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Site conditions, fire, and root disease: *Leptographium* sp. and *Heterobasidion annosum* paradigms

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CONFERENCE ABSTRACT

Forest tree species have evolved under climatic, geological, and biological forces over eons of time. Root disease fungi, particularly root rotting Basidiomycetes are key drivers of coniferous forest ecosystems. They have co-evolved with their hosts under the pressure of these forces, and as such, are ideally in some state of equilibrium with them. Nonetheless, there are significant departures from the notion that native root disease fungi function in the same manner under many present forest conditions as they did prior to anthropogenic influences upon the forest landscape. These cases are often unpredictable and bring about significant ecological consequences. For example, fire reintroduction in fire suppressed conifer stands has unplanned pathological consequences. Issues such as decades of fire exclusion and fire reintroduction also have implications vis-à-vis *Heterobasidion annosum* root disease in *Sequoia giganteum* ecosystems. With respect to other root infecting fungi, our research showed an association of delayed mortality in longleaf pine with presence of *Leptographium terebrantis*, *L. procerum*, and other Ophiostomatoid pathogens, even after relatively cool burns. These fungal species are not considered virulent and longleaf pine is generally considered resistant to many diseases. These examples of unintended pathological consequences of management actions are a small number of many.

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implications vis-à-vis *Heterobasidion annosum* root disease in *Sequoia giganteum* ecosystems. With respect to other root infecting fungi, our research showed an association of delayed mortality in longleaf pine with presence of *Leptographium terebrantis*, *Leptographium procerum*, and other Ophiostomatoid pathogens, even after relatively cool burns. These fungal species are not considered virulent and longleaf pine is generally deemed resistant to many diseases. These unintended pathological consequences arising from management actions are a small number of many.

An example of such unintended pathological consequences is found in a longleaf pine ecosystem (*Pinus palustris* Mill.). Our research on the Savannah River Site showed delayed mortality of longleaf pine following prescribed burning (Figure 1) associated with the presence of *Leptographium terebrantis*, *L. procerum*, and other Ophiostomatoid fungi in the woody roots even after relatively cool burns (3, 5). In these studies, *Leptographium* species were widespread in woody tree roots of longleaf pine in all crown symptom classes. However, when periodic annual increment (PAI) is measured with respect to symptomatic trees, a decline was statistically significant at least eight years prior to measurement in severely symptomatic trees. It is possible that decrease in PAI is an indicator of *H. annosum* impact on these trees. Why are we observing these root pathogens and associated mortality in a tree species that is adapted to fire? What are the roles of insect vectors for these fungi in this phenomenon? Notwithstanding these questions, we also found *Heterobasidion annosum* infection to be widespread on the study site, possibly indicating the Ophiostomatoid fungi are playing a secondary role in mortality.

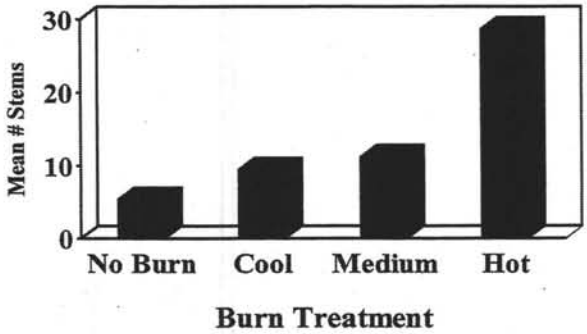

Figure 1. Longleaf pine mortality on the Savannah River Site three years after cool medium and hot intensity prescribed burn treatments.

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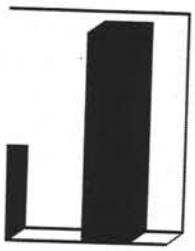

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Savannah River Site three
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We hypothesized many sites no longer possess specific edaphic and environmental conditions under which the species evolved because altered fire regimes, changes in soil conditions, or other factors that render trees susceptible to root pathogens. A scenario of events following prescribed burning that may explain this mortality may be the presence of fine roots in accumulated duff layers become damaged, thus weakening tree defenses. Long-standing *H. annosum* infection also continually weakens trees on such sites. This in turn predisposes roots to infection by opportunistic pathogens such as *Leptographium* sp. A slow decline syndrome is then set in motion whereby affected trees succumb to bark beetle attack or other stressors. We think opportunistic pathogens like *Leptographium* sp. are indicators of ecosystem stress or poor stand health due to various stress agents, rather than a primary cause of mortality.

On the other hand, we recently conducted (2006) root disease studies on impacted areas following the 1998 wildfires in the Osceola National Forest in Florida. We found infection by *Leptograhium* or Ophiostomatoid fungal species to be minor compared to the findings reported in studies conducted within a year following the fires. The *Leptographium* species reported by Hanula *et al.* (1) was not found in the same surviving trees. In this ecosystem, we hypothesize the slash pine and longleaf pine species are native to these sites and such pathogens, being opportunistic, do not become established in roots as they do in "off site" tree species or severely stressed ecosystems. Normal prescribed fire regimes are maintained on the Osceola National Forest sites, in contrast to less frequent fire regime in the Savannah River Site study.

Issues such as decades of fire exclusion and fire reintroduction also have implications vis-à-vis *H. annosum* root disease. The remaining stands of giant sequoia (*Sequoiadendron giganteum* (Lindl.) Buckholz) have been subject to decades of fire exclusion in United States national parks. This allows shade tolerant true firs (*Abies* sp.) to encroach in the understory. Firs have widespread infection from the *Ha* S biological species and there is evidence for increased root rot in the sequoia through contagion of infected root contacts of sequoia with true fir (4). In a recent long-term study on fire reintroduction effects in giant sequoia stands, we found a positive correlation between white fire density in sequoia stands and incidence of *H. annosum* (Figure 2). The results await future post-treatment studies but the information gained will be valuable in preserving this tree species.

Relationship between white fir density and number of Annosum gaps

$r^2 = 0.67,\ p = 0.007$

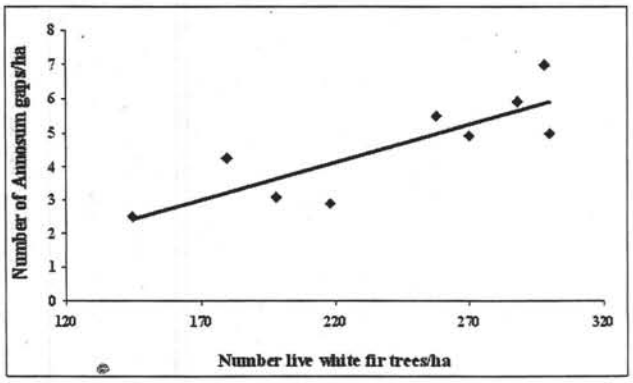

Figure 2. *H. annosum* is positively correlated with increasing white fir density in *Sequoia giganteum* stands.

Many pathological problems in forest stands arise from what we define as "exotic ecosystems", a pathologically unstable ecosystem arising from rapid edaphic and environmental changes brought about by past land use or current management practices (2). Pathological impacts or disease risk from fire, prescribed or wildfire, must be evaluated based upon a summation of factors such as tree species/site suitability, disturbances, or other stress factors. Pathological consequences can be unpredictable, but that may be a function of our incomplete knowledge of factors necessary for pathogens to affect forest stands.

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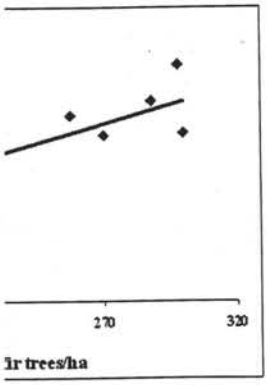

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