Joint Fire Science Program
Fire Science Brief
RESEARCH SUPPORTING SOUND DECISIONS

Post-fire revegetation in the Klamath-Siskiyou region. Credit: David Hibbs.

Recovery after Severe Fire in the Klamath-Siskiyou: What Happens without Planting?

Summary

The Klamath-Siskiyou forest of southern Oregon and northern California is home to a fire-adapted conifer ecosystem that historically experienced frequent, low-intensity fire. Often the management response to severe fire in the Klamath-Siskiyou includes planting—there is genuine and historical concern that without planting, the conifers will diminish. But David Hibbs and his colleagues at Oregon State University realized that there were very little data on whether these forests require management-based planting to recover. They wondered if natural recovery was possible, even after severe wildfire. The team found a series of severely burned, unmanaged plots, and measured conifer abundance, age, and live-crown ratio. They found that even in unplanted, unmanaged burned forest natural conifer regeneration is reliable and abundant. Recruitment is also ongoing well after the fire. Furthermore, there was little evidence that tree recruitment was affected by distances as great as 400 meters to source trees. Their results suggest that in many cases, planting may not be required to support conifer forest recovery in the Klamath-Siskiyou.

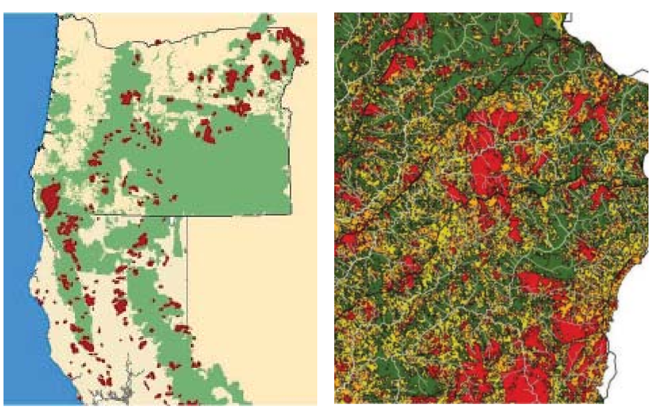
Key Findings

- On most sites, natural regeneration of conifers was abundant 10 to 20 years after a fire.
- Natural regeneration of conifers was usually abundant up to 400 meters from living trees. It was difficult to find places more than 400 meters from living trees.
- Conifers continued regenerating 10 to 15 years after the fire.
- Natural regeneration was most limited on the drier, hotter low elevation, southern slopes on the eastern Klamath Mountains.
- Shrub cover was positively associated with seedling growth in the Douglas-fir/tanoak association and negatively in the white fire association.

Introduction

The Klamath-Siskiyou forest of southern Oregon and northern California is a fire-adapted conifer ecosystem rich with history and with current management concerns. This large area of mountainous conifer forests probably experienced mixed severity fire throughout its pre-settlement history. Research has shown that historically this ecosystem has regenerated itself naturally. However, after an era of fire exclusion, new and different concerns have arisen.

Today it is unclear whether the proportion of high severity fires has increased in certain areas. But it is very apparent that some of today's fires contribute to questions of how to manage the areas post-fire. For example, from 1970 to 2004 more than 600 wildfires burned almost 15 million acres (over six million hectares) in California and nearly 5 million acres (two million hectares) in Oregon, according to a paper in the *Journal of Forestry* (April/May 2007). In 2002, the Biscuit Fire—the largest fire ever recorded in Oregon—burned almost 500,000 acres (200,000 hectares) of the Rogue/Siskiyou National Forest.



Large wildfires from 1970–2002 in California and Oregon (left) and the Biscuit fire severity (right).

David Hibbs, a researcher at Oregon State University (OSU) in Corvallis, knew that most management practices of the area include planting to restock conifers after severe fire, but he and his team saw a gap in the literature; there was little understanding of what would happen in these forests if they were left to recover naturally after such a fire. "We wanted to see if we could find a predictive tool that could help managers in post-fire reforestation planning." Ideally, this tool would include information on the natural recovery potential of forests within the Klamath-Siskiyou region.

There is also a history of concerns in the Klamath-Siskiyou region about what will happen to the mixed conifer forest that has undergone severe burns. With sweeping areas of so-called "brushfields" (expansive areas where conifers have never reclaimed dominance) in Oregon and serious concerns about shrubs and hardwood species replacing the conifer forest, management practices have leaned heavily on replanting. But according to Hibbs, there is practically no information on how these forests will respond if left alone to recover from severe wildfire, without the expense and challenge of planting.

Armed with funding from the Joint Fire Science Program, Hibbs—along with his colleagues Jeffrey Shatford and Klaus Puettmann, also at OSU—set out to see what would happen if areas of the forest that had experienced severe wildfire were left to recover on their own.

Finding severely burned, *unmanaged* areas

Fortunately, the team had access not only to the forest itself, but also to maps detailing historic burn areas. The challenge for them was to find patches of forest in the Klamath-Siskiyou that had undergone high severity burns and that had also remained unmanaged. Says Hibbs, "It was not easy to find and track this 'natural regeneration' in an actively-managed forest ecosystem."

They chose their sites first by locating burn sites with GIS mapping data. They also checked each possible site with aerial photographs taken between 1–3 years post fire. Then they addressed three major criteria: (1) the burn had to be severe, killing all above ground vegetation and conifers (more than 90 percent tree mortality due to fire), (2) the fire had to have occurred either in the mid 1980s or mid 1990s such that they had two age classes of fire (i.e., it had to be a canopy-replacing event that occurred 9–19 years earlier), and (3) there had to be no post fire management, including logging or tree planting. With the photographs, GIS data, and criteria satisfied, the team then planned their sites.

The Klamath Siskiyou Region.

They sampled in the three most common plant series, according to the USDA Forest Service plant series designations. They were low (also called the Douglas-fir series, and lowest in elevation), medium (the Douglas-fir/tanoak series), and high (the white fir series) elevation plots. They also assigned plots at various distances from the burn edge; which determines how far the plots are from conifer seed sources. They wanted to know if distance from a seed source affected the area's ability to regenerate naturally. Hibbs explains, "We wanted to see if we find more seedlings near living trees than further away from them."

They chose plot locations using the photographs and random number allocations, according to their paper in the *Journal of Forestry*. They located the plots from 50–400 meters to a seed source. The researchers made sampling plots that were comprised of thirty 4 x 4 m cells in a grid of 3 x 10 cells/plot. Each cell, then, took up about 1/250th of an acre: which is one way to measure how well "stocked" each area is with conifers. According the *Journal of Forestry* paper, "Each cell…provided a means to assess the dispersal of regenerating…conifers. A plot with at least one conifer in each cell was considered fully stocked." Whether an area is fully "stocked" is an important measure to managers and planners who try to meet stocking requirements on federally managed lands.

"Meanwhile," says Hibbs, "the terrain is really rugged. We had to swim through six to ten foot tall shrub habitat that was very dense, and which had poison oak and the occasional rattlesnake."

"We went in there and located all the conifer seedlings as well as all the sprouting hardwoods," says Hibbs. "We took data on the whole plant community, but our main focus was the conifers." The researchers had three main measurement goals: they aged and counted the seedlings, measured the live crown ratio of the seedlings, and measured their growth in height.

"We aged the seedlings by counting whorls as best we could, and we also took a sub sample to cut and measure tree rings," says Hibbs. "The live crown ratio helped us see how happy the trees were, since we wanted to know how the trees in these very shrubby sites faired without any kind of management. And we measured how much the tree grew in height by measuring between whorls."

He adds, "90 percent of the trees we measured were still living under the shrub canopy. So a big question is; are they going to survive and come out beyond the shrub cover?"

Examples of post-fire revegetation types. (Left to right) Seed bank, resprouts, and dispersed seed.

Severe burn and vigorous seedlings

The team found, in severely burned sites with no management for the last twenty years, "that, in general, there are lots and lots and lots of conifer seedlings out there," says Hibbs.

The researchers did find that conifer density varied by elevation, or series." We saw that the lowest elevation (drier) sites tended to have the fewest conifer seedlings, while the higher elevation sites had much more. But even then, the low elevation sites had an average of 1,694 conifer seedlings per hectare (4,184 per acre)," says Hibbs. "The biggest point here," says Hibbs, "is that there are *a lot* of vigorous seedlings."

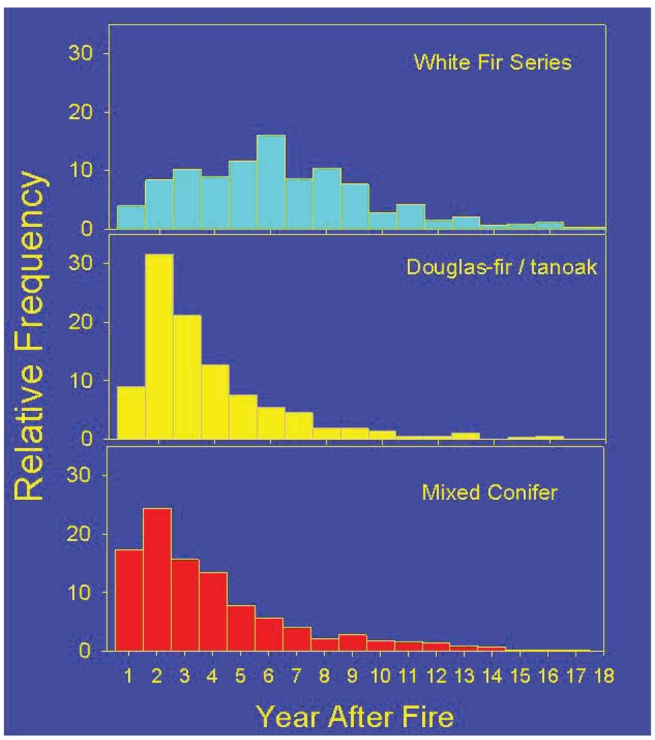
Sampling post-fire revegetation. Shrubs are dense and diverse, tree seedlings abundant.

According to their *Journal of Forestry* paper, the total conifer density ranged over three orders of magnitude. There was an average of 1,694 conifer seedlings per hectare (1 hectacre equals 2.47 acres) in the low elevation sites, with a range of 83–8,188 trees per hectare in the lower and mid-elevation Douglas-fir and Douglas-fir/tanoak series combined. Meanwhile, in the higher elevation white fir series, there was an average of 7,621 trees per hectare with a range from 688 to a 16,771 trees per hectare.

"But the big question is, will these trees make it up through the shrub canopy?" he asks.

Though the shrub canopy was tall and extensive, the researchers found no evidence of young conifer mortality due to shrub cover. What's more, the average live crown ratio of conifers was 68 percent and many of the trees were closing in height to the shrub canopy. The researchers saw evidence that the young trees will continue to grow, and that they will grow above and beyond the shrub canopy.

Says Hibbs, "We saw from the live crown ratios that these trees, on average, are growing more than four inches a year in height—they are reasonably happy seedlings so a fairly large portion of these will grow up to be big, mature trees. The live crown ratio data are convincing—the conifers will be successful in emerging from the shrub cover." A side study, done as part of an undergraduate honors thesis, even showed a positive relationship between seedling growth and conifer cover in the Douglas-fir/tanoak series.



Regeneration is a gradual process.

Meanwhile, the ages of the seedlings gave the researchers a fairly big surprise. According to Hibbs, there is a sense that most regeneration after a fire occurs shortly after the burn. "But," he says, "We found that seedlings in our plots started growing at all sorts of different times post fire. Actually, we were surprised to see that the peak in successful regeneration actually occurred well after the fire."

They write in their *Journal of Forestry* paper, "On all sites, conifer density increased over our study period. The establishment of up to 30 well-distributed dominant seedlings per plot was seldom synchronized within an individual plot, fire, or across the landscape in a given year. For example, the time required for seedlings to occupy the 30 cells in a 12 x 40-meter plot exhibited the full spectrum of possibilities: immediate and rapid filling, initially delayed (4 to 9 years) and then rapid filling, slow but constant filling, and chronically limited."

There are a couple of important implications to these results. First, says Hibbs, "If you are not in a hurry, there will likely be plenty of natural regeneration coming in (to these kinds of areas)." Next says Hibbs—and this is particularly relevant to managers who use salvage logging—"Our results suggest that early salvage logging may not make much difference to regeneration." In other words, some have argued that early salvage logging post fire can damage the chances of successful recovery because the logging itself kills emerging seedlings. The team's data suggest that this may not make much difference in the long run because they found that successful and abundant conifer recruitment continues for years, even after severe fire.

"So," says Hibbs, "The two major take home messages from this part of the research are that there are tons of vigorous seedlings out there, and that they come in over a long period of time."

Site quality may lead to better model

Recall that the third question the team addressed asked whether the distance from a seed source affected the area's ability to regenerate naturally.

"Well, first off," says Hibbs, "It's important to know that there are living trees out there—even in the midst of these severe burn areas. The farthest distance we could locate a plot from a living tree was 350 meters."

That said, the researchers found practically no relationship between seedling density and distance from living trees.

"We really expected a decline in seedling abundance the further you move away from mature, source trees. But we didn't see that. The seed is getting out there—we just aren't sure how."

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According to their *Journal of Forestry* paper, they found as many as 84 to 1,100 trees per hectare, more than 300 meters from a seed source, "suggesting that at this scale, forest recovery is not a simple function of distance to surviving trees that act as seed sources."

There is a word of caution here, however. "It's not a universal good news story," says Hibbs. We did find that the hotter and drier the plots, the fewer seedlings there were."

Perhaps that is the good news. The researchers' data offer compelling evidence that natural regeneration is not only possible, but likely. But the data also show evidence of a relationship to site quality. This is good news, says Hibbs, "Because the data will allow us to put together a much more predictive model that can help managers and planners predict the success of natural regeneration as a function of site quality after a wildfire."

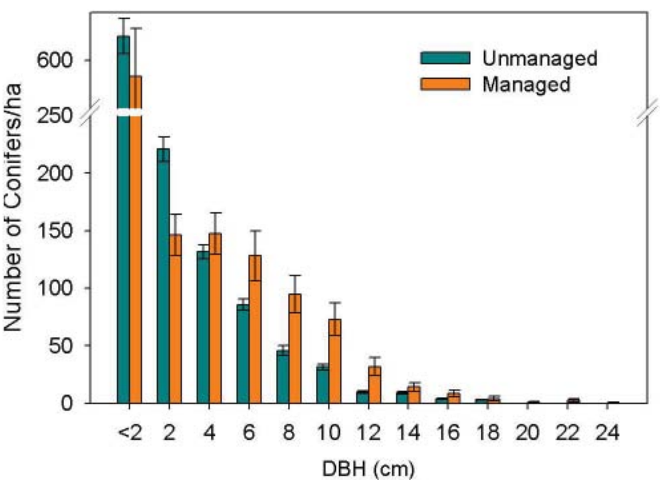
They write in their *Journal of Forestry* paper, "Forest managers who use natural regeneration will need to develop planning and decision tools that can accommodate spatial variability and include thresholds for regeneration success with a much longer regeneration phase than commonly accepted in the region."

What happens when severely burned sites *are* planted?

The results from this work on severely burned, unmanaged sites naturally beg the question: So what would happen if these same kinds of sites were managed? Would there be evidence for better forest recovery?

As they began taking in their data, Hibbs and his team became increasingly curious about the answer to this question. So, during the second summer of data collection, Hibb's master's thesis student Maria Lopez implemented a parallel study.

She located similar sites to the ones already described above (severely burned where most vegetation was killed), but the difference this time, was that her sites had since been *managed*. Management meant that they had been salvage logged, fuels treated, planted and had competing vegetation manually treated once.



Managed versus unmanaged plots. More larger trees with management, but same total number of trees (DBH = depth at breast height).

Management Implications

- Most post-fire areas in the Klamath Mountains are well stocked with successful regeneration within 10 to 20 years of a fire so planting is not required to assure a future forest
- The hottest, driest sites in the region require planting to either assure stocking or to secure a pine component to the forest.
- Parallel work is showing that planting after these same fires did increase tree size by age 20 but only by modest amounts.
- Shrubs can sometime be beneficial to conifer regeneration.

"There are two things worth mentioning here," says Hibbs addressing the preliminary results of Lopez's work. "There was a big change in the species composition of the shrub community compared to unmanaged plots, and there were no more conifers regenerating in the managed plots compared to our unmanaged plots."

The shrub community result was a surprise to the researchers. Hibbs says that management in Lopez's plots on hotter, drier sites drastically reduced the *Manazita* spp. and doubled the amount of shrubs of the genus *Ceanothus*. "This in intriguing" says Hibbs, "because *Ceanothus* shrubs can be nitrogen fixers. Is this a 'good thing' in these managed plots? We don't know."

"Meanwhile," he goes on, "Even with tree planting in these areas, we saw clearly that there are no more conifers growing in these plots than in unplanted, unmanaged plots. However, the conifers we measured *were* bigger—about 50 percent of these young conifers were larger in the managed, versus unmanaged, plots." Again, he adds, "Is that 'good' for forest recovery? We don't know yet. It really depends on management objectives."

Perhaps the biggest take home point, according to Hibbs, is that, "Given all the effort required in managing these areas—including planting, salvage logging, fuel treatment, and release cuts—managing the plots made surprisingly little difference, according to our research."

This may be the key to the whole story: The conifer forests of the Klamath-Siskiyou region are resilient, and the researchers' work clearly shows that even severe fire does not appear to spell long-term conifer loss. The team's data highlight a sense of biological exuberance in these forests, that managers and planners of these areas may find relieving, if not down right, comforting.

Further Information: Publications and Web Resources

Otiz, M.J.L. 2007. Plant community recovery after high-severity wildfire and post-fire management in the Klamath Region, Master's Thesis: http://www.fsl.orst.edu/cfer/pdfs/LopezThesis.pdf

Predicting Post-Fire Regeneration Needs: Spatial and Temporal Variation in Natural Regeneration in Northern California and Southwest Oregon, JFSP Final Report, Project 05-2-1-40. https://www.firescience.gov/projects/05-2-1-40/project/05-2-1-40_final_report.pdf

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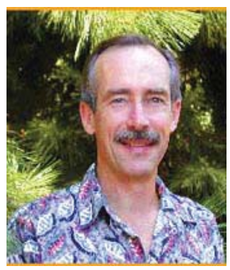
Scientist Profile



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The information in this Brief is written from JFSP Project Number 05-2-1-40, which is available at www.firescience.gov.

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Joint Fire Science Program
Manager's Viewpoint
WRITTEN BY MANAGERS FOR MANAGERS
May 2009

Predicting Post-fire Regeneration Needs: Spatial and Temporal Variation in Natural Regeneration in Southwest Oregon and Northern California

Written By: Paige Houston

Purpose of this opinion piece

Manager's Viewpoint is an opinion piece written by a fire or land manager based on information in a JFSP final report and other supporting documents. This is our way of helping managers interpret science findings. If readers have differing viewpoints, we encourage further dialogue through additional opinions. Please contact Tim Swedberg to submit input (timothy_swedberg@nifc.blm.gov). Our intent is to start conversations about what works and what doesn't.

Problem

Post-fire regeneration methods is a topic in which little research has been undertaken to fully understand how ecosystems and landscapes recover "naturally" after catastrophic fire events. This particular study area, located in the coastal region of southern Oregon and northern California, includes a large regional landscape of national forests and wilderness areas. The research intends to illustrate how natural regeneration succession occurs post fire and which areas within those burned perimeters show the highest survival and densities in the context of seed source availability and distance from that seed source.

This project addresses several key issues, including: What is natural regeneration's role after wildfires? What can land managers do to become better informed in understanding ecological processes? How can land managers identify natural regeneration areas in a spatial and temporal setting? Thus, this study will assist land managers in prioritizing goals to meet management objectives and compare productivity decades later.

Application by Land Managers: Role of Natural Regeneration Post Wildfires

Statistics derived from the study illustrate useful information to land managers regarding burned areas and how to sustain natural regeneration post fire in southwestern Oregon. Findings show natural regeneration is limited on drier sites and typically lower elevation on the eastern range, with increased abundance within 450 meters from seed sources.

This information is compelling relating to the concept behind the productivity gradient—specifically, that on certain xeric sites (seedlings/saplings), vegetation was not as abundant

(Shatford and Hibbs 2006). In addition, this study's statistics will provide land managers guidelines in understanding stand dynamics decades after fires, as survival of conifers is apparent after high-severity fires.

Site characteristics such as vegetation, soil, diversity of species, and density of seedlings/ saplings offer a great way for land managers to focus attention on areas that don't meet criteria for the role of natural regeneration post wildfire. The landscape-level analysis will provide avenues in which information will be shared for understanding ecological processes in the future.

Information Sharing and Understanding Ecological Processes

Surveys have been completed and reported within the Cooperative Forest Ecosystem Research (CFER) 2006 annual report that illustrate findings of natural regeneration taking place up to two decades after high-severity fires. These findings allow researchers and scientists to collaborate effectively, knowing that land managers will then be implementing and prioritizing goals on the ground. In addition, ongoing workshops in the Pacific Southwest Region are sharing technology in understanding ecological processes—helping to focus those goals. In other words, landscape-level surveys offer findings of where natural regeneration is not occurring and where artificial regeneration may be effective to achieve management objectives (Shatford and Hibbs 2006).

Landscape-level surveys offer findings of where natural regeneration is not occurring and where artificial regeneration may be effective to achieve management objectives.

The CFER annual report has compiled key identifiers from tables, including distance from seed source, surrounding vegetation, crown density of naturally occurring conifers, soil, and species of vegetation. Thus, the report provides scientists and managers the ability to share this information in terms of productivity across a productivity gradient.

Ecological processes and stand dynamics on the xeric sites show climax species such as Douglas fir as the highest trees per acre compared to other more seral species such as ponderosa pine and incense cedar. This comparison was the same as elevation increased, except the true firs out-competed the Douglas-fir species (Shatford and Hibbs 2007). Implications from the study also took into account that the hottest and driest sites will require some artificial planting methods to ensure success in stocking and seed availability for future regeneration.

Spatially and Temporally Arranged Regeneration

As the findings have illustrated regarding regeneration over time and space, artificial planting is not needed due to how well the forests are recovering post fire. Ten to 20 years later we see positive signs of how adaptation is occurring. As more time passes, more and more conifers and hardwoods are replenishing (Shatford and Hibbs 2006).

In a spatial context, some factors that effect how coniferous forests adapt are termed "edge effect." Distance from the edge determines growth rates (Chen, Franklin and Spies 1992). In other words, when disturbance occurs—such as with high-severity fires—the types of species that will likely occur—how many, and how fast they grow—are dependent on how they are spatially and temporally arranged and their location to the edge of other live conifers and vegetation.

Prioritizing Goals to Meet Management Objectives

Overall, land managers can apply this project into everyday land management planning that assists in prioritizing goals for future management activities. To meet management objectives in the future and keep apprised of recent developments, land managers will need to continue the ongoing collaboration with scientists, including participating in workshops, field trips, seminars, symposiums, and other organized technology transfer events. Such efforts will assist in prioritizing goals, especially when budgets are tight and goals conflict. Adding to this management challenge is the fact that research is limited regarding how natural regeneration is adapting to environmental changes and catastrophic fire events that can consume viable seed sources for a sustainable future.

Overall, land managers can apply this project into everyday land management planning that assists in prioritizing goals for future management activities.

This study took great effort to organize the surrounding forests and adjacent districts along with multiple land managers within the Forest Service to identify the best way to understand ecological processes and achieve results with little funding. As research findings continue and updates are forthcoming, this project will provide land managers a way to gain insight into post-fire regeneration processes.

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Shatford, Jeff and David E. Hibbs. 2007. JFSP 05-2-1-40. Predicting Post-fire Regeneration Needs: Spatial and Temporal Variation in Natural Regeneration in Southwestern Oregon and Northern California. Final Report.

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Manager Profile

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The information in this Manager's Viewpoint is based on JFSP Project 05-2-1-40, Predicting Post-Fire Regeneration Needs: Spatial and Temporal Variation in Natural Regeneration in Southwest Oregon and Northern California; Principal Investigator was David E. Hibbs.