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Post-Wildfire (Salvage) Logging – the Controversy

NCSR Fire Ecology and Management Series

Northwest Center for Sustainable Resources (NCSR)
Chemeketa Community College, Salem, Oregon
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Fire Ecology and Management Series

This six-module series is designed to address both the general role of fire in ecosystems as well as specific wildfire management issues in forest ecosystems. The series includes the following modules:

- Ecological Role of Fire
- Historical Fire Regimes and their Application to Forest Management
- Anatomy of a Wildfire - the B&B Complex Fires
- Pre-Fire Intervention - Thinning and Prescribed Burning
- Post-Wildfire (Salvage) Logging – the Controversy
- An Evaluation of Media Coverage of Wildfire Issues

The *Ecological Role of Fire* introduces the role of wildfire to students in a broad range of disciplines. This introductory module forms the foundation for the next four modules in the series, each of which addresses a different aspect of wildfire management. *An Evaluation of Media Coverage of Wildfire Issues* is an adaptation of a previous NCSR module designed to provide students with the skills to objectively evaluate articles about wildfire-related issues. It can be used as a stand-alone module in a variety of natural resource offerings.

Please feel free to comment or provide input.

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NCSR curriculum modules are designed as comprehensive instructions for students and supporting materials for faculty. The student instructions are designed to facilitate adaptation in a variety of settings. In addition to the instructional materials for students, the modules contain separate supporting information in the "Notes to Instructors" section. The modules also contain other sections which contain additional supporting information such as a “Glossary” and “Suggested Resources.”

Acknowledgements

We thank Steve Resh of Allegany College of Maryland in Cumberland, Maryland, and Harry Hutchins of Itasca Community College in Grand Rapids, Minnesota, and Rick O’Hara of Chemeketa Community College in Salem, Oregon for their thoughtful reviews. Their comments and suggestions greatly improved the quality of this module.

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Post-Wildfire (Salvage) Logging – the Controversy – Module Description

This module is the fifth in the *Fire Ecology and Management Series*. The question of whether or not to remove trees after a wildfire is among the most contentious issues related to wildfire management. This lecture-based module examines our current state of knowledge on post-fire salvage logging and restoration. A *PowerPoint* presentation describes the arguments in support of, and those in opposition to, salvage logging. These arguments are then evaluated in the context of findings from recent scientific investigations. This research challenges some long-held beliefs regarding the benefits of salvage logging as a tool of post-fire management. Students are asked to develop their own views on this complex issue.

Post-Wildfire (Salvage) Logging – the Controversy

Introduction

In this lecture-based module, issues associated with post-fire management are presented. The module is based on a series of *PowerPoint* slides paired with a textual outline of the major points. Detailed supplementary lecture notes for use by the instructor are included in the notes section for each slide. Citations of relevant print and web-based resources are also provided for the instructor as background, supplemental use in the classroom and for additional research. Several are appropriate to assign as student reading.

The module is most appropriate for use in courses such as *Fire Ecology*, *Wildfire Management*, *Forest Management*, *Environmental Science* and *Introduction to Natural Resources*. Instructors in *General Biology* courses may also be interested in selecting the salvage logging debate as a special topic in the ecology section of the course.

Objectives

Upon completion of this module students should be able to:

1. Define salvage logging
2. Describe the arguments of supporters and detractors of salvage logging
3. Analyze data from scientific studies that examine the effects of salvage logging
4. Discuss the long-term goals of wildfire management and how they might be achieved

Procedure

The accompanying *PowerPoint* presentation should be delivered to students at an appropriate time in the course. Alternatively, the presentation could be made available to students on-line, where they could review the material on their own. Some background on fire behavior, fire history, fire effects is assumed (see NCSR modules, *Ecological Role of Fire* and *Anatomy of a Wildfire*).

Additional text or titles may be added to the *PowerPoint* slides to match your particular instructional style.

Assessment

Student learning of the material in this module is probably best assessed with essay or short answer questions on an exam. The module also presents an opportunity for students to evaluate graphical presentations of data that are relevant to post-fire management.

Consider the following:

1. Discuss the main arguments used in favor of and, in opposition to, the practice of salvage logging.

2. Describe the experimental design of studies that have been conducted to evaluate the impacts of salvage logging.

3. What factors should be taken into account before the decision is made to implement salvage logging after a fire?

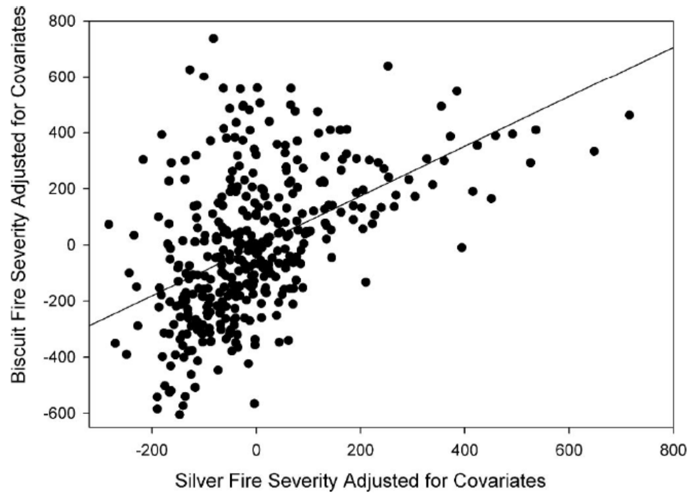
4. Cite specific findings from recent studies to evaluate one of the following hypotheses:

    a. Post-fire logging reduces future fire risk.
    b. Post-fire management is required to restore forests after a severe wildfire.

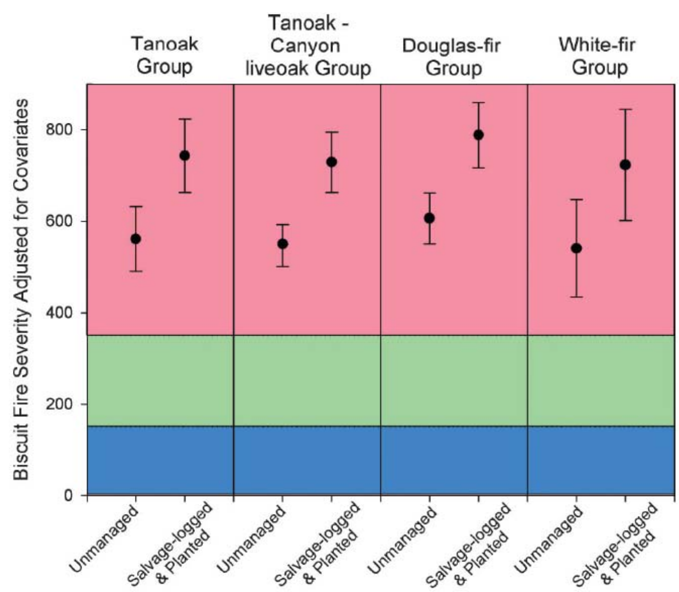
5. Describe your views on the salvage logging issue. Under what conditions would you support the practice?

6. How would you describe the ultimate long-term goals of wildfire management? What management interventions are required to achieve those goals?

7. The following two graphs were published in a recent article that appeared in the Proceedings of the National Academy of Science. For each graph describe:
   a. your evaluation of the trends illustrated in the graph
   b. the importance of these trends as they relate to the issue of post-salvage logging



Data points represent localities where fire severity was assessed in the 1987 Silver Fire (x-axis) and the 2002 Biscuit Fire (y-axis).



The material also lends itself to class discussion centered around some of the issues raised in the presentation. The discussion may be structured in a number of ways – here are two suggestions:

1. Assign one or more of the articles cited in the "Resources" section of the module, present the accompanying *PowerPoint* presentation and then direct an informal discussion around some of the questions above. The following articles are good selections to assign as student reading:

Donato, D.C., et al. 2006. Post-wildfire logging hinders regeneration and increases fire risk. Science 311:352.

DellaSala, D.A., et al. 2006. The facts and myths of post-fire management: a case study of the Biscuit Fire, southwest Oregon. Unpublished report. World Wildlife Fund, Klamath-Siskiyou Program, 116 Lithia Way, Ashland Oregon.

Noss, R.F., J.F. Franklin, et al. 2006. Managing fire-prone forests in the western United States. Front. Ecol. Environ 4(9):481-487.

Sessions, J., et al. 2004. Hastening the return of complex forests following fire: The consequences of delay. Journal of Forestry 102(3):38-45.

USDA Forest Service. 2007. Managing forests after fire. Pacific Northwest Research Station. PNW Science Update 15:1-11.

2. A more structured discussion may be developed using the town meeting approach described in the NCSR module, *Klamath Basin Irrigation: A Town Meeting.* Students select a stakeholder position to represent at a staged town meeting moderated by the instructor. For the salvage logging issue, stakeholders would include public land managers, timber interests, environmental groups, local politicians and researchers.

General Lecture Outline

I. Introduction
- Management concerns after a fire
- Definition of salvage logging
- Economics of salvage logging

II. Salvage logging - the controversy
- Arguments in support of salvage logging
- Arguments in opposition to salvage logging

III. Science informs the debate
- Salvage logging and conifer regeneration
- Salvage logging and the risk of future fires

IV. What have we learned?
- Impacts are complex and site-specific
- Science informing the debate is incomplete
- Salvage logging and reforestation
- Salvage logging and ecological restoration
- Salvage logging and future fire risk

V. The future of wildfire management
- Long-term management goals
- Recommendations for ecological restoration

See notes on *PowerPoint* slides for detailed lecture notes for *Post-Wildfire (Salvage) Logging – the Controversy* presentation.

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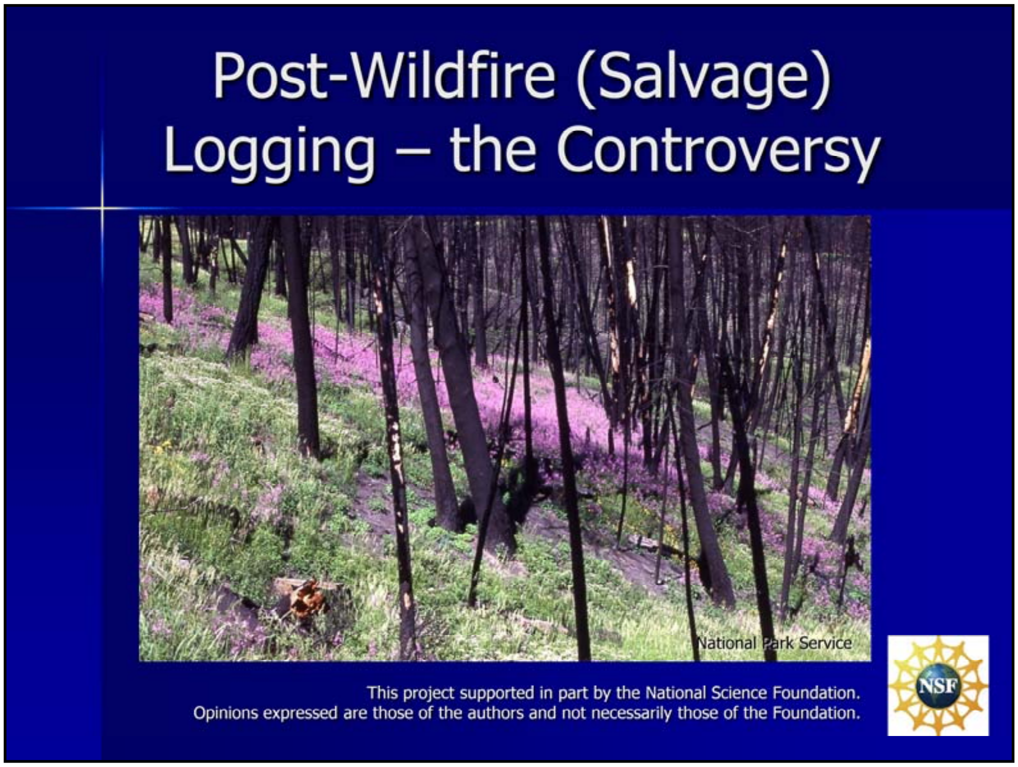
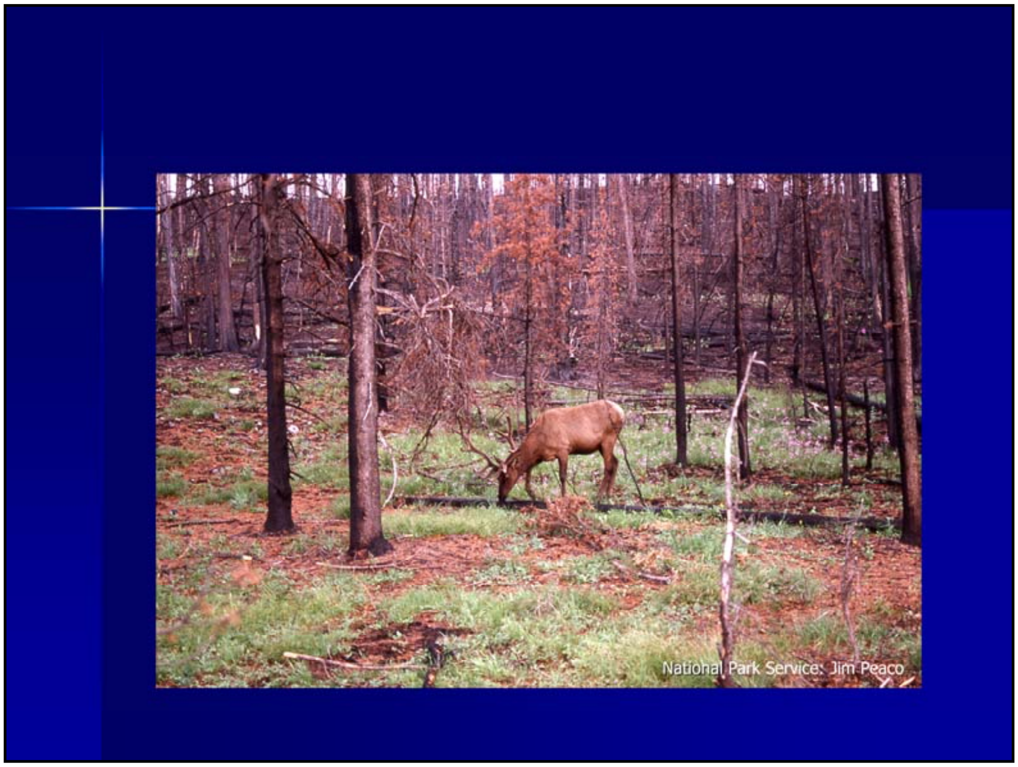
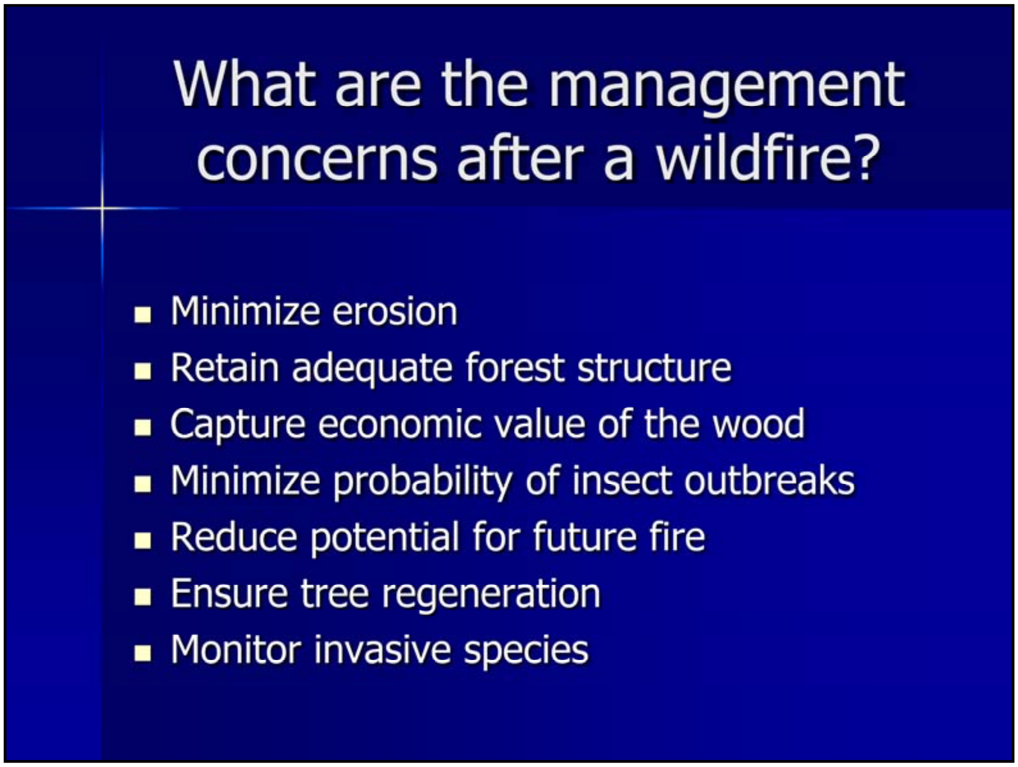
PowerPoint Slides with Instructor's Notes



This module examines the controversial issue of salvage logging after a major wildfire. Post-fire logging, its intended outcomes, and arguments in favor of the practice are described. Competing arguments are also presented as well as the results of recent scientific studies that evaluate these arguments.



Large wildfires are increasingly common in the western United States. Global climate change in combination with decades of fire suppression in fire-prone forests suggest that this is a trend that will continue for some time. The management of areas that have experienced a major fire, therefore is of great concern to land managers. Post-fire logging of fire killed trees has been a common practice for decades. Few issues in forestry have been as contentious as salvage logging after a wildfire. Although forests that have experienced wildfires are commonly considered “devastated” or at least “damaged”, this view is being challenged by new scientific studies. In most forest types, wildfires serve important roles such as reducing stand density, increasing biological diversity and increasing soil nutrients (see NCSR module *Ecological Role of Fire* for details).



What are the management concerns after a fire?

Once public health and safety concerns such as re-opening roads and removing hazardous trees are addressed, forest managers on public lands turn their attention to the following:

1. Minimize erosion and its effects on aquatic ecosystems (especially the flow of sediment into streams and its effects on aquatic organisms)
2. Retain adequate forest structure (snags, logs and remnant trees for wildlife species that require these structures as essential habitat components, such as cavity nesting birds and some amphibians)
3. Capture economic value of the wood before significant decomposition diminishes its value. Logs lose approximately 20% of their economic value per year
4. Minimize probability of insect outbreaks among fire-stressed trees (bark beetles and wood borers may attack fire damaged trees)
5. Reduce potential for future fire (i.e., a severe re-burn)
6. Ensure tree regeneration
7. Reduce establishment of/monitor invasive species

What role does post-fire logging (salvage logging) play in addressing these concerns?

Photo – Landing used for a salvage logging operation near McClure British Columbia, Canada, north of Kamloops

First - What is salvage logging? Salvage logging is the removal of trees from a forested area after a disturbance, such as wildfire, windthrow or insect outbreak. Depending on the specifics of the timber sale, salvage logging may remove both live and dead trees (as seen here) or dead trees only. Logging may be complete (as seen in this photo) or partial, leaving some remnant trees behind. Generally, salvage logging is followed by replanting of conifer seedlings to re-establish the stand.

Source: Ministry of Forests and Range (British Columbia, Canada) , posted at: Botany Photo of the Day 12 March 2008 Post-fire Management of Forests

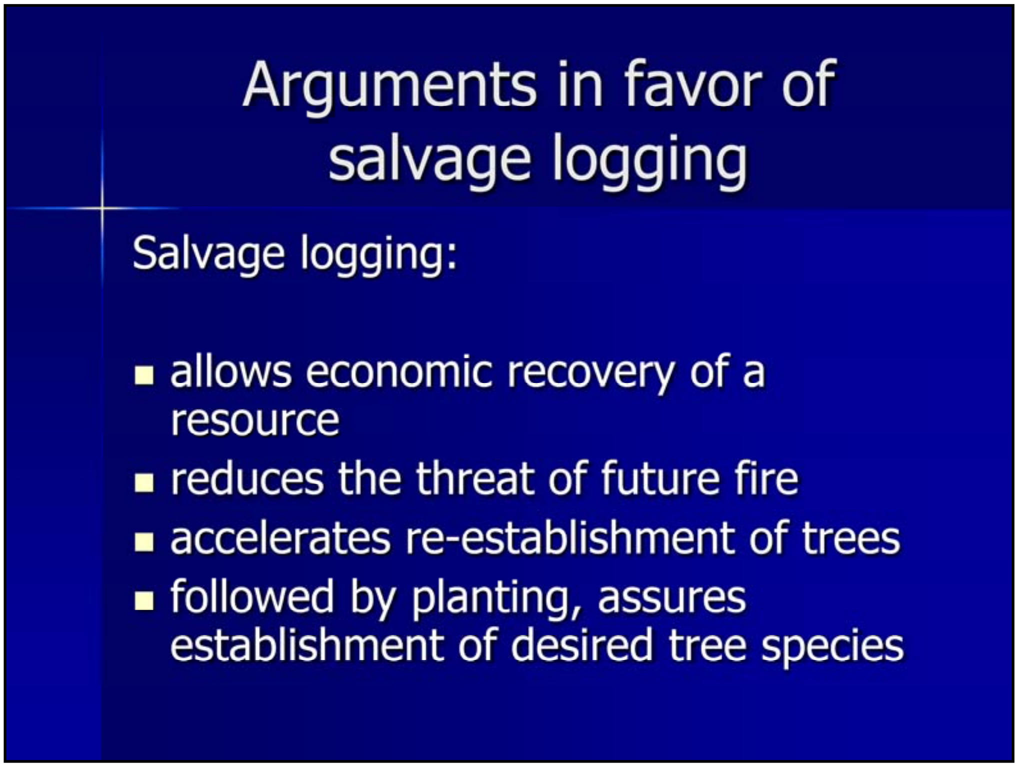
Wildfires do not ordinarily consume all vegetation within the burned area. Trees that are killed by fire, but otherwise remain essentially intact, retain much of their economic value. Although the outer bark may be scorched or charred, fire-killed trees can be harvested and milled just like live trees. However, time is of the essence. Once a tree is killed by fire, insects, fungi and bacteria enter the log and begin the process of decomposition. At some point, the economic value of the log declines to the point where it no longer makes sense to harvest. The sapwood immediately under the bark decomposes most rapidly due to its lower density and higher moisture content, while the heartwood takes longer (see NCSR module *Log Decomposition Laboratory* in *Environmental Science I* for a detailed explanation of the process of log decomposition).

The Ponderosa pine log shown here shows evidence of significant fungal growth (dark stain seen in sapwood) and beetle larvae activity (dark linear features seen in sapwood are beetle larvae galleries) one year post-fire. The log's economic value for finished products such as window sills and door frames is reduced.

Photo credit: Eini Lowell, USDA Forest Service Pacific Northwest Research Station Science Update Issue 15

The rate of deterioration following fire varies with species and environmental conditions. However, the highest value timber is obtained within the first year following fire. From 3 to 5 years after the fire, most value is gone. For the tree species and sizes killed by the Biscuit Fire (SW Oregon, 2002), for example, timber volume declines by approximately 20% per year.

Delays in salvage logging obviously have economic consequences. On public lands, salvage logging requires extensive environmental analysis and documentation to implement. Administrative appeals and litigation can delay the process as the economic value of the logs declines.

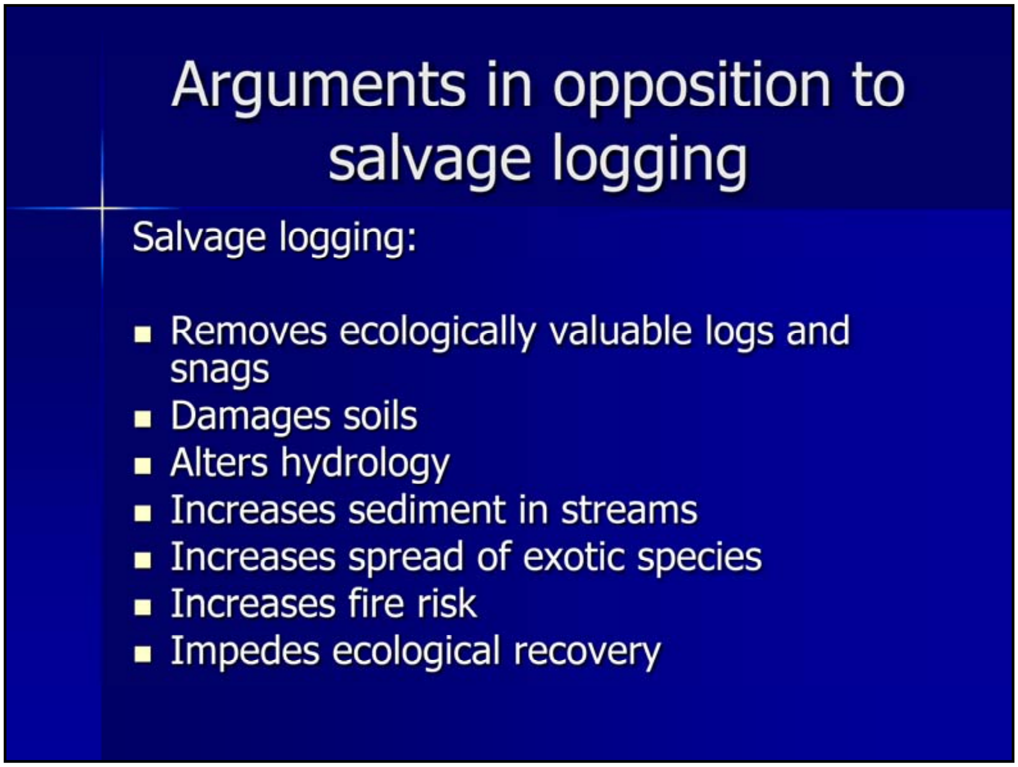


Post-fire management is a controversial topic. Much like pre-fire thinning, it is often justified on the basis of restoring "forest health." Salvage logging has been used for decades and the following arguments are often used in support of the practice:

•Salvage logging allows economic recovery of a resource. The decision not to salvage log is seen by some as wasteful. Also, revenue generated by salvage logging can be used to support other rehabilitation activities such as replanting.

•Salvage logging reduces the threat of future fire. The thinking here is that removal of dead or dying trees removes fuel that will feed a future fire; also, that replanting conifers will hasten the return of fire resistant forests.

•Salvage accelerates the re-establishment of trees. By removing residual trees dead or alive from the previous ecosystem, one can start with a clean slate for planting seedlings (often of a single, high value species such as Douglas-fir). For some forests, natural regeneration tends to be more haphazard and results in a stand with a variety of species – some "desired," some not.



The negative impacts of post-fire salvage logging have been examined by a number of authors (see module for sources). The arguments generally fall into the following categories:

•Removes ecologically valuable logs and snags – large snags and logs are important habitat components in both terrestrial and aquatic environments (e.g., nest sites for cavity-nesting birds, roosts for bats)

•Damage to soil – salvage logging damages soil by compaction, removal of organic material and by increasing topsoil erosion and runoff. Effects are especially severe when ground-based logging equipment is used.

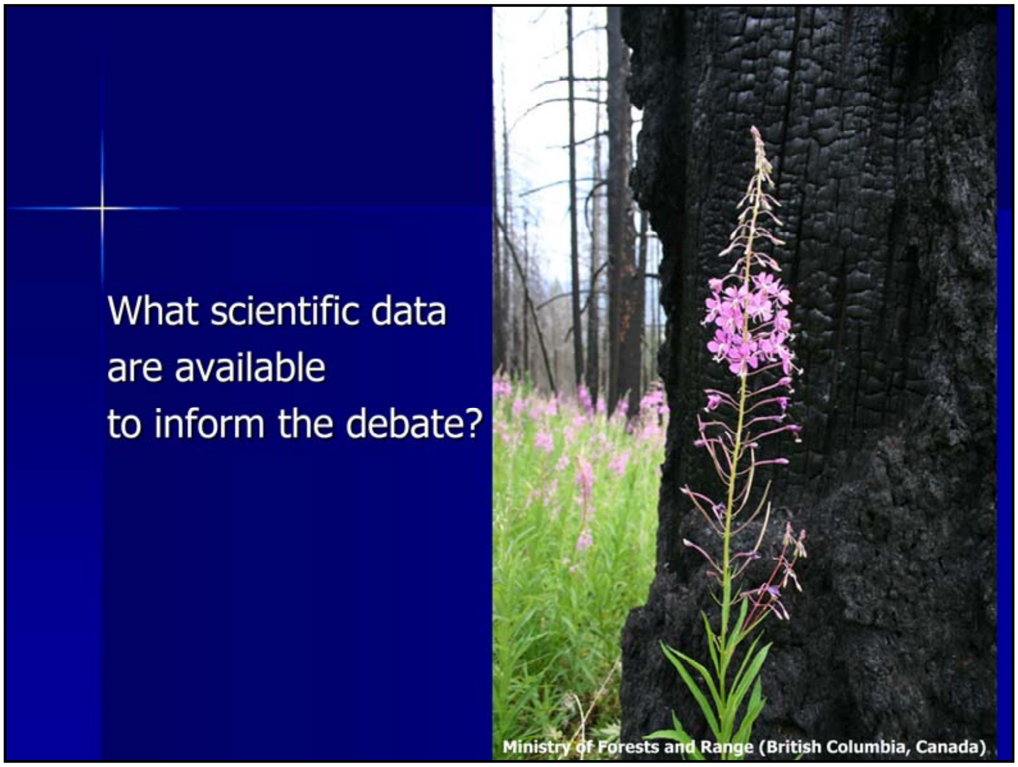
•Alters hydrology by increasing the frequency and magnitude of high flows

•Increases sediment loads in streams (increased turbidity), which is particularly harmful to aquatic organisms

•Increases spread of exotic species – anecdotal evidence that new road building and the movement of logging equipment brings seeds of exotic plants into a recently disturbed site (often ideal conditions for establishment of potentially invasive species). This requires further research.

•Increases severity of future fires – Although also claimed as a reason <u>for</u> salvage logging, increased surface fuels resulting from a logging operation may actually <u>increase</u> the risk of fire.

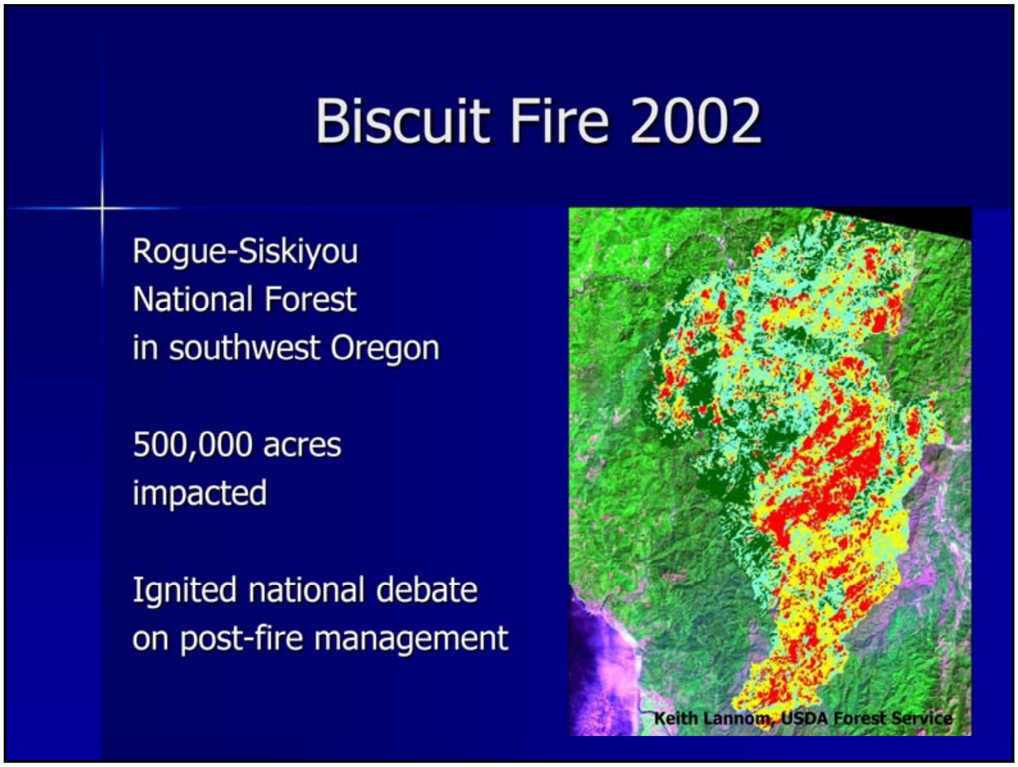
•Impedes ecological recovery – damages surviving trees and other vegetation, removes an important source of moisture in large logs and snags and affects microclimate by removing shade provided by remnant trees, large logs and snags



Given the opposing viewpoints seen in the previous slides, what scientific evidence do we have that informs the debate?

Fireweed (*Epilobium angustifolium*) after a fire in a Douglas-fir forest in British Columbia (McGillvray Fire, north of Chase, BC). Fireweed has deep rhizomes that sprout after a fire. It is a nitrogen-fixer and produces large numbers of wind-dispersed seeds that quickly occupy recently disturbed areas. It can grow at such high densities that regeneration of trees is impeded.

Source: Ministry of Forests and Range (British Columbia, Canada) , posted at: Botany Photo of the Day 12 March 2008 Post-fire Management of Forests

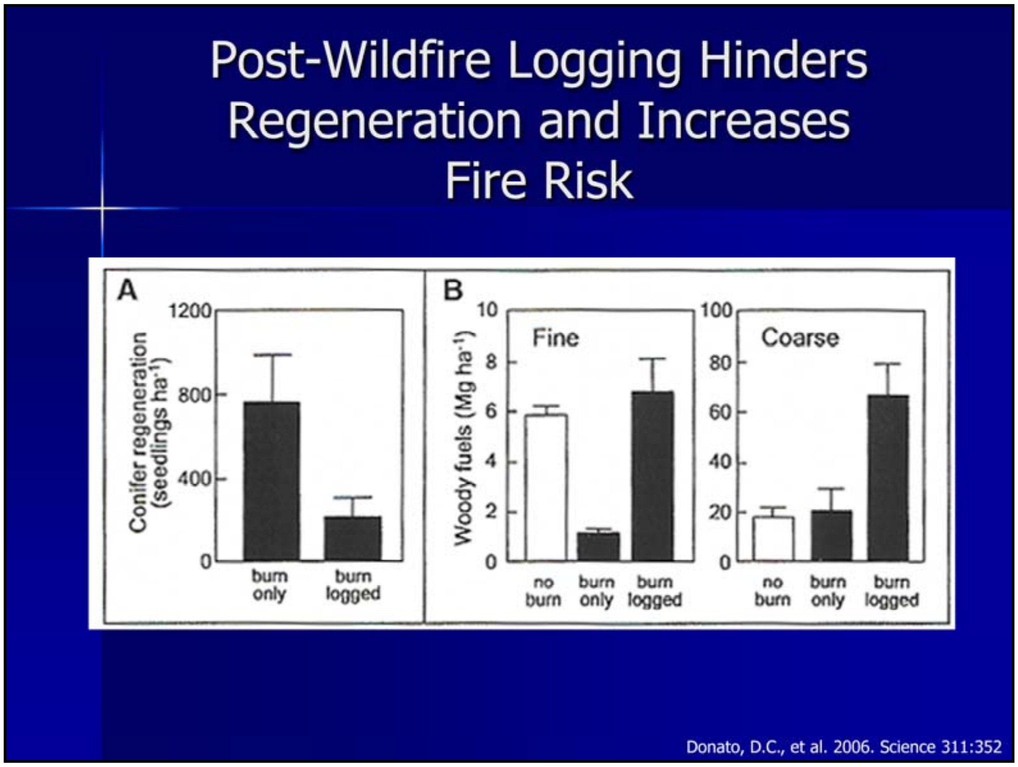


The Biscuit Fire in 2002 was one of the largest forest fires in modern U.S. history (nearly 500,000 acres). Most of the fire burned on forest managed by the Forest Service near the Oregon-California border. After the fire, proposals to engage in post-fire logging ignited a national debate concerning the practice. The debate continues today and is taking place in the absence of much scientific data that the practice enhances forest recovery or reduces the severity of future fires.

The map shown here indicates the burn severity for the Biscuit Fire. Green areas were not burned, blue areas burned with low severity, yellow areas with moderate severity and red areas with high severity.

Three key studies of the Biscuit Fire out of Oregon State University have shed some light on these relationships.

Source: Keith Lannom, Remote Sensing Applications Center, USDA Forest Service



See Notes Slide 10

Notes Slide 10

The view that post-fire logging reduces the risk of future fire and that forests will not regenerate after fire without intervention are two of the most commonly cited reasons for engaging in the practice. A 2006 study of the Biscuit Fire published in *Science* by a graduate student at Oregon State University challenged these two widely held beliefs.

Methods – Five study sites that had burned at high severity (>95% overstory tree mortality) in 2002 were sampled before (2004) and after (2005) salvage logging. The sites represented a broad range of biophysical conditions in mixed conifer forests. The number of conifer seedlings and the abundance of downed wood were sampled using systematically-placed transects.

Results (See figure above from original article):
Figure A – Natural conifer regeneration
Regeneration on sites that were not salvage logged ("burn only") was variable but generally abundant (averaged 310 seedlings per acre = 767 seedlings per hectare). Most were Douglas-fir. Density exceeds regional standards for fully stocked sites, suggesting that reforestation efforts may be unnecessary.

Post-fire logging significantly reduced seedling densities by 71% (to 91 seedlings per acre = 224 seedlings per ha). Reduction was thought to be due to soil disturbance and burial of seedlings by woody material during logging operations.
Therefore, if salvage logging is being done in part to accelerate reforestation, it seems to be counterproductive (according to these data).

Figure B – Both fine and course fuel loads on the forest floor were significantly increased by post-fire logging. The presence of these fuels increases short-term risk of re-burn. Subsequent fuel reduction treatments would be required to reduce this risk. The authors suggest that the lowest fire risk strategy would be to leave dead trees standing as long as possible where they are less available to low intensity flames.
An interesting audio account of this study and the controversy it caused can be accessed online at www.npr.org (*All Things Considered* – archives):

1. 5 January 2006 Study: Salvage logging boasts fire threat (4 min. 32 sec.)
2. 12 February 2006 Grad students in center of forest culling fracas (4 min.34 sec.)

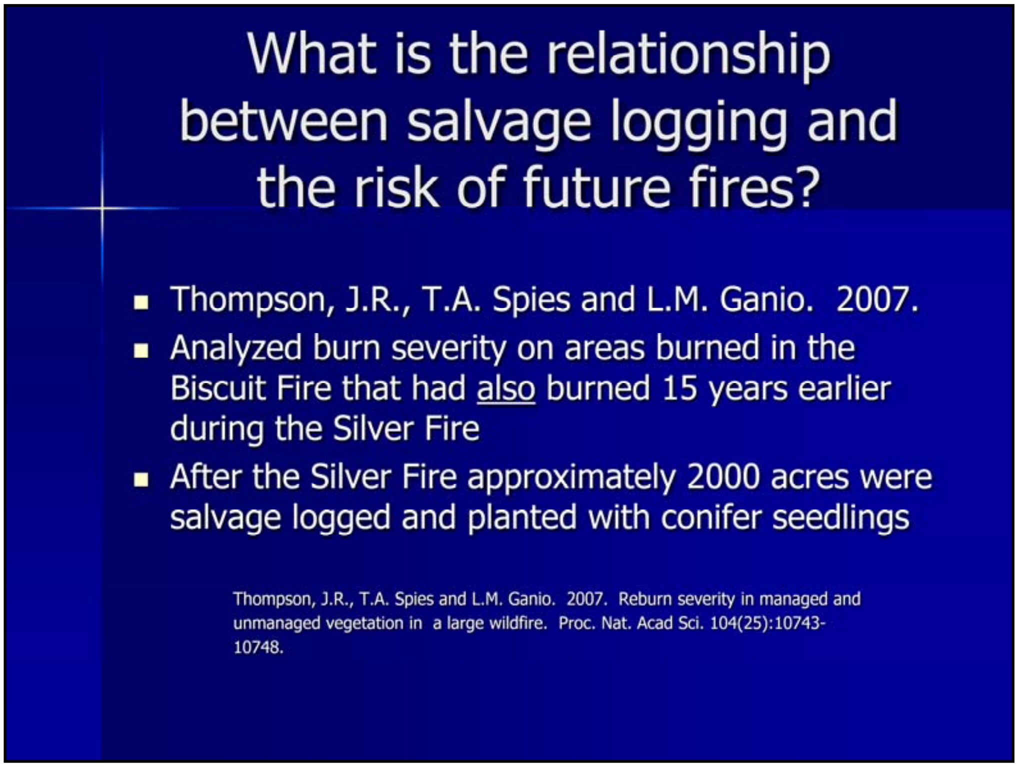
Criticism of the Donato study and the researchers' response to this criticism appears in *Science* (www.sciencemag.org):

Newton, M., et al. 2006. Comment on "Post-wildfire logging hinders regeneration and increases fire risk." Science 313 (5787):615a.
Baird, B.N. 2006. Comment on "Post-wildfire logging hinders regeneration and increases fire risk." Science 313 (5787): 615b.
Donato, D.C. 2006. Response to comments on "Post-wildfire logging hinders regeneration and increases fire risk." Science 313 (5787): 615c.

While the Donato study examined the abundance of fine and coarse fuels before and after salvage logging, it had to be <u>assumed</u> that the presence of these fuels would result in greater fire risk.

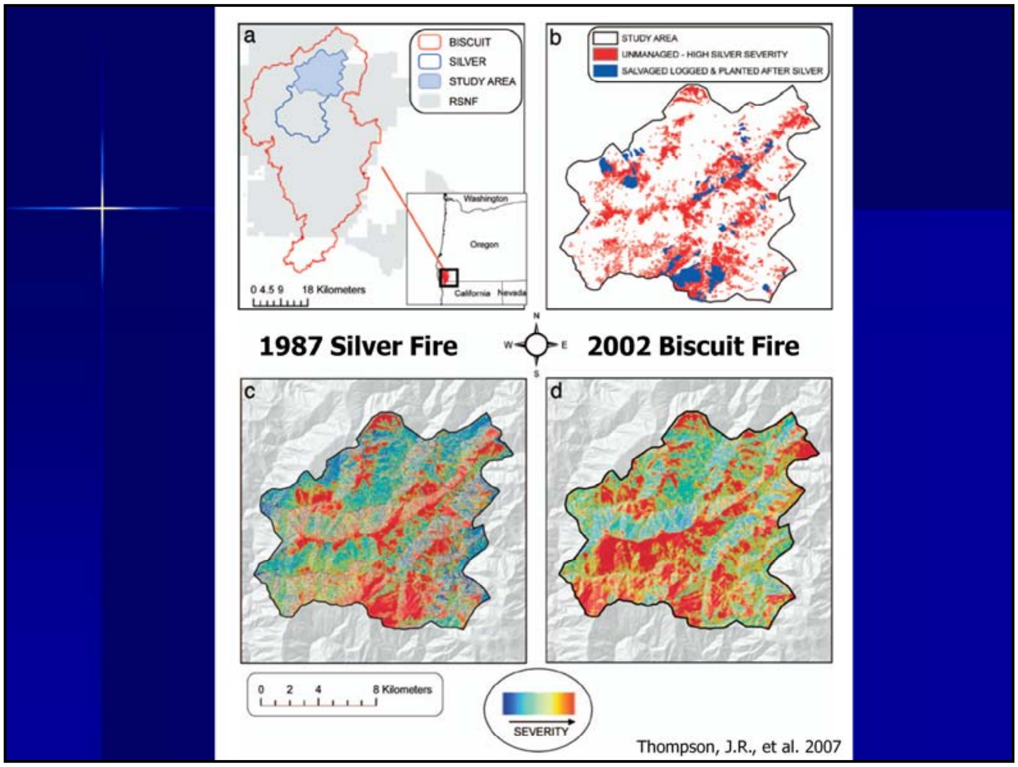
Photo: Four-years post-fire, no treatment, B&B Complex Fire, Central Oregon

Wynn Cudmore 2007



Thompson, et al. (2007) were the first to examine how recent fire history and post-fire management affects the severity of a large wildfire. The authors analyzed burn severity on approximately 45,000 acres (18,000 hectares) within the Biscuit Fire that had also burned 15 years previously in the Silver Fire. After the Silver Fire, approximately 2000 acres were salvage logged and planted with conifer seedlings. This history provided the opportunity for study of two central questions in the debate:

1. Was severity in the Biscuit Fire associated with severity in the Silver Fire in areas that had not been salvage logged and replanted?
2. Did areas that were salvage-logged and planted with conifer seedlings after the Silver Fire burn more or less severely in the Biscuit Fire when compared to unmanaged areas?



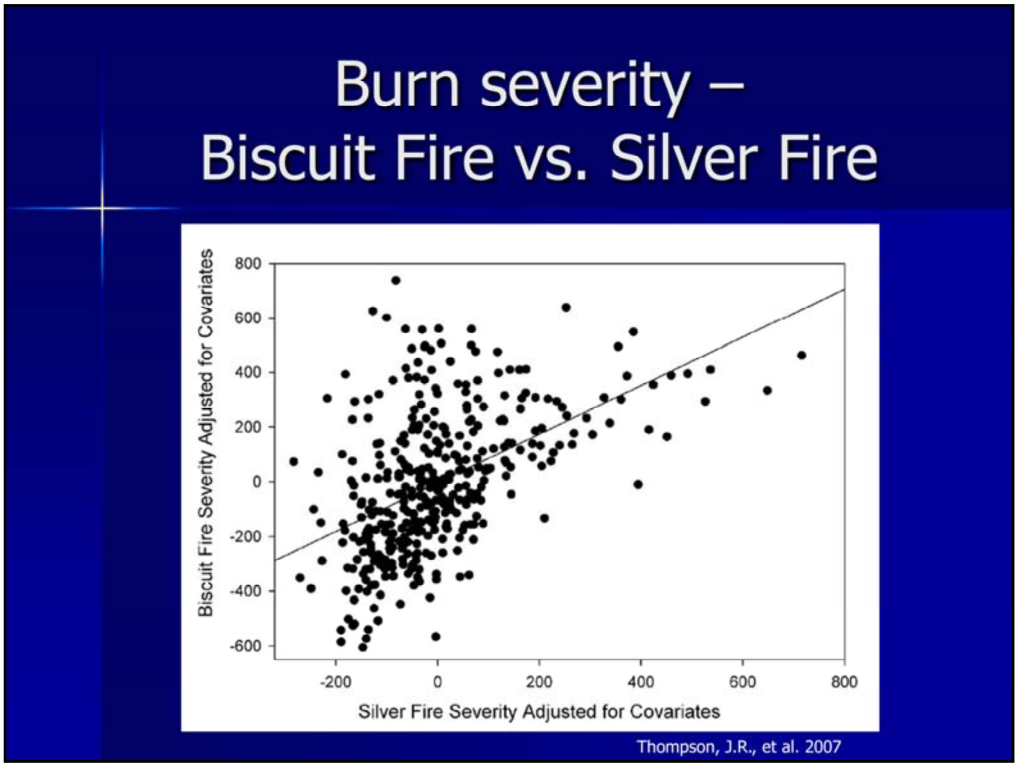
a – boundaries of 2002 Biscuit Fire and 1987 Silver Fire. The study area, which burned in both fires is highlighted in blue

b – disturbance history within study area; red indicates those areas that burned with high severity during Silver Fire and were left unmanaged, blue indicates those areas that were salvage logged and planted after the Silver Fire

c – burn severity of the 1987 Silver Fire

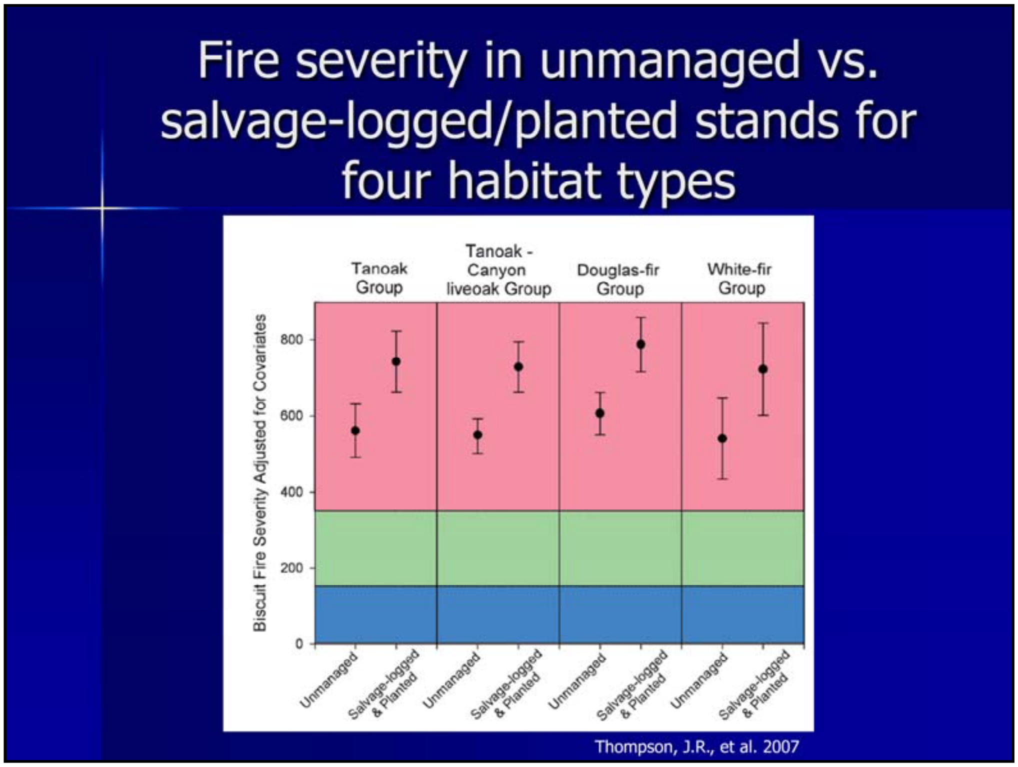
d – burn severity of the 2002 Biscuit Fire

Note similarity in areas that burned severely in both fires (in red).



1987 Silver Fire burn severity (measured on the x-axis) and 2002 Biscuit Fire burn severity (measured on the y-axis) were significantly and positively correlated ($P<0.0001$, $df=381$). In other words, those areas that burned at high severity in the 1987 fire, also tended to burn with high severity in the 2002 fire. And, those areas that burned at low severity in the 1987 fire, also tended to burn at low severity in the 2002 fire.

The most likely explanation for this relationship is that areas of higher Silver Fire severity had greater accumulations of fire-killed trees and other vegetation available as fuel to the Biscuit Fire.



See Notes Slide 15

Notes Slide 15

A comparison of Biscuit Fire burn severity in four different habitats (across top) as determined through satellite imagery. Means (black dots) and 95% confidence intervals (vertical bars) are indicated in figure. Color corresponds to fire severity as follows:
Blue - <10% canopy scorch
Green – 10-50% canopy scorch
Pink - >50% canopy scorch

For each habitat type, burn severity in those areas that burned at high severity in the 1987 Silver Fire and were left alone ("unmanaged" in figure) was compared to burn severity in those areas that were salvage logged and planted after the Silver Fire.

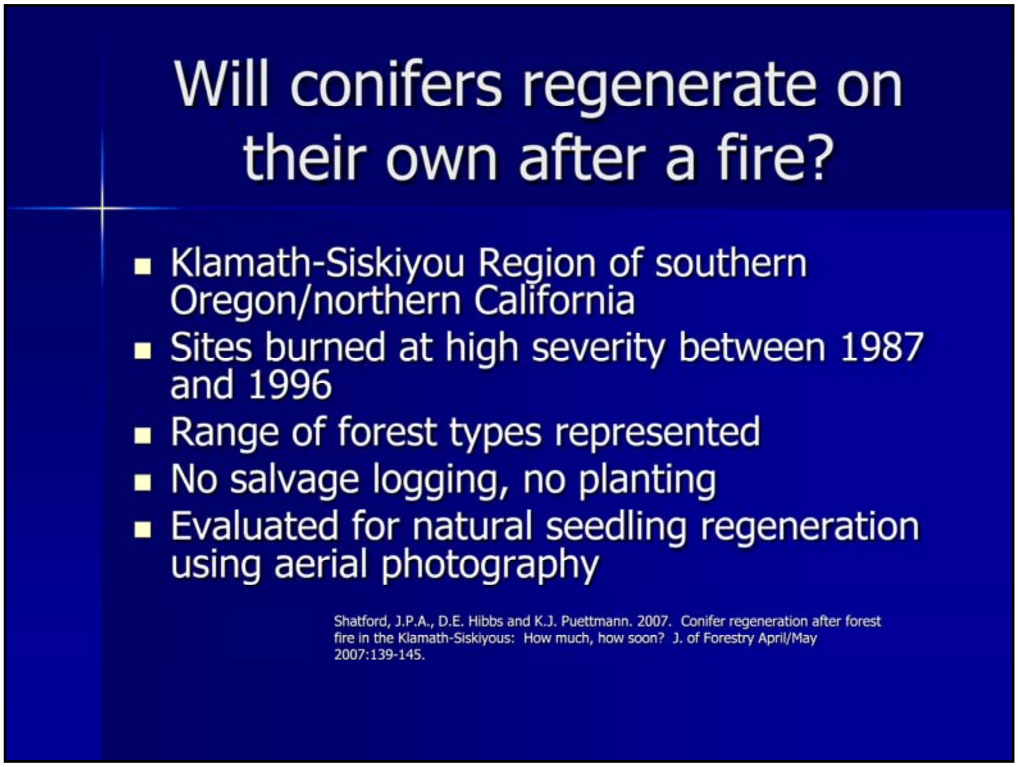
Note that for all habitat types, burn severity was higher in the salvage logged and planted areas. Fire severity was 16 to 61% higher in logged and replanted areas compared to those that were left to recover on their own in a fire 15 years earlier.

As stated by the authors of the study:
"The hypothesis that salvage-logging followed by replanting reduces reburn severity is not supported by these data."
The causative mechanism for these results is unknown. Some possibilities include:

1. Tree removal
2. Addition of more fine fuels to forest floor during the logging operation
3. Growth of new trees that for several decades may be vulnerable to fire

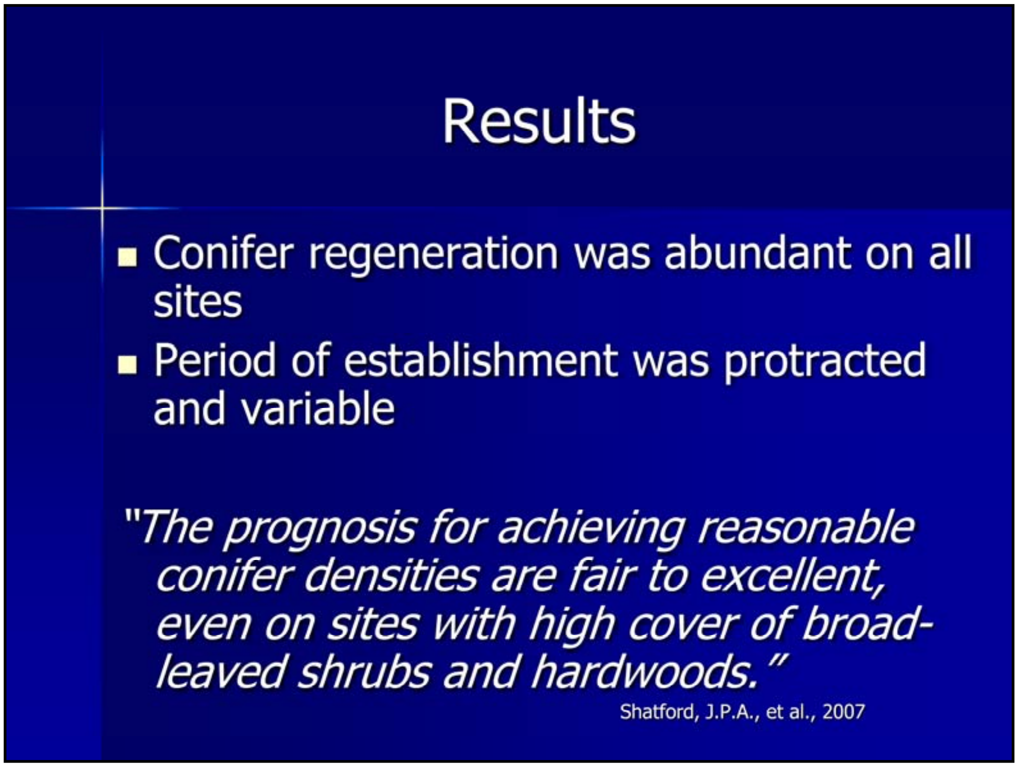
So, why are naturally regenerated forests less prone to high burn severity? Perhaps because regenerating trees are more patchy, have open gaps and have more species diversity. This awaits further research.

It is important to note that the conclusions of this study (like most ecological studies) hold true for this forest type only (i.e., mixed conifer/mixed evergreen-hardwood forest with various combinations of Douglas-fir, tanoak, sugar pine, white fir and chinquapin). Additionally, the conclusions pertain only to stands of this age (time since burn). Similar studies have not yet been conducted in other forest types and it remains to be seen whether or not the results of this study can be applied broadly.



Shatford, J.P.A., D.E. Hibbs and K.J. Puettmann. 2007. Conifer regeneration after forest fire in the Klamath-Siskiyous: How much, how soon? J. of Forestry April/May 2007:139-145.

One of the central questions concerning post-fire management is whether or not burned forests will recover on their own and at what timeframe. The Donato study suggested that natural conifer regeneration was abundant in areas impacted by the Biscuit Fire, but the question remained whether or not this was the case elsewhere. Shatford, et al. (2007) examined 8 sites in southern Oregon and northern California that had burned at high severity (>90% tree mortality) in the past 9 to 19 years (between 1987 and 1996). None of the sites were salvage logged or planted. The sites represented a range of forest types from dry, low elevation forests (Douglas-fir/ponderosa pine) to more mesic, high elevation forests (white fir). Conifer regeneration was evaluated using analysis of aerial photographs.



In general, conifer regeneration on all 8 study sites was abundant but variable. Conifer density averaged 686 trees per acre (1694 trees/hectare) on the drier sites dominated by Douglas-fir and 3084 trees per acre (7621 trees/hectare) on higher elevation, wetter sites dominated by white fir. These densities are equal to or greater than typical densities in 60-100 year old stands in this region.

Additionally, these values exceed tree densities on replanted sites in the region.

Time to establish seedlings was both variable and surprisingly extended. Seedlings were still sprouting on some sites 19 years after the fire. Patterns ranged from "immediate and rapidly filling" to "initially delayed and then rapidly filling" to "slow but constant filling" to "chronically limited."

The results of this study suggest that natural regeneration of seedlings after a fire is a common feature of forests in this region, particularly if forest managers are willing to accept protracted establishment times. Earlier suggestions that burned areas if left unmanaged will remain unproductive for extended periods of time are not supported by this study.

Protracted establishment times, establishment of a variety of species and a patchy recovery may provide an additional advantage to wildlife species. Higher levels of biodiversity (as measured by number of species) are often associated with early successional stages that develop naturally after a disturbance. Since recovery rates after severe, stand-replacing fires differ significantly from site to site, early successional habitat persists for varying amounts of time across the landscape.

This photo of natural regeneration of lodgepole pine seedlings after the 1988 fire in Yellowstone, suggests that natural regeneration may be a feature of other forest types as well.

Photo: Lodgepole seedlings Yellowstone National Park after 1988 fire (National Park Service)

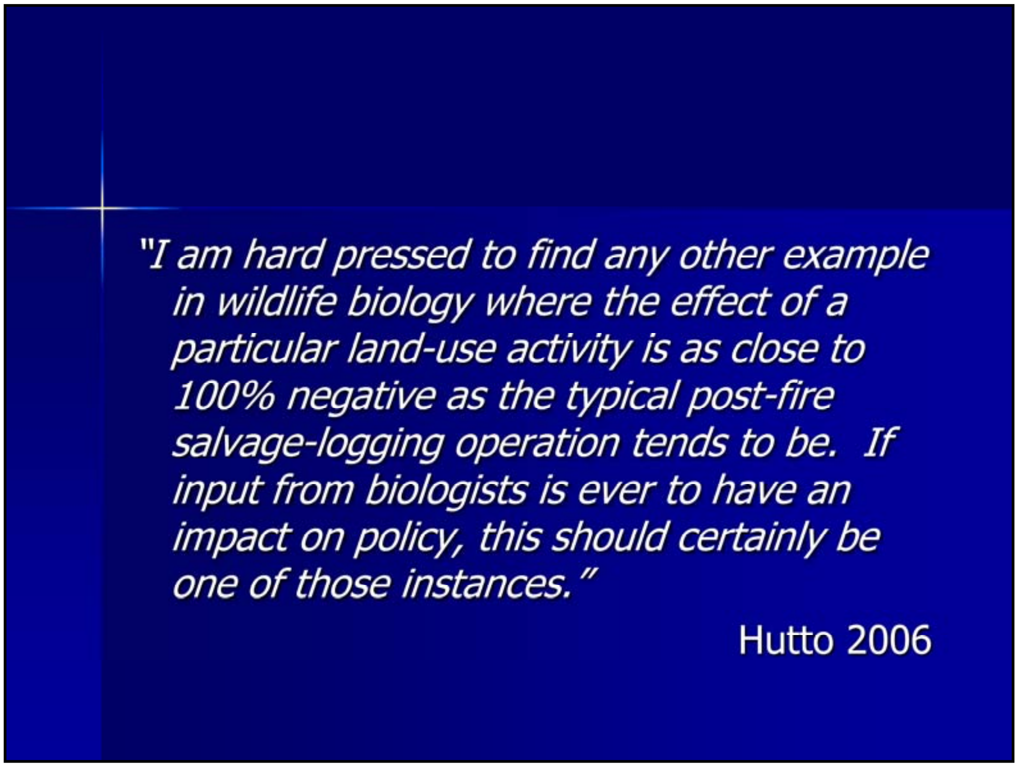
Reaction to Shatford, et al. 2007 study reflects different perspectives in forest management.

These studies have by no means quieted the debate concerning the costs and benefits of post-fire logging. Some researchers contend that “desirable species” like pines, fir and cedar have difficulty re-establishing themselves after a fire due to competition with shrubs and hardwoods, which come back quickly after a fire. These scientists recommend replanting and herbicide use to control competing vegetation. They also contend that the removal of dead and dying trees reduces future fire risk. In a changing climate with warmer and drier conditions, they feel that fire risk will be greater and conifer seedlings will have an even more difficult time becoming established.

For details see:

Sessions, J., et al. 2004. Hastening the return of complex forests following fire: The consequences of delay. Journal of Forestry 102(3):38-45.

Photo: Yellowstone Fire - National Park Service



An opposing view from a wildlife biologist.

Where does this leave us?

1. Impacts of post-fire salvage logging are complex and site-specific
2. Science informing the debate is incomplete
3. Salvage logging does not appear to be a <u>requirement</u> for reforestation
4. Salvage logging does not contribute to ecological recovery
5. Salvage logging delays the return of streams to historical conditions
6. The role of salvage logging in reducing future fire risk is dubious at best
7. The decision to salvage log or not depends on management goals

See Notes Slide 22

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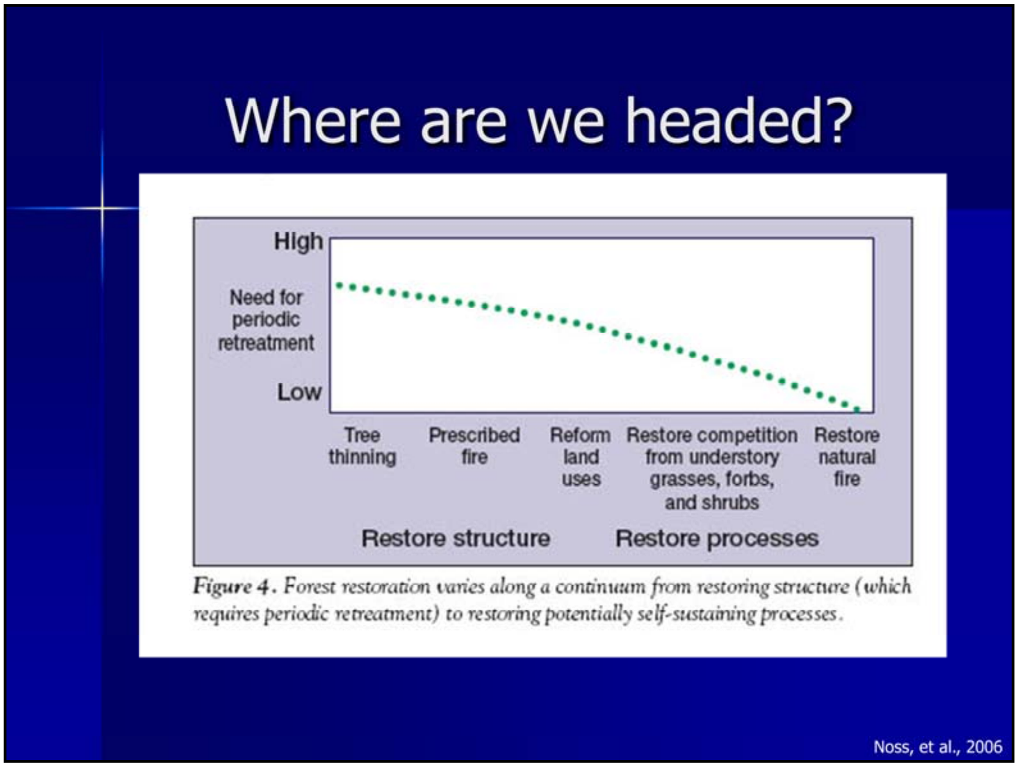
There is <u>much</u> is at stake in the decisions that are made concerning post-fire management – future fire risk, sustainability of forest ecosystems, local economies, timber–related jobs, stream conditions, etc.

Given our current state of knowledge, what generalizations can be reasonably made?

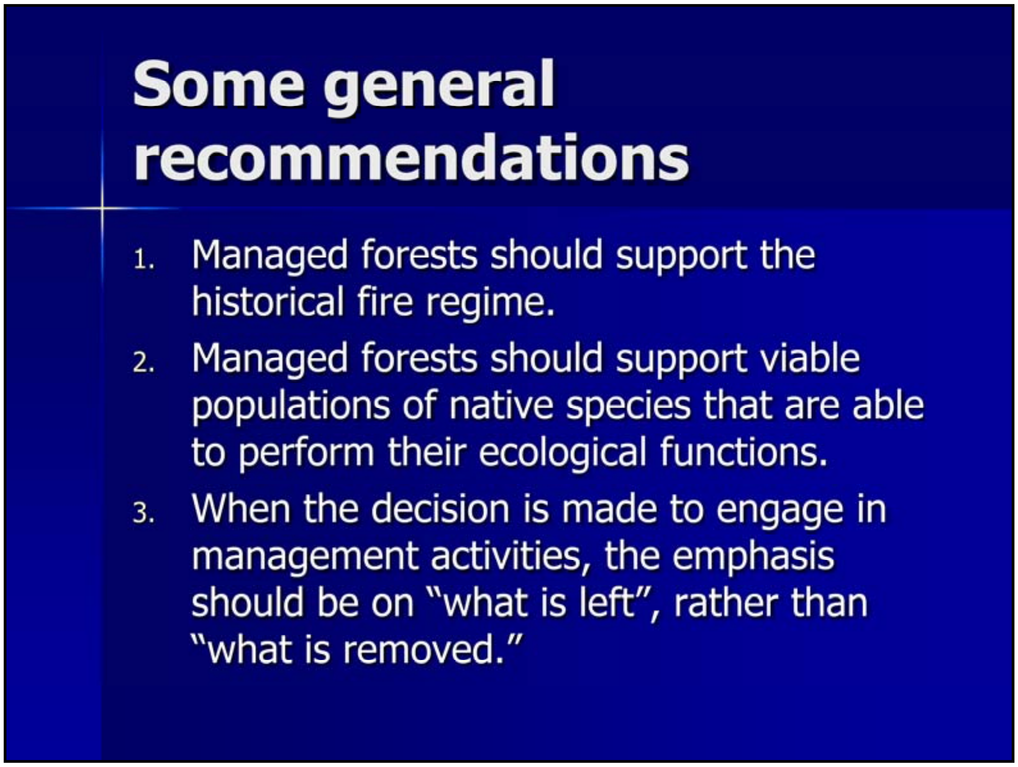
1. The ecological impacts of post-fire salvage logging are complex and site-specific. Impacts are dependent on a multitude of factors including, the methods used, time of year in which operations are conducted, soil characteristics, slope, forest type and the amount of time that has elapsed since the fire.
2. Science informing the debate is incomplete; however, the scientific basis for making decisions concerning post-fire management has improved dramatically in the past decade (several of these studies are described in this presentation). There is a need for further research in this area. Multi-site, longitudinal studies are needed to see if the results of narrower studies can be broadly applied. However, the issue is likely to remain complex and a one-size-fits–all solution is almost certainly unattainable.
3. Salvage logging does not appear to be a <u>requirement</u> for reforestation. Post-burn landscapes have substantial capacity for natural recovery. The rates and evenness of re-establishing forests after stand–replacing fires are highly variable. Natural recovery may diminish the <u>economic</u> value of the future forested landscape somewhat, but it probably enhances <u>ecological</u> value by promoting the high diversity found in the early ecological stages of succession.
4. Salvage logging does <u>not</u> contribute to ecological recovery and, in fact, is counterproductive to most ecological restoration efforts. Removal of "biological legacies" such as snags, remnant live trees, logs, etc. goes against current scientific thinking on the short-term and long-term role of these habitat components in forests (e.g., wildlife habitat, nutrient cycling, etc.).
5. Salvage logging delays the return of streams to historical conditions. Runoff of sediment, especially from logging roads is the most obvious impact. Other possible impacts on streams include increased temperature and loss of logs that will recruit into stream ecosystems due to removal of riparian trees.
6. The role of salvage logging in reducing future fire risk is dubious at best. There may be circumstances where, even after a wildfire, forested stands have fuel loads that exceed historical levels. Salvage logging might be used in this situation to reduce fire risk. However, this would appear to be the exception to the rule and there is now some evidence that suggests that salvage logging <u>increases</u> fire risk.
7. Ultimately, the decision to salvage log or not depends on management goals. There may be circumstances when salvage logging may be justified for economic or social reasons.

What does the future hold? Until recently, our view of forest fire management has focused almost entirely on “fuels”. This thinking is based on the reality that of the three components of the “fire triangle” – topography, weather, fuels – this is the only factor that can reasonably be manipulated by humans.



Recent developments in the field of ecological restoration have allowed us to broaden our understanding of how these ecosystems recover from a disturbance such as a severe wildfire.

The figure above (from Noss, et al., 2006) illustrates a continuum of restoration activities. Given the state of some fire-prone forests, the current emphasis is on the left portion of this continuum (thinning and prescribed burning). Significant resources are required here due to the need for initial and periodic treatment by forest managers. The long-term goal of management should be to reach the right side of this continuum where the roles of natural fire are restored. Note that when this goal is achieved, natural processes take care of most of the "heavy lifting" and the need for periodic treatments by humans declines.



Although the variability in forest types, local conditions, management history, etc. prevent the development of many generalized recommendations, current scientific thinking appears to suggest the following:

1. Managed forests should support the historical (or at least the desired) fire regime.
2. Managed forests should support viable populations of native species that are able to perform their ecological functions.
3. When the decision to engage in management activities such as thinning and salvage logging is made, the emphasis should be on “what is left” rather than “what is removed.”

See Notes Slide 26

Notes Slide 26

To date most forest practices related to wildfire implement site-specific practices that are designed to meet a single objective – fuels reduction, fire suppression, re-establishing vegetation, reducing erosion into streams or reducing the probability of future fires. Under the guiding ideals of ecosystem management, a more integrated approach is needed – an approach that emphasizes the interaction and dependency of terrestrial and aquatic ecosystems as well as the historical role of disturbance in those systems. Successful ecological restoration will require this more integrated approach.
These recommendations are adapted from several sources including the following (see module for complete citations):

Karr, J.R., et al. 2004; Lindenmayer, D.B. and R.F. Noss. 2006; Reeves, G.H., et al. 2006

1. Protect and restore watersheds before disturbance occurs.
   Ecosystem management strives to make forest ecosystems more resilient to the disturbances they encounter. Management activities before, during and after fires must take this into account. The goal should be to engage in restoration of physical and biological components of ecosystems as well as the ecological processes. Approaches that allow natural processes to manage the landscape can have ecological as well as economic benefits.
2. Allow natural recovery to occur (or intervene in ways that promote recovery).
3. Retain biological legacy.
   Old trees, logs, snags and other biological material provide many ecological benefits. For example, they enhance wildlife habitat, reduce erosion, nourish streams, and maintain desirable microclimates.
4. Protect soils.
   Soils and soil productivity cannot be replaced on time scales that are meaningful to humans.
5. Protect ecologically sensitive areas.
   Riparian areas, roadless areas, steep slopes, etc. play an important role in maintaining local and regional biodiversity.
6. Avoid creating new roads.
   Roads damage soils, help spread exotic species, and impact streams.
7. Limit seeding and replanting.
   Replanting and seeding (especially with non-native species) can interfere with native plant regeneration.
8. Continue research, monitoring and assessment.
   We have an incomplete understanding of these systems and a basic tenet of dealing with uncertainty has been adaptive management. We need to incorporate new information into management as it is obtained. Long-term studies that examine several sites are also important to fill in current gaps in knowledge.

Notes Slide 26 Continued…

9. Educate the public.

   The public needs to recognize that despite the threats to human life and structures posed by wildfire, not all are catastrophes. Disturbance is an inherent characteristic of ecosystems and an important component in the evolution and maintenance of ecosystems. Ecological restoration requires the maintenance of ecological processes, native species composition and forest structure at the stand level as well as the landscape level. In the context of wildfire, managed forests should be able to support the natural fire regime and have viable populations of native species that perform their own ecological services. One way to measure success is an approach that makes forests low maintenance and require minimal repeated treatments (see figure 4 from Noss, et al., 2006).

“Above all a guiding principle of forest management should be a precautionary approach that avoids ecological harm.” Noss, et al. 2006

THE END

Photo: Lodgepole seedlings Yellowstone Fire National Park Service

Photo Credits

- Ministry of Forests and Range (British Columbia, Canada)
- National Park Service – Jim Peaco
- National Park Service www.nps.gov
- NCSR www.ncsr.org
- Noss, et al., 2006
- Science, Donato, D.C. et al.
- Thompson, J.R., et al.2007
- USDA Forest Service: Keith Lannom
- USDA Forest Service Pacific NW Research Station: Eini Lowell

Resources

American Lands Alliance. 2005. After the fires: Do no harm in America's forests. A report on the impacts of logging on forest recovery. www.americanlands.org

This document is a view of post-fire salvage logging from an environmental group that clearly opposes the practice.

Beschta, R., et al. 2004. Post-fire management of forested public lands of the western United States. Conserv. Biol. 18:957-967.

This study evaluates the ecological effects of various post-fire treatments from the perspective of ecosystem recovery. Post-fire management practices that are consistent with (and inconsistent with) efforts to restore ecosystem functions after fire are discussed.

Carr, M. 2005. Wildland Waters USDA Forest Service. Summer 2005 FS-828. 22 pp.

This special issue on fire provides an excellent general introduction to the fire issue. Most aspects are briefly addressed including fire regimes, fuels management, restoration, fire responses, salvage logging, and rehabilitation. Links to additional resources are provided.

DellaSala, D.A., et al. 2006. The facts and myths of post-fire management: a case study of the Biscuit Fire, southwest Oregon. Unpublished report. World Wildlife Fund, Klamath-Siskiyou Program, 116 Lithia Way, Ashland Oregon www.nccsp.org/files/

This unpublished report by the World Wildlife Fund is a thorough, yet critical, assessment of salvage logging. In addition to an evaluation of the ecological impacts, the authors examine the economics of salvage logging operations. Citing a Government Accounting Office report (www.gao.gov/new.items/d06967.pdf) they find that the costs of the post-fire logging on the Biscuit Fire exceeded revenue by $14 million.

Donato, D.C., et al. 2006. Post-wildfire logging hinders regeneration and increases fire risk. Science 311:352

Hutto, R.L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (USA) conifer forests. Conserv. Biol. 9:1041-1058.

Hutto, R.L. 2006. Toward meaningful snag-management guidelines for post-fire salvage logging in North American conifer forests. Conserv. Biol. 20:984-993.

Karr, J.R., et al. 2004. The effects of post-fire salvage logging on aquatic ecosystems in the American West. BioScience 54(11):1029-1033.

This is a comprehensive review article on the effects of post-fire salvage logging on aquatic ecosystems.

Keeley, J.E., et al. 2006. A 21st century perspective on post-fire seeding. Journal of Forestry 104:103-104.

Lindenmayer, D.B., et al. 2008. Salvage logging and its ecological consequences. Island Press, Covelo, California. 272 pp.

Lindenmayer, D.B., et al. 2004. Saving forest or saving fiber? Salvage harvesting policies after natural disturbance impairs ecosystem and species recovery. Science 303:1303.

Lindenmayer, D.B. and R.F. Noss. 2006. Salvage logging, ecosystem processes, and biodiversity conservation. Conserv. Biol. 20:949-958.

McIver, J.D., and L. Starr. 2000. Environmental effects of post-fire logging: literature review and annotated bibliography. Gen. Tech. Rep. PNW-GTR-486. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 72 pp.

Twenty one post-fire logging studies are reviewed and interpreted in this Forest Service report. The lack of scientific information informing the salvage logging debate is noted. They conclude that the immediate environmental effects of post-fire logging are variable and dependent upon a number of factors including burn severity, slope, soil texture, road building, logging methods and post-fire weather.

Noss, R.F., J.F. Franklin, et al. 2006. Managing fire-prone forests in the western United States. Front. Ecol. Environ 4(9):481-487.

This is an excellent review of the literature on the ecology and management of fire-prone forests in the western United States. It is suitable to assign to students as supplemental reading. The article and the references cited within should also provide faculty with a comprehensive understanding of this complex issue. It has been posted on-line by the Ecological Society of America at:
www.frontiersinecology.org.

Reeves, G.H., et al. 2006. Post-fire logging in riparian areas. Conserv. Biol. 20(4):994-1004.

This article reviews the impacts of salvage logging in burned forests along streams.

Sessions, J., et al. 2004. Hastening the return of complex forests following fire: The consequences of delay. Journal of Forestry 102(3):38-45.

Authors of this article contend that "desirable species" like pines, fir and cedar have difficulty re-establishing themselves after a fire due to competition with shrubs and hardwoods, which come back quickly after a fire. They recommend replanting and herbicide use to control competing vegetation. They also contend that the removal of dead and dying trees reduces future fire risk. In a changing climate with warmer and drier conditions, they feel that fire risk will be greater and conifer seedlings will have an even more difficult time becoming established.

Shatford, J.P.A., D.E. Hibbs and K.J. Puettmann. 2007. Conifer regeneration after forest fire in the Klamath-Siskiyous: How much, how soon? J. of Forestry April/May 2007:139-145.

This article presents our current state of knowledge on the question of whether or not burned forests will recover on their own and over what timeframe. The authors examined natural conifer regeneration from 9 to 19 years after the fires in California and Oregon. They found successful seedling establishment across the entire range of forest types in the region.

Thompson, J.R., T.A. Spies and L.M. Ganio. 2007. Reburn severity in managed and unmanaged vegetation in a large wildfire. Proc. Nat. Acad. Sci. 104(25):10743-10748.

This study was the first to examine how recent fire history and post-fire management affect the severity of a large wildfire. The authors analyzed burn severity in an area impacted by a major 2002 fire that had also burned 15 years previously. Since after the earlier fire approximately 2000 acres were salvage logged and planted, this history provided the opportunity for study of the impact of salvage logging on the severity of future fire. For all habitat types examined, burn severity was higher in the salvage logged and planted areas, or as stated by the authors of the study:
"The hypothesis that salvage-logging followed by replanting reduces reburn severity is not supported by these data."

USDA Forest Service. 2007. Managing forests after fire. Pacific Northwest Research Station. PNW Science Update 15:1-11
www.fs.fed.us/pnw

This is an excellent overview of post-fire management including salvage logging. PNW Science Update *is written for a general audience and is suitable to assign to students as supplemental reading.*