Sudden Oak Death Mortality and Fire: Lessons from the Basin Complex[1]

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Abstract

Land managers, fire suppression professionals, and research scientists have speculated about the relationship between increased *Phytophthora ramorum*-caused hardwood mortality and wildfire incidence, severity, and behavior in coastal California. Little quantitative data has emerged to measure the nature of any such relationship. The Basin Complex and Chalk fires in the summer and fall of 2008 along the Big Sur Coast provided the first opportunity for observers to confirm or disconfirm speculations about fire and *P. ramorum.* In an effort to focus research, outreach, and technical assistance, we conducted an information-gathering survey targeted at select personnel who worked on the Basin Complex and Chalk fires, and followed the survey with a series of meetings with land management professionals and scientists to obtain recommendations for how these firefighters' experiences should inform future research and outreach efforts. Recommendations included more effective provision of needed maps and safety information; future research into the best methods for sanitizing water or ensuring that infested stream water is not used to fight fire; investigation into characteristics of live fuels in areas of increased hardwood mortality to aid fire behavior analysts with predictions; and increased coordination with firefighting agencies for information distribution and standardization of demobilization procedures.

Introduction

Concern about potential interactions between fire and large numbers of dead hardwood trees killed by *Phytophthora ramorum*, the cause of sudden oak death (SOD), has been present for some time among scientists, land managers, and residents of the coastal California wildland-urban interface. It is unknown whether the amounts and configurations of fuels contributed to coastal forests by *P. ramorum* might make fires in those forests behave differently, might make them more difficult to suppress, or might contribute to a large-scale change in fire ecology. Most of the limited experience with, and research on, *P. ramorum* and fire has so far concentrated on single field-based (K. Julin, personal communication) or lab-based (K. Fischer, personal communication) case studies, on GIS-based analyses (Moritz and Odion 2005), or on speculation from land managers and the public on fire's probable effects on the pathogen. One study did compare ground surface fuel loadings in infested and uninfested stands in two forest types (redwood/tanoak and Douglas-fir/tanoak) at Point Reyes National Seashore, finding that fuel loadings were significantly greater in diseased redwood/tanoak forests than in Douglas-fir/tanoak forests, with most of this increased loading coming from the 1000-hour (>3 inches in diameter) fuel class. On the other hand, surface fuel loading was significantly greater in healthy Douglas-

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fir/tanoak stands than in diseased Douglas-fir/tanoak stands, with most of this increased loading coming from greater amounts of duff (Moritz and others 2008).

The Basin Complex fire in Big Sur, which began on June 21, 2008 as several smaller fires that subsequently coalesced, burned 162,818 acres before being declared contained on July 27 (InciWeb 2008a). The western and northern flanks of this fire burned in several areas noted for heavy tanoak (*Lithocarpus densiflorus*) and coast live oak (*Quercus agrifolia*) mortality caused by *P. ramorum*. The Chalk Fire began later, on September 27, and burned 16,269 acres before being declared contained on October 30 (InciWeb 2008b). The Chalk Fire burned farther south along the coast than the Basin Complex, and like the former fire, it burned in areas containing trees killed by *P. ramorum.* This series of fires provided the first opportunity for interested observers to gauge the effects of increased hardwood mortality on firefighter safety, fire suppression operations, fire behavior, fire severity, vegetation response, and pathogen persistence in burned areas.

Methods

Systematic studies are underway to provide some of this information (D. Rizzo, personal communication; Metz, this volume). However, in an attempt to capture the perspective of experienced firefighters to inform a discussion of operational and information needs for people working on similar fires in the future, we launched a survey-driven effort that used a two-stage approach to consolidate the available anecdotal information. First, we administered a survey regarding fire behavior and fire operations in the Basin Complex and Chalk Fires to a core group of incident management team (IMT) personnel. Second, we convened a series of three web meetings with a variety of firefighting administrators, ecologists, and land managers to bring some of the issues raised by survey respondents under the lens of scientific knowledge for development of a concise set of recommendations for policy, education, and operations related to fire and SOD.

We distributed our initial survey to a small group of firefighting administrators with experience on the Basin Complex and Chalk Fires, obtaining additional contacts through iterative requests of the people whom we were talking to as well as through a posting on MyFireCommunity.net, a virtual community of wildfire professionals. As IMTs are composed of personnel from various agencies and states, we spoke to individuals from a variety of jurisdictions in both California and Oregon who worked on the fires. Since one of the longstanding questions about SOD and fire involved whether the creation of a custom fuel model is warranted for areas with heavy hardwood mortality, we made particular attempts to solicit participation from fire behavior analysts.

The survey addressed the following general topic areas:

Fire Behavior	Fire Operations
General changes in fire behavior	Maintaining fire lines
Spotting	Hazard trees/safety challenges
Rates of spread	Hot spots
Flame lengths	Mop-up
Energy release	Demobilization process/sanitation
Residence time	Water cleanliness
Difficulty in predicting fire behavior	Future research needs
Future research needs	

The core group of fire professionals who were administered the survey included 12 individuals with direct experience on the fires in Big Sur. Their responses informed the series of web meetings, which included 20 additional professionals. In each meeting, the general issues surrounding fire and SOD were presented as background material, and survey results were summarized for meeting participants. The first discussion specifically addressed fire operations issues, and the second addressed fire behavior and fire ecology. The third discussion synthesized the results of the first two discussions to reach conclusions on how best to move forward with integrated education and mapping efforts, policy recommendations, and future research needs.

Results and Discussion

Survey Results: Fire Behavior

Most striking about the responses from firefighting personnel who worked on the Basin Complex was the perception that *P. ramorum*-caused mortality had markedly increased surface fuel loading. This resulted in noticeably longer flame lengths, with one respondent commenting that quiet (~4-foot flame length) fires burning in grass fuel models sometimes increased to 20-foot flame lengths when they ran into areas of tanoak and coast live oak mortality. The same respondent estimated that the fuel loading has increased by a factor of five. Such fuel-fed increases in flame length can make direct attack tactics on the flame front infeasible and usually require firefighters to retreat to the nearest ridge to initiate back burning.

Indeed, this was reported numerous times during operations on the Basin Complex. Choice of tactics is not a value-neutral topic, as it can influence the eventual amount of forest burned (whether purposefully or not), structures chosen for protection or abandoned, and amount of involvement and input from the local community (Terence 2008, Sabalow 2008). One survey respondent explained that on the Basin Complex, community perceptions of the U.S. Department of Agriculture, Forest Service (USDA FS) management in the northern part of the fire, where the most tanoak and oak mortality was located, were more negative in general than perceptions of both the California Department of Forestry and Fire Protection (CAL FIRE) and the USDA FS management farther south in the Chalk Fire. This had to do at least partly with the amount of indirect attack necessary in the northern part of the fire.

However, it would be premature to conclude that increased hardwood mortality because of *P. ramorum* was solely responsible for repeated choices to use indirect attack, since other respondents noted that changes in tactics are not uncommon in Big Sur, where rugged topography, fluctuating weather, and an abundance of fuels often cause increases in fire behavior that necessitate flexible decision making in regard to attack strategy. Also, areas of increased tanoak and oak surface fuels were patchy. One respondent noted that the fuels were arranged in “jackpots” and that the fire behavior increased and subsided cyclically as the fire traveled from jackpot to jackpot, while another noted that the Chalk Fire burned in such steep topography that most of the surface fuels had already rolled to the bottoms of draws before the fire started. Another respondent, however, observed a larger-than-normal amount of rolling flaming material on the northwest side of the Basin Complex, as fuels remaining on the tops of steep slopes ignited and fell down the slopes.

Additionally, most people who were surveyed noted greater-than-normal spotting activity, either through increased ember production or increased spotting distance, from standing dead oaks and tanoaks. Standing dead trees, especially during the period of time when dead, brown leaves remain on the tree, are both good generators of ember material and good receivers for windblown embers that begin new spot fires. Spotting distances were noted to be over half a mile in some cases. This is in contrast to the Indians Fire, which burned at the same time to the east and eventually merged with Basin Complex. The Indians Fire burned in areas with little tanoak and a relatively light pattern of coast live oak mortality. As a result, one survey recipient reported that spotting on that fire did not appreciably increase.

Short-range spotting also made fireline placement more difficult on the Basin Complex. Besides the difficulty of cutting firelines in areas with piled-up mortality, embers landing on the far side of the line and igniting new spot fires often invalidated efforts to construct new lines soon after they were made.

Compounding this problem, large numbers of *P. ramorum*-killed trees fell across firelines. In general, the hazard caused by large numbers of falling dead trees elicited the most unanimous concern of all the survey topics; as one firefighting administrator put it, “Everyone knows someone who has been hit by a tree, so it’s the number one concern,” especially because failure rates were very high on this fire. One respondent estimated that half the standing dead trees in burned areas fell over within a time window between 20 minutes and twelve hours of fire front passage—much more quickly than could normally be expected. Personnel could not easily tell which trees posed a hazard, as they fell in unpredictable patterns and at unpredictable times.

It was noted that the fires in the Basin Complex burned actively downhill even at night, when humidity decreased in areas above the inversion layer that was present. This is a common component of coastal California fire weather (Pyne and others 1996). As such, conditions that encourage active burning at night are likely to be present in other areas with accelerated hardwood mortality caused by *P. ramorum.*

The prediction procedures used by fire behavior analysts working on the Basin Complex were conventional. In the absence of specific data or knowledge about burning conditions in the forest type where the fire is actively burning, they fit their current visual observations to whichever of the 13 standard fuel models seems most applicable. This may also involve adjusting various parameters in fire prediction modules such as FMA+[5] to fit observed deviations from the standard models. On the Basin Complex, analysts reported that the fire began in conditions that matched Fuel Model 2 (timber with grass understory, little to no surface fuel) and then transitioned to conditions that matched a modified version of either Fuel Model 11 (light logging slash) or Fuel Model 12 (medium logging slash). The differences in energy release and residence time between the latter two models are considerable, with the medium slash model generating much greater rates of spread, much more intense energy release and often firebrands (Anderson 1982), which can make control more difficult. However, both models differ from the Fuel Model 8 or 9 (timber with loose litter) that analysts might normally have expected to match the conditions in hardwood-dominated forests. Generally, fire behavior analysts expressed the opinion that the available fuel models, with sufficient experience on the part of the analyst in adjusting parameters to fit the individual situation, are sufficient to predict fire behavior in areas with heavy hardwood mortality. One respondent said that if the development of a custom fuel model could generate public interest and involvement in the issue, it might be worth the time and expense to develop it (see discussion below).

Survey Results: Fire Operations

To enhance fire suppression operations in areas of increased hardwood mortality, respondents recommended a number of measures that can be taken. Most of these measures involve information sharing. First on the list, as mentioned above, is the hazard of falling trees. Although firefighters receive daily briefings reminding them that trees killed by *P. ramorum* are likely to fail rapidly and unpredictably, they do not always know as they move about the landscape where they are in relation to areas of heavy mortality. In response to this need, respondents voiced their desire for reliable, fine-scale maps of mortality on the landscape to distribute to firefighters for safety purposes and also to use when making decisions about tactics and resource deployment. Some respondents also suggested that methods or technologies for rapid diagnosis of infected trees would also be very useful—a need that they share with others managing SOD.

The need for better and instantly available maps dovetails with a need for increased communication between fire behavior analysts working on different fires in scattered, far-flung coastal areas in California. According to one respondent, IMT members who observe unusual fire conditions on one incident are very likely to report these conditions to other IMT members within the same organization, but not necessarily to IMT members from other organizations. For example, communication about conditions in the field would flow freely from analyst to analyst within the Forest Service or within CAL FIRE, but not from analysts within the Forest Service to those from CAL FIRE or vice versa. Virtual communities like the one mentioned before in this paper are helpful, but not all fire management personnel are members of such communities. This spotlights a need for a central repository of information—both map information and informal communication—about fuels conditions throughout coastal California.

Another operations concern involved treatment of water used for firefighting. No unusual measures were apparently taken on the Basin Complex to sanitize drafted water to ensure that *P. ramorum* was not moved from infested streams to other areas

[5] Fuels Management Analyst Plus, a software package that predicts fire behavior, torching and crown fire activity, and tree mortality based on forest structure and fire weather information.

of the landscape. IMT members and fire behavior analysts typically had little opinion one way or the other about the need for this practice.

Opinions on the efficacy of sanitation procedures taken to decontaminate vehicles and equipment during the demobilization process varied widely. Some people believed that no out-of-the-ordinary procedures were implemented, while others cited a more extensive process involving water tank sterilization prior to leaving the area and the use of Lysol® for tool disinfection. One individual wondered what was done with the numerous rental vehicles used on the fires before they were returned. Respondents also had difficulty explaining where to obtain definitive answers to questions about the demobilization process. This testified to the decentralized nature of this part of fire suppression operations, in which each module made its own decisions regarding sanitation. However, another fire manager, who worked on fires in Mendocino County (another *P. ramorum*-infested county) during the same summer, mentioned that demobilization procedures are established at the unit level by CAL FIRE, which would indicate some level of standardization of the process. Follow-up contacts may be warranted on this issue.

Synthesis and Discussion

There was general agreement among respondents that increased hardwood mortality increased fire behavior (including rates of spread, fireline intensity, flame length, and spotting) in general—one fire behavior analyst opined that fire behavior generally increased by a factor of 20 to 25 percent. The mechanisms for this increase appeared to come primarily through (1) longer flame lengths and longer residence times because of increased surface fuel loads and (2) more unpredictable spread because of increased spotting related to dead leaves in the oaks and tanoaks.

However, respondents were split in their reactions to this increase in fire behavior. This split occurred between respondents who were local to the fire and those who traveled from out of the area to work on the fire. In general, local respondents were more united in their concern about the increase in fire behavior than out-of-area respondents. One form that this concern takes is a push for an increase in quantity and aggressiveness of fuels treatments. When asked about future research needs, several respondents were respectful of the need for more research, but said that fuel treatments should be an overriding priority for the money that might fund that research. Out-of-area respondents, however, seemed more inclined to say that while the Basin Complex "burned very well" and the fire behavior was sometimes extreme, they are always prepared for extreme fire behavior in this part of California—mortality or no mortality.

Among both groups, little support was voiced for the idea of developing a custom fuel model. It was suggested that effort should go instead into quantifying the nature of the live fuels that grow up through the dead fuels on the forest floor, as the number and arrangement of live fuels are the primary variable factors for adjustment in fire behavior prediction programs when utilizing slash-type fuel models.

In the ensuing discussions, deliberations of the foregoing issues among the larger group of scientists and land managers unearthed some solid directions for information-sharing and new avenues for exploring potential solutions for problems, while leaving some intractable issues more nebulous. With regard to fire operations, water treatment and mapping/information-sharing generated some definite suggestions. One proposed option regarding water involved closing whole watercourses to water drafting, since individual water tender and engine operators do not have time or training to treat the water that goes into their tanks. This approach is taken by CAL FIRE in northwestern California to avoid moving water that is infested by *P. lateralis,* the cause of Port Orford-cedar root disease. However, it was noted that not all locations in coastal California have abundant water sources, so whatever water is present must be utilized; moreover, the likelihood of infecting trees or plants in the dry season in inland areas with water drafted from watercourses may be small. It was suggested that researchers investigate the efficacy against *P. ramorum* of new sanitizers and also the feasibility of using water drafting systems in which sanitizers are injected automatically into every tank of water, eliminating the need for direct handling of chemicals.

The USDA FS Forest Health Protection (FHP) performs aerial surveys each year that capture most of the detailed landscape-level hardwood mortality sought by firefighters. USDA FS FHP also has the capability of depicting the cumulative density of mortality in each mapped polygon (Z. Heath, FHP, personal communication). These maps, along with maps depicting infested watercourses, can be made available to firefighters through the Forest Resource and Assessment Program (FRAP) website maintained by CAL FIRE. Meeting participants mentioned that both CAL FIRE and USDA FS routinely use FRAP for data layer access during fire incidents. Regular updates to the mortality information will require a point person to serve as liaison between USDA FS FHP and FRAP personnel. Additionally, it was suggested that the availability of hardwood mortality and watercourse infestation maps should be advertised at California IMT and Safety Officer meetings. Other kinds of information, such as improved safety messages about snag hazards, can potentially be shared through the California IMT meetings as well.

The less tangible aspects of the synthesis conversations involved policy and public opinion. The availability, or lack thereof, of funding for fuels treatments in areas with high levels of hardwood mortality is a perennially difficult problem. It was noted that, while this issue was rated high on lists of issues eligible for American Recovery and Reinvestment Act funds, none of the proposed projects has yet received funding. Moreover, some of the counties with high levels of hardwood mortality do not have large areas of federally owned land, making it difficult for those counties to attract federal funding for fuels treatments. Another obstacle to timely implementation of treatments is documentation required for National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements—documentation that must begin months or even years before projects can begin. Although streamlining these permitting processes in the name of environmental "emergencies" is an idea that is often proposed, in reality, authorities are rarely amenable to signing off on the kinds of programmatic commitments that would enable such projects to proceed at the levels needed.

Complicating the funding picture are the constantly varying nature of public opinion and constantly changing levels of awareness of fuels-related hazards on the landscape. One participant in the web meetings suggested that the public as a whole may actually be becoming **less** aware of fuel hazard issues in California. In this context, he suggested that although hardwood mortality does not present a new or unique problem—fuel is fuel—SOD provides a chance to capture the public's imagination and harness energy for new fuels management efforts. As we look toward the next fire season, finding a way to meet these thorny, unresolved challenges—as well as implementing the definite suggestions for action made at these meetings—is imperative.

Summary Recommendations

Following is a list of recommendations for action to improve firefighter safety, increase the effectiveness of fire suppression operations, and better understand fire behavior in areas with increased hardwood mortality.

- Coordinate mapping efforts between USDA FS FHP and FRAP to provide a *P. ramorum*-related mapping resource at two scales: mortality (including density within each mortality polygon) at a fine scale, and infested watercourses throughout the state.
- Investigate new sanitizers for water disinfestations.
- Investigate the costs and benefits of water drafting systems with injected sanitizers.
- Update the California Oak Mortality Task Force safety message for firefighters and investigate avenues for distribution.
- Initiate conversation with CAL FIRE units and USDA FS Pacific Southwest Region about improving demobilization procedures.
- Investigate the characterization of live fuels growing in areas of increased hardwood mortality for input to fire prediction programs.
- Provide these recommendations and the updated safety message to California IMT and Safety Officer meetings.

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