree, strongly. {#221}

I worry about terms such as keystone pumpers and phraeatophytes as if there was some negative connotation of riparian vegetation. Actually, ecophys studies have found lower water usage by spp such as willows because this is a good adaptation to reduced soil conditions. {#222}

Re #217
I agree!!! and I don't think that fires have a greater role in the disturbance regimes in riparian areas than floods - simply a complementary one and a smaller one. {#224}

Re 224, etc. Fires don't transport river sediment and LWD, floods do. But fires set them up to be transported in a big way. It's widely recognized in geomorphology/hydrology that not all floods of equal magnitude (i.e. all 25 year floods) are equally effective. (For example, 1993 flood in the Mississippi R. transported very little sediment.) Is flood effectiveness influenced by fire sequencing? {#238}

#217: However frequency is not the whole story. 10% of the slides produce 90% of the debris volume. {#226}

I would suggest that often large fires create a post fire environment that tends to cause the conditions for severe storms to develop preferentially over burned areas increasing rainfall flooding. Difficult to research but lots of circumstantial evidence {#227}

Keystone pumpers refers to deep rooters that provide water for shallow rooters via hydraulic lift {#228}

Re #203: Important to identify short-term and long-term risks and differences between fringe populations that may be driven to local extinction by short-term impacts. But many areas do not fall into this category. More importantly, we lack the knowledge to accurately assess these differences, evaluate trade offs, and make informed decisions. The result will be some high risk, experimental land management policies and treatments, and only with failure will be learn... {#229}

Re:217 See also Swanson et al. 1981. Fred did a great job summarizing, conceptualizing... {#230}

#222 No negative connotation was intended by our group. Phreatophytes ought to be considered innocent until proven guilty. {#232}

On the point 7a of the presentation, this would be difficult to do unless you have some incredible weather history. If you use some model like farsite, and allow a fire to burn for some extended period of time, how ever account for the atmospheric conditions that allow for rapid fire growth, a tool like RERAP might help but lots of assumptions. {#233}

#220 - True. Only hope is that they can document what doesn't work without drowning themselves {#234}

#233 - Always problems, but it might be worth an attempt to see if it is useful.. {#235}

#233 I wondered about that too, seems like a huge project to do the full fire weather reconstruction even for a handful of fires..but perhaps if we did, and found some rules of thumb for a region, some general model rules could be developed. {#236}

The list of potential research needs is getting increasing long for all groups. It seems that ultimately one has to ask what is the question we are trying to solve--i.e., what is the objective of the research. And, what is the appropriate scale for doing experiments--e.g., small scale plot studies? stream reaches? or small subwatersheds? {#237}

Not aware of keystone pumpers in the scientific literature {#239}

Re#237 - Length of lists is directly proportional to the groups unwillingness to focus on the question we were presented {#240}

#227 Agree, have seen way more intense storm cells over black areas than you would expect by chance...there is an albedo effect or something at work..someone ought to do a probability analysis using permutation tests perhaps of observed post-fire high-intensity rainfall events. {#244}

#227 Research by Grant Meyer implies some correlation of debris-rich flood events w high-severity, large wildfire episodes in the Holocene record of Yellowstone NP. {#252}

#237 I agree with you ultimate question, but that was not the objective of this brainstorming effort. {#245}

#237 - Fire is a landscape phenomenon - maybe we should put more emphasis on landscape scale research... {#247}

Re:237 -- Again, scale required depends on the question. {#249}

#240 More research = less arm waving {#253)

VIIIc. Fire Scientists/Ecologists

I. Knowledge Gaps/Needed Research

A. Fire Behavior

Models –

How to predict fire behavior so it will be meaningful at the right scale

Are current duel models appropriate for riparian?

- No real validations for FARSITE
- FARSITE maybe wrong scale for fine scale riparian application
- Why don't models work - fuels? weather? topography?

Conditions under which riparian zones act to alter fire behavior Are there thresholds (or not)?

Large vs. smaller streams? Moderate vs. extreme fire weather?

Canvass fire management experts to Delphi the issue (as a beginning)

Evaluate fires across types/sizes/seasons where riparian zones were present.

Fire Severity- Behavioral Modeling now assumes independence of landscape elements (pixel, etc.) - makes severity tougher to estimate

Longer Term Response usually not measured

Make a FOFEM-type model that is more complex - include duration as well as flame length/scorch.

Effects of large scale "restoration" on riparian response (fire safe uplands affect hydrology and perhaps riparian vegetation directly? {#9}

6. Comments on Fire Scientists/Ecologists presentation

Using models for purposes outside of the scale and purpose for which they were developed is always dangerous.{#241}

Seriously, is there a way to validate or calibrate a fire behavior model? {#259}

259: Calibration (based on observations vs. predictions) are possible but have zero degrees of freedom and probably cannot be extrapolated {#278}

Re 259: A very good question, especially in comparison to #242 {#261}

Re 241--Maybe just misguided... {#243}

Would it be beneficial to have a subroutine or sub model in FARSITE that addresses riparian? {#248}

What is FOFEM? Are you suggesting developing a new model and abandoning FARSITE? Or are you suggesting some improvements in FARSITE to make it better at some of the applications that are appropriate for it? {#250}

Re: 250 FOFEM = First Order Fire Effects Model, comes out of Kevin Ryan's Fire Effect project out of the Fire Lab at Missoula -- the same folks that brought you FARSITE {#260}

Re 250--The latter...whatever works to address riparian. {#251}

Fire severity should definitely be more than just biomass consumption, even if this is the easiest variable to measure. {#254}

#254 Besides, difficult to reconstruct biomass consumed in post-fire reconsruction..in fact how can you measure this at all outside of a chamber in the lab? {#270}

Re. earlier comments by Agee, models are needed that include interactions among pixels. independent pixels isn't going to cut it {#258}

If the pixel size is greater than the driving variables, pixel analysis wont cut it either. {#262}

Longer term effects/monitoring gets into that gray area of monitoring vs. research, which both management and research disavow. But it is critical if we are to move off of short-term databases to longer term empirical databases. {#265}

FOFEM is a shot at predicting fire effects, farsite is an attempt to model fire spread.... {#267}

From everything that I've heard it seems like it would require a very sizeable effort to develop a fire behavior model that address riparian issues. Since the fire managers don't seem to have a need for that level of specificity, who would want to pay for such a model and what value would it have? {#273}

#273 A great question...often for ecological problems of this scale, empirical analysis & meta-analysis of case studies is more useful than models whose behaviors is driven largely by unmeasured and/or difficult-to-predict parameters. {#289}

Re: #259. The Joint Fire Science Program hopes to find out. There is a "rapid response" RFP soliciting proposals for research scientists to conduct research on active fires and "measure" some of the unvalidated outputs of fire behavior models. {#274}

Long term studies are needed concerning fire effects on vegetation, etc. on burned riparian areas and it is extremely difficult to maintain funding for remeasurement and maintaining plots. {#279}

Seems that a common theme throughout all the sessions is that some measure of riparian dimension (e.g., width of riparian zone, stream size, stream order) and fire severity (or intensity?) are primary variables around which we can begin to better understand the role of fire and riparian systems in forest and range landscapes. {#280}

Re: #250. The First Order Fire Effects Model (FOFEM) is an effects predictor. FARSITE is a behavior model. {#281}

Re #273 - We're here to figure out whether the fire managers might, in fact, want to have this level of specificity. {#282}

Re: #273 -- Maybe veg & wildlife managers might have a need? -- there are other forest management issues besides fire management {#285}

Re #285 - Good point!! {#286}

We need better understanding of the role of fire in riparian zones; more studies of fire history, fire behavior (perhaps the riparian zone has a different fire regime than the associated uplands) and response to fire.. As riparian vegetation is often disturbance-adapted (floods), the resilience of the zone following fire is likely greater than that of the upland. {#287}

Public land managers have to have an interest in this well-they are the ones that prioritize the budget and most of them aren't in fire. {#288}

#281 - These can be integrated take FARSITE on a pixel by pixel basis (e.g., flame length) and apply FOFEM to the tree list of that pixel. as a landscape plan tool it is powerful, but probably doesn't work as well as the pixel level. {#290}

We need a fire behavior model the models a backing fire {#291}

Remember that the criticisms of FARSITE are primarily because of scale. apply it to the proper scale and you have a powerful tool. {#292}

#279 - GASP! Another case where we cannot afford to get the data on the ground! But we'll have NRIS to store all the data we can't afford to get. {#293}

#285: The role of fire (and prescribed fire) on riparian ecosystems is an important research need. Probably much more so than the role of riparian areas on fire. {#294}

284. Agreed, I think you have an important point {#295}

Whoops I goofed. #295 meant to reference #294 {#297}

Re: #283. http://www.nifc.gov/joint_fire_sci/jointfiresci.html. Its RFP No. 2001-2. {#296}

Fire Management

Topic: What are some knowledge gaps/needed research on the relationships of riparian zones and fire in western forest landscape?

· Develop a Photo Series of riparian fuels.
· Explore the application of foams and retardants to protect and enhance riparian zones.
· A formal research review of EA's, EIS's, Burn Plans to see where prescribed burns have been planned where riparian zones where identified as potential control lines.
· Water consumption model, by channel types, to predict potential sites for a various fire suppression uses, in a Pre-Attack (Fire) planning tool.
· What are the effects or potential of diversions to suppression? 1. what were historic uses, 2. New diversions of water to future fire suppression efforts, 3. Has there been a net gain or loss on the suppression effort. What are the economic trade-offs of moving water where it needs to be?

· Fire history study to establish where the fire held or was controlled by a riparian zones, using GIS fire history over-lays, with riparian layers, by vegetation, elevation, stream type (class), wet year-dry year, and more….

· Climate and water supply issues to potential regional fire suppression issues. Length of the wet period, to the length of the fire season. The potential water availability for fire suppression in the future. {#10}

· What is a given aquifers susceptibility to drought, based on source: ground water source vs. snow melt to long-range drought.

· Develop a series of curves based on moisture, that could be used a tool "like a probability of ignition" that a given riparian zone would be effective in

changing fire behavior, to help in the decision process. (Using weather, fuels, topography, shading, wind reduction and riparian conditions at the time of the fire) {#11}

8. Comments on Fire Management presentation

In the Photo Series, what should be recorded as fuels? Live shrub biomass? 1000 hr loadings? Vertical continuity? Or just std. fuel transect data?
WFSA's on fire incidents should be added to the EA's EIS's, Burn plans. {#61}

What a great job-fire management rules {#22}

Really like your idea of the decadal scale of aquifer response to longer-time-scale climate patterns. Have heard from some of the people working at Coweeta Hydro Labs that see this kind of response. {#25}

There must be some type of decision process used (even if it is not formalized) to decide what type of fire-line to put on the landscape - i.e. to put in a hand-dug line or bring in a cat. This decision process could be transferred in part to whether a riparian zone would be successful in controlling the movement of a fire. {#26}

I like the idea of a fire history study. It should give us some valuable insight into how important or unimportant riparian areas have been. {#27}

Wow, what a great presentation! {#43}

These are the best ideas to come out of this 2-day workshop! {#42}

Clearly, the hydrologic and geomorphic controlling variables are the MOST important controls on the behavior of fires within the landscape. {#40}

We need to divert all fire and fuels monies into geomorphic/hydrologic research (then you would see the effects of diversion on fire behavior within western landscapes). {#39}

Maybe the rip zone that was foamed would have benefited from fire. Since most shrub species are fire adapted, I would hope that we eventually allow these areas to burn. {#29}

#29: That was my ultimate feeling. That was 11+ years ago and I need to go back and see that unit again. I suspect the rz is fine. {#45}

I agree that a series of curves built from empirical data on moisture would seem to be useful and straightforward to do. {#46}

Consider future climate warming impacts on water availability. It's coming.... {#47}

I agree that some regional generalizations may be possible re: aquifer behavior and drought, given a bit of empirical research and a good classification of the hydro setting involved (e.g.. glacial til pothole wetlands v. fluvial fringe wetlands...much different aquifer dynamics are involved; nevertheless regional coherence of behavior within these types is often apparent). {#48}

Great idea to study where fire held or was controlled by a riparian zone; this would certainly cut down on the "arm waving." {#49}

Would be useful for research on other groups topics too. {#60}

Might need some more fire history info to evaluate how different fire frequency was in various forest types/locations across the West. {#52}

#47 It's not just coming, it's here. {#51}

Photo series is a good idea--I wonder if there would be universal agreement on the number of types (photos) to be included? {#57}

Developing a set of moisture curves makes sense, but would probably be most useful if viewed in terms of the size of the riparian area as well as the other topographic/climatic variables. {#56}

Regarding your recommended "Fire History Study". I really like this idea. However, how would you encompass the historical effects of management on the current character of riparian systems in such a study? Would you propose some measure of riparian integrity (varying from fully functional to fully degraded and everything in-between) to help organize the historical data base? Would you approach the historical land use effects in a different way? {#55}

Start keeping track via transcripts of decisions made in fighting fire, specifically how riparian zones are factored into on the ground suppression activities and put transcripts into computer so that they are widely available for post-fire analysis. {#54}

Comment to #26-there is a decision point on whether to use handline or equipment. The least destructive methods is preferable. Line Officer direction sets the parameters. unfortunately while fed firefighters are finally getting their stuff in one sock about minimum impacts our cooperators like to run dozers all over the place. {#59}

Photos series are ok. Just think how much money we spend on photos in the agency and NO DATA IS COLLECTED TO BACK UP THE PHOTO! {#63}

Re 63: Yes!!!! {#66}

Although WE think riparian zones are important. fire managers may or may not, and will not spend $$$$ documenting how they use riparian.

Photos don't lie. {#65}

Re 65: They don't speak either (or at least they have a very limited vocabulary). {#68}

#65 Photographers do! {#67}

Actually photos do lie and quite successfully. They are essentially worthless without data to back them up. {#70}

I'll argue with numbers any day with someone who just has a photo! {#71}

In addition to stream size as a fire-break factor, there is stream density--i.e. smaller order streams are packed more densely across the landscape, giving fires less running space between them. Therefore mid-order streams may have an aggregate effect on fire characteristics their size alone won't indicate. {#72}

#72 good point about stream density {#74}

Re #65 Ground photos are great, but don't forget air photos are also very useful {#75}

I agree with #64. The focus and justification of keeping riparian areas because of their importance as a fire tool is misguided. {#76}

Re #76 I DISAGREE! We have historically used these areas and will continue to use them for fire mgmt. Our ability to ensure water in these systems is dependent on this claim, we won't get a right for aquatic or riparian resources by themselves, even though we think that is the most important use. {#84}

#59 I agree, tremendous improvement in federal agency firefighting awareness of avoiding resource impacts in last decade. {#77}

Some techniques have been developed to analyze veg cover in photos, to try and adjust for the effect of looking across the vegetation rather than directly down on it. It was published by some Australians and quantified against actual transect data -- so photo stuff can be quantified to some extent. {#78}

Numbers from/for the wrong variables are not better than photos {#79}

IX. Final Truths (Vote)

Voting Results

Agree/Disagree (5-Point) (Allow bypass)

Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

Number of ballot items: 7

Total number of voters (N): 27

Mean

4.58 1. While observations and intuitive knowledge would suggest that riparian zones are valuable for fire management and safety we lack much quantification to address many needed resource management needs.

4.38 2. Riparian areas influence fire behavior/fire properties. However, we also recognize that fire is one of the natural disturbances shaping riparian stream ecosystems this suggests a total fire exclusion policy in these areas is unwise and unnecessary.

4.23 3. Riparian zones and streams have some influence on the fire properties of forested landscapes

4.15 4. Riparian areas influence fire in the landscape where fuel moisture, loadings, composition and topography are different. This is true where fuels and microclimate may be strong controlling factors during fires. Under extreme weather events, fire behavior is largely influenced by weather variables.

4.08 5. The long terms effect of land management (exclusion, water diversions, etc) can affect the function of riparian zones on the landscape. Fuel loads, vegetation composition, geomorphology and hydrology can be affected such that fire intensity/behavior is much greater than historically occurred under a similar weather scenario (The Perry model)

4.00 6. Access to water sources is important in fire management activities (Rx fire and wildland fires). However, it is difficult to describe or generally state the value except that they are important for safety, containment, and mop up activities.

3.58 7. Riparian zones/streams in steep first order high elevation streams have little, if any influence on fire behavior because of few differences in the upland vs. riparian environment.

Number of Votes in Each Rating

	SA (5)	A (4)	N (3)	D (2)	SD (1)
1. While obs	15	11	0	0	0
2. Riparian	14	9	2	1	0
3. Riparian	10	14	1	0	1
4. Riparian	8	15	2	1	0
5. The long	9	10	7	0	0
6. Access to	6	15	4	1	0
7. Riparian	5	11	5	4	1

	Total	STD	n

1. While obs	119	0.50	26
2. Riparian	114	0.80	26
3. Riparian	110	0.86	26
4. Riparian	108	0.73	26
5. The long	106	0.80	26
6. Access to	104	0.75	26
7. Riparian	93	1.10	26

Ballot Items in Original Order

1. Riparian zones and streams have some influence on the fire properties of forested landscapes
2. Riparian zones/streams in steep first order high elevation streams have little, if any influence on fire behavior because of few differences in the upland vs. riparian environment.
3. Access to water sources is important in fire management activities (Rx fire and wildland fires). However, it is difficult to describe or generally state the value except that they are important for safety, containment, and mop up activities.
4. Riparian areas influence fire behavior/fire properties. However, we also recognize that fire is one of the natural disturbances shaping riparian stream ecosystems. This suggests a total fire exclusion policy in these areas is unwise and unnecessary.
5. Riparian areas influence fire in the landscape where fuel moisture, loadings, composition and topography are different. This is true where fuels and microclimate may be strong controlling factors during fires. Under extreme weather events, fire behavior is largely influenced by weather variables.
6. The long terms effect of land management (exclusion, water diversions, etc) can affect the function of riparian zones on the landscape. Fuel loads, vegetation composition, geomorphology and hydrology can be affected such that fire intensity/behavior is much greater than historically occurred under a similar weather scenario (The Perry model)
7. While observations and intuitive knowledge would suggest that riparian zones are valuable for fire management and safety we lack much quantification to address many needed resource management needs.

a. Final Comments on the Session

What did you think of this session/workshop?

Brought forth some very useful ideas & issues {#3}

Group Sessions approach was interesting. Have never done this before. {#5}

Great "brain dump" from great minds! Awesome dynamics.. {#6}

Boone did a very good job running the session. {#8}

I think that we identified some interesting questions and data needs... {#9}

I thought that this was a very interesting group to bring together with a great amount of knowledge in numerous disciplines. {#10}

I liked it. Although some parts could have been done/run a bit better, I liked the group system format. I think you got more from us and more useful material than in a standard workshop format. {#11}

I am getting better at my typing skills as a result. {#12}

Interesting. Would have been more productive if all members had had the handout before they came, but sometimes it's OK to spend time on side trips. {#14}

Great introductory session with some great minds and disciplines. However, we lacked the time to integrate, synthesize, and assess the relative merits of the research listings and hypothesis that were put before the group. {#15}

liked the combination of electronic submission of ideas with small group discussion & just a little large group discussion -- avoided dominance by 2-3 people of entire discussion as is typical of verbal session {#16}

Some advantages to the anonymous simultaneous nature of the exchange, but in my opinion this needs to be balanced by the need to build community and exchange views on a personal level. Less time at the terminal, more in breakout groups... {#17}

The key now is how this large hodge-podge will be assimilated into a coherent message. A big job! {#18}

I thought until the end there was a confusion between the strengths/interests of many of the participants, who were interested in riparian function, and the real objective of the workshop, which was to ferret out the strengths of the fire claim. Had we been more focused on the latter, we might have made better progress and not been so worried about "it depends" as much. {#19}

I appreciated the high caliber of folks that were involved and their efforts. Also liked the interdisciplinary nature of the workshop. Much remains to be done. Good job Boone and All! {#20}

Interesting blend of research scientists and fire managers. Need more of these. In retrospect, I think there should have been an introductory session on fire management so that we were all on the same wavelength. {#21}

Very stimulating. I learned so much from everyone. Thanks! to Boone and the Stream Team! {#22}

The format of the meeting was interesting although I am wondering what the report will look like after edits. {#24}

Learned a lot--would be interesting to follow up over the internet somehow {#25}

It was an interesting approach to collectively sucking information from a diverse group of folks. {#27}

The process is almost overwhelming in terms of trying the absorb the information generated. I think the real value will come when we get to see the synthesized results in the report. {#28}

Re 21: I agree. {#29}

I had some concerns about the computer process, but it did actually work ok. A bit more time in some of the small group sessions could have allowed some better development. I think it was a good approach for this type of information/brainstorming workshop. There was a lot of expertise and years of experience in the room. {#30}

I agree, more deliberate tactics for evaluation and coming to some sort of group agreement on summary statements (if possible) might have been useful. {#31}

I was impressed by the technology brought to bear. thank you, Ana for being so patient with us. {#32}

As I have experienced many times in my academic, technical and professional background in fire management I continue to see a need for more understanding of fire, it's behavior, and effects to the biota. In general, fire effects knowledge on specific resources is an area of need. {#34}

Re 34: yes, but this knowledge is best developed by scientists who study the system in collaboration with fire scientists, not fire scientists alone. {#57}

I thought it was a very valuable session. The real pay back will be if we get to see a final product in a timely manner. I would have liked to see more time available on the computer-moderated sessions. I mainly had time to put down some of my own ideas. Rarely could I read , consider and comment on the comments of others in the time available. {#35}

I really enjoyed the workshop. The anonymity of the comments really freed me up to write how I felt. The discussion help me organize my thoughts about potential researchable topics. {#36}

Re:35 Agree {#37}

Re 18 Boone's big JOB {#38}

I did get several ideas that will help me with regard to designing my research fire treatments. It was good to see a workshop where fire management, fire ecologists, and other disciplines were brought together. This does not happen enough. {#39}

I thought the format was unique and very good. The interactive computer system is fantastic, allowing all of us with our strong opinions (and heads) to talk at once, to get our ideas out and not to have the sessions dominated by a few people. Excellent. Really liked the small groups as well - it was great to interact with these other people who are working on the same questions that I am. It was great to work in an interdisciplinary session. Also, great to be able to simply work in a think-tank environment where no particular product was expected. This stimulated many ideas for me in where to direct some of my work and where my colleagues and I can start contributing to the fire ecology/management scene. {#40}

Once the information data for this workshop is complied, do a test drive of the conceptual models in a smaller working group setting that is more regionally focused to help refine the concepts and identify and short comings. {#41}

#33 Doesn't that depend? {#42}

I agree with 35. I am a slow reader and typist. Wish I were quicker, but I still did enjoy this and really got into the whole process! {#43}

Need more time to bring together topics, rather than leave it as a shotgun result {#44}

I'm looking forward to the report, but don't expect answers. Really all we can expect to accomplish at this point is to define some issues and needs. I think the workshop was probably very successful at that. {#45}

I suggest for a report title "Turning the stream into steam - the riparian fire connection" {#46}

Yes Anna....THANK YOU for your patience and expert skill in running this electronic show. Too bad Boone didn't ask you to help him with the coffee details. {#47}

The cross-disciplinary interactions were great. However, there wasn't sufficient time to really understand many of the presented perspectives. For example, the group may have my conclusion, but you really don't know why I feel that way. {#48}

I think we need to revisit the question of whether fire suppression should drive water rights issue from ethical perspective. {#49}

Thanks to the Stream Team for initiating the session, and Boone for facilitating it. I think this was a good start at identifying important issues, general conceptions about how these systems work, and major knowledge gaps. The chat-room experience was educational! I would like to see an abridged and abbreviated version of the outcome. {#50}

I found that the way the screen bounced around when new items was added was very distracting. Also, it would have been helpful if the comments would have appeared chronologically with their number given along the left margin. {#51}

Re 51: yes, there are some improvements needed in the software. {#65}

Although the computer input was novel and useful, the breakout groups were extremely critical in developing conceptual frameworks. Without the group work, the computer technology would have still been fun, but not nearly as enlightening. Let's face it, interaction makes the world go round... {#52}

This session is a decent model for other such sessions for discussion of fire effects. Use silent keyboards. {#53}

If some good research topics come out of this it will be successful and if researchers can get fire folks to assist in data collection observation this would be a success. {#56}

I learned a lot from this workshop and appreciate the opportunity to participate. The verbal and electronic discussions were excellent, and I have to believe the format of soliciting comments anonymously facilitated that. A very good group.

Thanks to Boone for providing the structure and organization, and thanks to Larry for providing the resources.

I particularly like the suggestion made at the very end that we could have been presented the same set of questions at the start and at the end to see whether opinion changed. {#58}

This type of venue has great potential. Right now, it is still rather primitive. With some advanced content and context analysis software, we could get some rapid summarization of the thoughts of the group. Now it is hard to assimilate the multiple threads. {#59}

Both frustrating and informative. I felt that we usually didn't get into the meat of the matters in our discussions, in part because of the short time available, and in part because of the media -- typing on these damn computers. But the computers did facilitate the "we can all talk at once" and allowed many voices to be heard.

For me, the break-out groups, presentations and subsequent discussion (both verbal and via keyboard) saved the meeting. One hour was enough to get into the issues and the groups were small enough to be functional. I also liked that groups were organized to be

both interdisciplinary and interdisciplinary. Finally, thank (Boone and others) for the prework that went on to organize the event. {#62}

Thanks to Anna {#63}

Thanks to Anna for patience and skill in facilitating this. {#64}

Great workshop. I liked the mix of electronic and small group discussions. Interdisciplinary mix was great. good job Boone! {#66}

I immensely benefited from interaction with the capable and thoughtful fire mgmt folks here..thanks! {#67}

I also really liked the idea of coming to a session to brainstorm and not be asked to produce a paper from it. Very productive and pleasant. {#68}

The down side is that we leave not knowing if we will have accomplished anything - a great data dump exercise, good luck Boone with the report, and thanks for the invite. {#69}

Ditto. Thanks to Anna {#70}

Feedback to the center--silent keyboards and stop the jumping of the screen as new comments are added. It is a real problem when you are trying to read the comments to respond. {#71}

Re 72: to figure out how to get the bucks... {#75}

I appreciated the opportunity to interact with experienced fire folks. Rarely get the opportunity. {#73}

APPENDICES

Participants To The Fire And Riparian Relationships Workshop
Tucson, AZ. March 13-15, 2001.

Name (in no particular order)	Phone	Email
Scott Vail- Forest FMO - El Dorado National Forest, Placerville, California	530-621-5225	svail@fs.fed.us
Wayne Minshall- Stream Ecology, Idaho State University, Pocatello, ID	208-282-2236	Minswayn@isu.edu
Steve Wondzell- Research Hydrologist-Ecologist, USFS, PNW Res Sta. Olympia, WA	360-753-7691	swondzell@fs.fed.us
Patricia McDowell, Geomorphologist, University of Oregon, Eugene	541-346-4567	PMCD@oregon.uoregon.edu
Boone Kauffman, Fire and Riparian Ecology, Oregon State University, Corvallis, OR	541-737-1625	boone.kauffman@orst.edu
Mike Lohrey, Hydrology and fire, USFS-R6, Portland Oregon	503-808-2902	mlohrey@fs.fed.us
Gene Rogers,Deputy Fire Staff Officer, Winema National Forest Klamath Falls, OR	541-883-6866	gdrogers@fs.fed.us
Chris Frissell - Stream Ecologist, Senior Scientist, Pacific Rivers Council, PMB 219 1 2nd Ave east Suite C, Polson, MT 59860	406-883-1503	hanfris@digisys.net
R. L. Beschta, Hydrologist, Oregon State University, Corvallis, OR	541-737-4292	beschta@for.orst.edu
Bernie Bahro, Fuels and Fire Specialist Sierra Nevada Framework, US Forest Service, CA	916-498-5376	bbahro@fs.fed.us
Jon Keeley - Fire and wetlands ecology, USGS,-BRD, CA	559-565-3170	jon_keeley@usgs.gov
Elaine Sutherland, Ecologist, - USFS-RMRS Missoula MT	706-542-4169	esutherland@fs.fed.us
Carol Hunsaker, Ecologist , PSW Research Station, Fresno, CA	359-323-3211	chunsaker@fs.fed.us
James K, Agee, Fire Ecology, University of	206-543-2688	jagee@u.washington.edu

Washington, Seattle, WA		
Gregg Riegel- Ecologist, USDA Forest Service Bend, OR	541-383-5423	Griegel@fs.fed.us
Elizabeth Crowe- Ecologist, USDA Forest Service Bend, OR		
Jeanne Chambers, Ecologist, USFS, Reno, NV	775-784-5329	jchambers@fs.fed.us
John Pitlick, Geomorphology, University of Colorado, Boulder	303- 492-5906	John.Pitlick@Colorado.edu
Bill Baker, Prof., Dept. of Geography University of Wyoming	307-766-3311	bakerwl@uwyo.edu;
Laurie Osterstock, Fire Supression, USFS, Albuquerque, NM	505-842-3254	losterstock@fs.fed.us
Phil Omi, Fire Science, Colorado State University	970-491-5819	philip.omi@colostate.edu
Dave Perry, Ecosystems Ecologist, Oregon State University (retired and in Hawaii)		perryd@bigisland.net
Ron Wakimoto, Fire Science, University of Montana, Missoula	406-243-6201	wakimoto@forestry.umt.edu
Robert Clark, Manager, Joint Fire Science Program NIFC	208-387-5349	Bob_Clark@nifc.blm.gov
Bob Ziemer, Geomorphology, US Forest Service, PSW Res Sta. Arcata, CA	707-822-3691	rziemer@fs.fed.us
Mary Manning, Ecologist, USDA Forest Service Regional Office, Missoula MT	406-329-3304	Mmanning@fs.fed.us
Bob Greswell- Fisheries ecologist, USGS-BRD (FRESC), Corvallis, OR	541-750-7410	gresswellr@fsl.orst.edu
Holly McLean , Attorney		
John Potyondy, USFS-RMRS, Stream Team, Ft Collins, CO	970-295-5986	jpotyondy@fs.fed.us
Larry Schmidt, USFS-RMRS, Stream Team, Ft Collins, CO	970-295-5984	lschmidt@fs.fed.us

AN INTRODUCTION TO THE ECOLOGY AND BEHAVIOR OF FIRE IN RIPARIAN ZONES AND ADJACENT LANDSCAPES: IMPLICATIONS OF INSTREAM FLOWS AND FIRE MANAGEMENT

For the workshop on The Multiple Influences of Riparian/Stream Ecosystems on Fires in Western Forest Landscapes

By
J Boone Kauffman
Department of Fisheries and Wildlife
Oregon State University
Corvallis, OR 97331

Presented To:

Rocky Mountain Forest and Range Experiment Station
Stream Systems Technology Center
Fort Collins, CO 80526-2098

It is well established that upland forest condition and structure influences riparian/stream ecosystems. Conversely, how do riparian/stream ecosystems affect uplands? We will explore this question through examination of how riparian/stream ecosystems affect wildland fires and wildland fire management; how land and water management influences riparian/stream ecosystem structure and how riparian/stream conditions affect fire suppression efforts?

Workshop Objectives:

Global Objective: Bring together specialists in stream/riparian ecology, fire science, hydrology, and fire suppression (25-30 participants from Federal Agencies and Universities) to describe the state of our knowledge on how riparian/ stream ecosystems affect wildland fire. What is the functional role of riparian/stream ecosystems as it affects fire on the landscape? What is the functional role of riparian/stream ecosystems as it affects fire suppression activities on the landscape.

The Ecology And Behavior Of Fire In Riparian Zones And Adjacent Landscapes: Implications Of Instream Flows And Fire Management- An Assessment Of The State Of The Science.

Natural riparian zones are some of the most diverse, dynamic, and complex ecosystems on Earth (Naiman and Décamps 1997, Kauffman et al. 2001). They are an interface between terrestrial and aquatic ecosystems. Riparian zones, like many interfaces, edges, or ecotones, possess relatively high degrees of resources, control energy and material flux, are sites of biological and physical interaction at the terrestrial/aquatic interface, maintain critical habitats for rare and threatened species, and are refuges and source areas for pests and predators (Naiman and Décamps 1997). Because of their unique properties, they may be sites of increased natural disturbances (floods) while simultaneously functioning as buffers or barriers to other natural disturbances (i.e, natural fire breaks on the landscape).

Riparian zones have been investigated from many perspectives, which has created a diverse and often confusing array of definitions based on hydrologic, topographic, edaphic, and vegetative criteria. For example, Kauffman and Krueger (1984) defined riparian zones as those assemblages of plant and animal communities whose presence can either be directly or indirectly attributed to factors that are stream induced or stream related. Naiman and Décamps (1997) stated that riparian zones encompass the stream channel between the high and low water marks and that portion of the terrestrial landscape from the high water mark towards uplands where vegetation may be influenced by elevated water tables, flooding, and the ability of the soils to hold water. These definitions describe the influences of hydrologic processes and the increased availability of moisture on the streamside or floodplain biota, but do not include the multiple functional roles that encompass how the terrestrial biota influences the geomorphology, hydrology, or stream processes (e.g., beavers, or vegetation and how they influence the channel morphology, biogeochemistry, or biotic composition of the aquatic ecosystem). Interactions between terrestrial and aquatic ecosystems include modifications of

microclimate (e.g., light, temperature, and humidity), alteration of nutrient inputs from hillslopes, contribution of organic matter to streams and floodplains, and retention of inputs (Gregory et al. 1991). These interactions create feed back responses to the entire landscape in that they influence landscape scale disturbances such as the intensity and spread of wild fires. From an ecosystem perspective, riparian zones are defined in terms of their multiple functional roles as the interface between aquatic and terrestrial environments. Therefore, *riparian zones* are defined as the 3-dimensional zones of direct physical and biotic interactions between terrestrial and aquatic ecosystems; boundaries of the riparian zone extend outward to the limits of flooding and upward into the canopy of streamside vegetation (Swanson et al. 1982; Gregory et al. 1991).

Among the features of the riparian zone that result in high biodiversity is its unique position on the landscape. Because riparian zones are at the lowest point in the landscape, gravitational forces contribute to the input of sediments and organic matter. This includes the mineral elements that form soils (both alluvium and colluvium ranging in size from clay particles to boulders) as well as organic matter (from bits of lichen to old-growth logs). These may be deposited at any time (i.e., objects rolling downhill), during storms (wind-throw, overland flow, etc.), or during extreme events such as landslides or debris flows, or storms occurring after fires. Just as the riparian zone affects the nature of fire in landscapes, fire affects the structure and function of riparian and aquatic systems. Sediment deposition on floodplains following fire may be a dominant process defining in the composition and structure of some montane riparian zones. For example, the presence of charcoal in floodplain sediments is ubiquitous throughout Blue Mountain riparian zones in Oregon.

Also related to topographic position is the microclimate of riparian zones, which results in the presence of unique habitats. This microclimate is related to the proximity of open water that influences temperature and relative humidity. In steep canyons, topographic shade can be important. Disturbances from high winds and the frequency of lightning are often lower in riparian zones compared to ridgelines. Because of the higher relative humidity and increased shade, fire-return intervals can be longer and fire severity can be lower in the riparian zone. Also, these areas may be cold air drainages during the winter.

The distribution and composition of riparian plant and animal communities reflect histories of both fluvial disturbance from floods and nonfluvial disturbances originating from adjacent upland areas. These disturbances include fire, wind, plant disease, and insect outbreaks. The frequency, timing, and magnitude of the disturbances influence the structure and composition of the biotic community. Floods following fires may result in both the erosion of established floodplains as well as the deposition of varied substrates (and large wood) where succession or stand establishment begins anew. These events have create complex patterns of soil morphology, and groundwater dynamics that influence riparian plant and animal communities (Gregory et al. 1991, Otting 1998, Dwire 2001).

Fire History of Riparian zones

Numerous studies document the tendency for riparian forests or other low-lying wet areas to burn less frequently and with lower severity than upland forests. Fire history studies have concluded that both the frequency and severity of wildfires are lower in riparian zones than adjacent uplands (Morrison and Swanson, Teensma 1987, Weisberg 1998). Differences in fire severity can also be observed in the composition of riparian zones in forested landscapes. For example, in unconstrained reaches of western Oregon, riparian areas may have a greater abundance of western red cedar *(Thuja plicata*- not fire resistant) while uplands are dominated by Douglas-fir (*Pseudotsuga menziesii* - fire resistant). Differences in fire severity and frequency are likely due to a number of climatic and topographic phenomena. One reason involves a basic principle of fire science: fire burns more rapidly uphill than downhill. Therefore, uphill locations are more likely to burn than downhill locations assuming a random distribution of ignition sources (Weisberg 1998). Another mechanism is the tendency for riparian zones and their associated streams or rivers to serve as firebreaks. Riparian areas often contain a relatively large component of hardwoods with lower flammability than coniferous species. The topographic position of riparian zones means less sunlight will strike them, temperatures stay cooler longer, and relative humidity remains higher than upslope areas during much of the fire season.

Linkages Between Riparian/stream Flow Management, Wildland Fires and Fire Suppression Activities.

Riparian zones are focal points of wildland fire suppression activities for a number of logical reasons (Lohrey 1999). Among the most obvious is the presence of available surface water that can be used in suppression activities. In addition, as fuels in riparian zones of forested landscapes are often higher in moisture content and may remain above the moisture content of extinction longer than uplands. Fuels loads (biomass) may also be lower in riparian zones. In unconstrained reaches, the composition of riparian zones may be dominated by herbaceous plants (meadows). These all may combine such that the riparian zone and the channel functions as a fuel/fire break. Wetland meadows and large openings within riparian areas (gravel bars) may serve as safety areas (escape zones) which are necessary for firefighter safety. Riparian zones are also areas where backfires are ignited during wildfire suppression. This is because of their location (bottom of the slope) often-level topography, and accessibility.

The presence of water greatly facilitates efficient fire suppression activities. The effectiveness of fire suppression can be influenced by the presence of deep pools. It could be hypothesized that land use activities that diminish pools would indirectly increase the probability of deleterious wildfires in the surrounding landscape. Included in factors contributing to pool loss are diversions which may eliminate channel/pool forming flows. Similarly it can be hypothesized that land management activities resulting in riparian degradation predispose a forest landscape to increased levels of fire severity. This would occur in areas with channel degradation (incision or widening) or in areas where waters have been diverted. These influences would decrease riparian zone width, result in a drier microclimate, and create a more xeric vegetation composition.

Channel degradation and/or diversions can result in riparian vegetation replacement from that of riparian/wetland obligates to upland species. While these complex linkages between forest landscapes, wildfire, riparian/channel characteristics, and land/water use are tenable, they have not been studied. To begin to explore these linkages, a workshop with the participation of an interdisciplinary group scientists and fire suppression specialists is needed. Goals of the workshop include describing the state of the knowledge of these linkages in western forest landscapes.

Goals and Description of the Workshop

A workshop geared to elucidate the issues associated with the complex interactions of riparian zones, wildfires, and resource protection/management is needed. This workshop will be unique in that for the first time leaders in the diverse fields of riparian ecology, hydrology, geomorphology, fire science, and fire suppression will be assembled. The goals of the workshop are: (1) discuss what we know of the relationships of fire and riparian zones from spatial scales of the riparian area to the landscape; (2) discuss the role and values of riparian areas in fire suppression activities; (3) discuss the effects of land and water management on the fire regime of riparian zones; (4) discuss the effects of land and water management on the efficiency and capability of wildland fire suppression; and (5) identify knowledge gaps and needed research on these subjects.
The workshop will largely focus on forests with a low severity fire regime (sensu Agee 1989). Low severity fire regimes are those landscapes where fire return intervals are frequent (2-35 years), the fire intensity is usually low (an understory or surface fire) and the ecological severity is usually low (most vegetation species survive via mechanisms of thick bark, sprouting or seed survival). In the western USA, this type of fire regime is largely dominated by low and mid-elevation conifer forests dominated by ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), western larch (*Larix occidentalis*), Douglas-fir (*Pseudotsuga menziesii*), and redwoods (*Sequoia sempervirens*). While the focus of the workshop will center upon on landscapes within this fire regime, it is understood that there is much relevant information from other fire regimes (i.e., moderate and high severity fire regimes such as northwestern Douglas-fir forests or Intermountain subalpine forests). Therefore, discussions and conclusions should be relevant for a large areas of forested landscapes in the western USA.

Since Euro-American settlement, forests with a low severity fire regime have undergone profound changes due to land use activities. These land use activities include logging, road building, livestock grazing, and fire suppression. Within the riparian zones of these landscapes, the same land uses have affected the composition, structure, and function of riparian zones. In addition, the effects of water withdrawals for irrigation and municipal uses have greatly affected riparian/aquatic ecosystems. As hydrology/water tables affect the riparian biota, both physically and chemically, alterations due to withdrawals can have dramatic consequences. If land uses result in a drier riparian environment, then their function as a natural fire breaks will be diminished. This could affect the fire behavior and the ultimate size of the area burned (i.e., fuels are continuous where natural breaks

once existed). In addition, with less surface water available, fire suppression activities would also be compromised.

Literature cited

Agee, James, K. 1993. Fire ecology of Pacific Northwest Forests Island Press. Washington DC.

Dwire, K. 2001. Connectivity of riparian meadows and low-order streams in the Blue Mountains, Oregon: interactions among hydrology, soil, and vegetation. Ph.D. Dissertation. Oregon State University, Corvallis, Oregon, USA.

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41: 540B550.

Kauffman, J. B., and W. C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications: a review. Journal of Range Management 37:430-437.

Kauffman, J.B. M. Mahrt, L. Mahrt, and D. Edge. 2001. Riparian wildlife communities and habitats. In: Wildlife Habitats and Species Associations in Oregon and Washington: Building a Common Understanding for Management. Oregon State University Press.

Lohrey, M. H. 1999. Affidavit on Organic Act Fire Claims. 18 August 1999. Unpublished. 8p.

Morrison, P, and F. J. Swanson 1990. Fire history and pattern in a Cascade Range landscape. USDA Forest Serve General Technical Report PNW-GTR-254.

Naiman, R. J. and H. Décamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics 28:621-658.

Otting, N. J. 1999. Ecological characteristics of montane floodplain plant communities in the upper Grande Ronde Basin, Oregon. MS Thesis, Oregon State University, Corvallis, Oregon, USA.

Swanson, F. J., S. V. Gregory, J. R. Sedell, and A.G. Campbell. 1982. Land-water interactions: the riparian zone. Pages 267-291 *in* Edmonds, R.L. editor. Analysis of coniferous forest ecosystems in the western United States. US/IBP Synthesis Series 14. Hutchinson Ross Publishing, Stroudsburg, Pennsylvania, USA.

Teensma, P.D.A. 1987. Fire history and fire regimes of the central western Cascades of Oregon. Ph.D. Dissertation University of Oregon, Eugene, OR.

Weisberg, P.J. 1998. Fire history, fire regimes and development of forest structure in the central western Cascades. Ph.D. Dissertation. Oregon State University, Corvallis, OR.