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

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Annual report – Highlights

In 2006, we completed our second and final field season surveying historic fires in southwestern Oregon and northern California. Additionally, we identified and received copies of natural regeneration data from forest management agencies in southwestern Oregon. Findings to date were presented at one agency workshop and a Joint Fire Science Program field tour. We have submitted one manuscript to the Journal of Forestry (pending). We continue to develop ties with silviculture personnel in the Klamath National Forest and other agency offices in the region and have been invited to present our findings at the Southwestern Oregon Ecosystem Management Workshop in Gold Beach, Oregon, on January 30-31, 2007 and the US Forest Service Region 5 Fuels and Vegetation Workshop in Reno, Nevada, in February 2007.

Study Rationale

Regeneration research over the past several decades has focused on artificial regeneration. Natural regeneration provides many advantages but information is lacking on how to merge this approach with management goals. Shrinking budgets and increased burned areas has made post-fire reforestation planning an ever more frequent but difficult task for forest managers.

Approach

We established a two part research program focused on areas of high severity wildfire (i.e. canopy replacing events):

1) landscape level survey of naturally regenerating areas 10-20 years after fire disturbance, and
2) soliciting existing data on natural regeneration from agency offices and ecologists in the region.

These approaches are intended to complement one another: part 1 will investigate both temporal and spatial patterns of regeneration across the region, while part 2 will provide a spatially robust, but temporally limited, analysis of natural regeneration. By improving predictions of natural regeneration patterns in time and space, this study will be highly informative to forest managers trying to prioritize management actions after wildfire.

Primary Questions

- What is the annual rate of conifer regeneration in the first 1 – 2 decades after stand replacing wildfire?
- How does this vary among tree species or forest type?
- How do slope, aspect and elevation interact to influence the abundance of conifer regeneration?
- Does distance from seed source (intact forest edge) play a major role in forest recovery and conifer abundance?
- What is the composition of early successional habitats - conifers, hardwoods and shrubs, and their relative abundance?

Part 1 – Landscape Level Survey

Study area

We sampled across a broad gradient of productivity from moist, highly productive Douglas-fir/Tanoak series near the Pacific Coast, to the more arid Douglas-fir and Pine-Oak series inland, encompassing southern Oregon and northern California (Figure 1).

- Avoided obvious serpentine areas due to their limited productivity.
- Sampled in areas subject to high severity wildfire that occurred between 1983 and 1996.
- Sites were not salvage logged or planted following wildfire.
- To date, 37 plots were sampled in 2005 and 62 were sampled in 2006. These plots ranged in location from the Umpqua National Forest south to the Shasta Trinity National Forest and from Interstate 5 to within 15 km of the Pacific Ocean.
- Canopy openings ranged from approximately 5 ha to more than 50 ha.

Survey Method

At each location a 12 x 40 meter transect was established to estimate:

- tree density (by species and size class) for both conifers and hardwoods.
- percent cover of all woody plants by species.
- snag density to characterize the stand conditions before the wild fire.

Each transect was comprised of 30 4x4 m cells. In each cell we aged the dominant conifer, if present, to determine stocking rate each year since the fire. Tree height and recent leader growth of up to 30 dominant trees/transect were also measured.

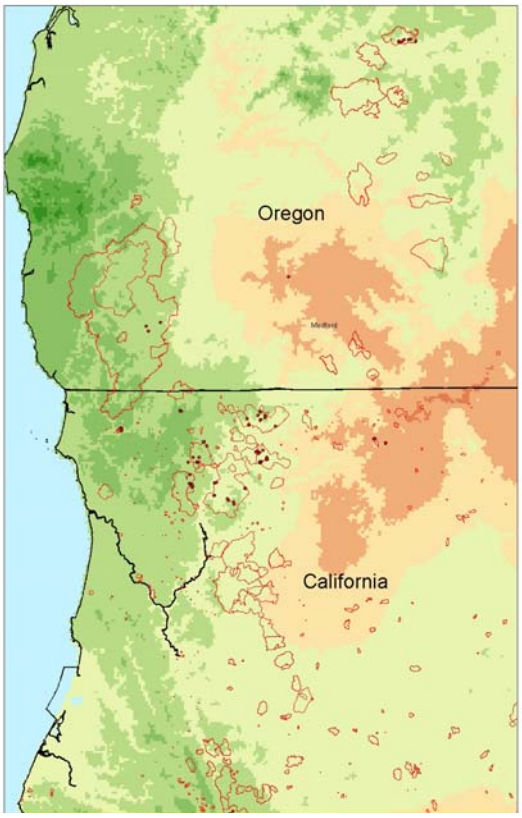

Figure 1. Large (greater than 1,000 ha) forest fires from 1970-2002 in northern California and SW Oregon. Sites within the region range in annual precipitation from 50 - >200 cm/ year. Our study includes samples from the Boulder Creek Wilderness in the north to sites in the Yolla Bolla National Forest in the south (red circles = study plots).

Results (2005 data only)

- Competing vegetation, shrubs and resprouting hardwoods were abundant on many sites except on xeric sites (sites with low rainfall or shallow soils).
- Distance from seed source to transect ranged from 0 to greater than 400 m.
- Density of natural regenerating conifers ranged over three orders of magnitude (Table 1).
- In Douglas-fir groups (including tanoak associations and mixed-conifer forests), regeneration ranged from a low of 146 trees per hectare (tph) to a high of 8188 tph (1878 ± 2184 [mean ± SD], *n*= 18).

Low to Mid - Elevation Douglas-fir Sites

	Douglas-fir	Sugar Pine	Knobcone	Ponderosa	True fir	Incense cedar	per plot	per Acre	per ha
	327	2	0	8	0	56	393	3315	8188
	5	0	300	5	0	0	310	2615	6458
	117	0	3	41	2	8	171	1442	3563
	116	0	0	23	2	10	151	1274	3146
	140	0	0	0	0	0	142	1198	2958
	128	0	5	1	1	0	135	1139	2813
	82	0	29	0	7	0	118	995	2458
	2	1	77	0	0	0	81	683	1688
	46	1	0	0	26	0	73	616	1521
	53	0	0	2	0	2	57	481	1188
	3	23	16	1	0	0	43	363	896
	24	0	0	15	0	0	42	354	875
	13	4	0	15	0	0	33	278	688
	0	0	27	0	0	0	27	228	563
	25	0	0	0	0	0	25	211	521
	8	0	0	13	0	2	23	194	479
	2	8	1	0	0	4	15	127	313
	1	0	0	5	0	6	12	101	250
	8	0	0	0	0	0	8	67	167
	7	0	1	0	0	0	8	67	167
	6	0	0	2	0	0	8	67	167
	0	0	0	4	0	3	7	59	146
	0	2	1	0	0	1	4	34	83
	1	0	0	0	0	0	1	8	21
Average	46	2	19	6	2	4	79	663	1638

High Elevation True Fir Sites

	1	0	0	0	793	1	805	6790	16771
	1	0	0	0	680	1	683	5761	14229
	2	1	1	0	540	0	544	4588	11333
	93	1	10	0	383	1	488	4116	10167
	0	0	0	0	487	0	487	4108	10146
	0	0	0	0	432	0	432	3644	9000
	154	0	3	0	109	3	271	2286	5646
	84	1	6	0	48	1	140	1181	2917
	48	0	0	0	35	0	83	700	1729
	1	1	0	0	56	0	58	489	1208
	2	0	0	0	31	0	33	278	688
Average	35	0	2	0	327	1	366	3086	7621

Table 1. Conifer seedlings/saplings occupying each of 35 transects (12x40m) sampled 10-20 years after wildfires in SW Oregon and northern California.

- On true fir sites, regeneration ranged from a low of 688 tph to a high of 16,771 tph (9193 ± 5763 [mean ± SD], *n*=8).
- A 4- x 4-m (~1/250 acre or ~1/600 ha) cell containing a sapling >1 year was considered occupied or stocked. Conifer stocking at Douglas-fir sites averaged 65%, and true fir sites averaged 80% stocking (Figure 2).

Although the abundance of natural regeneration was frequently high (Table 1), the age (Figure 2) size and species composition (Table 1) of saplings ranged considerably. Frequently, the regenerating saplings were over topped by shrubs and hardwoods. However, there was no evidence of recent conifer sapling mortality (i.e., no dead or dying saplings) caused by competition from shrubs or self-thinning. Saplings were generally in good condition, with dominant trees having a live crown ratio of 50% or greater.

2006 Data Collection

Field surveys were conducted from May 15 through September 26, 2006. We have added an additional 62 plots in unmanaged sites, including sites in the Klamath and Shasta-Trinity National Forests and on Bureau of Land Management (BLM) lands near Grants Pass, Oregon (accompanying site photos Figures 3-10).

Part 2 - Agency data

At least two USFS Ranger Districts have provided data from past natural regeneration surveys in post-wildfire settings. Natural regeneration following fire was sampled on the EcoPlots used for vegetation studies in southern Oregon. Additional sources have been identified including Forest Inventory Analysis Plots and will be sought.

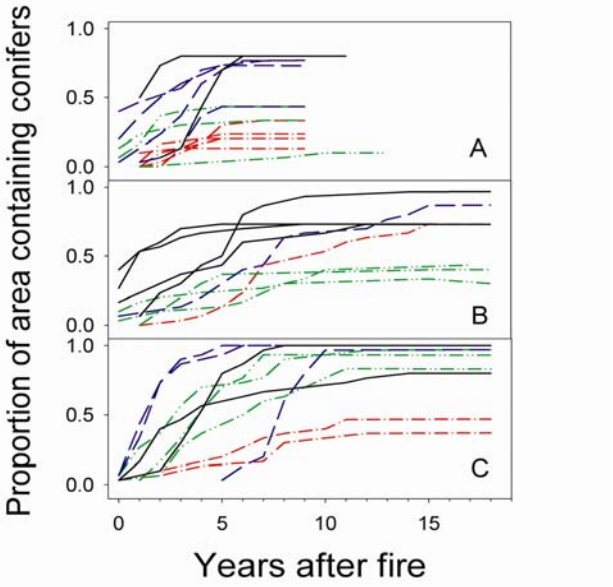

Figure 2 | The proportion of 4x4m cells in each plot containing one or more established conifers over time since wildfire provides an indication of fine scale dispersal of conifers across a stand. a Establishment after fires of 1992–96 on low elevation sites. b Establishment after fires of 1987 on low elevation sites. c Establishment after fires of 1987 on high elevation sites in the Klamath-Siskiyou region. The Y axis represents the proportion of the thirty 4x4 m cells comprising each plot occupied by one or more conifer seedlings (1.0= 100% occupancy).

Technology Transfer

Our work has generated considerable interest to date amongst forest managers in the region. Jeff Shatford assisted in the organization of a 1 day workshop held at Gold Beach, Oregon on February 8th, 2006. This event was attended by over 75 federal agency personnel and industry representatives. Our findings were of particular interest to those in the audience dealing with regeneration challenges following the Biscuit fire of 2002.

A manuscript of our findings to date was submitted to the Journal of Forestry in March 2006. Our findings are highly relevant to the on-going debate regarding post-fire forest recovery (Donato et al. Jan. 2006, publication in

Science and comments by Newton et al. 2006). We provide insights to natural forest succession in the area of contention. We are working through the reviewers' comments and will re-submit our manuscript this fall.

Over the course of our field visits in the Klamath National Forest and elsewhere, we have developed a strong working relationship with silviculture managers in the area. This has greatly benefited our ability to identify suitable study sites and understand the forest ecology and management history both in forest regeneration and wildfire management.

Upcoming

Analysis of our four proposed environmental drivers: climate, elevation, aspect and distance to seed source will commence once data is entered in electronic format. Data from agency files will be collated and screened for information content to determine what factors each have in common, or can be generated (e.g. from GIS layers), and analyzed accordingly.

We anticipate sharing our results this winter at the Southwestern Oregon Ecosystem Management workshop January 30-31, 2007, in Gold Beach, Oregon and the USFS Region 5 winter meeting February 2007 in Reno, Nevada. We look forward to the opportunity to reach our core audience with these results of this research program.

Emerging Questions

Our initial findings have already generated interest and additional questions among our research group.

- How do the size and density of conifer trees on our unmanaged sites compare with forest recovery on managed sites in the same area and following the same wildfires 10-20 years later? This has lead to a graduate student project with data collected this past summer.
- Will the high density of conifers observed under the shrub layer survive and emerge above the competing hardwood and shrub layer? Growth data (two years of conifer leader growth) collected in 2006 will help address this question.
- What role does the abundant shrub and hardwood community play in ecosystem recovery after the large disturbance, particularly nutrient inputs and retention? A preliminary study of these factors will move forward with BLM funding in 2007.
- How does the vegetation community influence the structure of the subsequent conifer stand, i.e. tree density, growth rate, diameter distributions, crown height, etc.?

Figure 3. Nineteen years after wildfire consumed this white fir stand in the Klamath National Forest, trees were still relatively small (0.5-2 m) but numerous (>5,000/ha).

Figure 4. Laying out the 12x40 m transect through ceonothus beneath large snags left after the fire of 1987.

Figure 5. A young forest of Douglas-fir and Ponderosa pine growing vigorously along with the brush on the site of the Lake Fire of 1987, Klamath National Forest.

Figure 6. Salvage logging after the Hermit Fire in 1988 left a ¼ mile buffer on the SW Trinity River. The unsalvaged buffer (pictured here) provided a great opportunity to study natural regeneration ~20 years after fire.

Figure 7. Across the Trinity river, on a south facing slope, manzanita and canyon-live oak were winning out over conifers.

Figure 9. Blackened snags still standing 19 years after the Lake fire of 1987.

Figure 8. Knobcone pine and Douglas-fir saplings emerge above the manzanita in the Siskiyous Wilderness area burned 19 years previously.

Figure 10. Scant vegetation on a south facing site with rocky soil indicative of 'harsh' conditions, conifers were making a come back after a wildfire in 1987.

The Cooperative Forest Ecosystem Research (CFER) program was developed to facilitate sound management of forest ecosystems, with emphasis on meeting priority research information needs of the Bureau of Land Management (BLM) and the Oregon Department of Forestry (ODF) in Western Oregon.

The information contained in this document is preliminary in nature and has not been peer-reviewed. The data are not guaranteed to be correct or complete. Users are cautioned to consider carefully the provisional nature of the information.

The CFER program cooperators provide financial support, faculty and staff to conduct research and information exchange, study sites, assistance with project installations, and in-kind support as needed.

Program cooperators include: