Proceedings of the 62nd Annual Western International Forest Disease Work Conference

September 8-12, 2014
Cedar City, Utah

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R. Haze Hunter Conference Center
Southern Utah University
Cedar City, UT, U.S.

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Papers are formatted and have minor editing for language, and style, but otherwise are printed as they were submitted. The authors are responsible for content.

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and
Alan Kanaskie

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2014 Annual Western International Forest Disease Work Conference Program
R. Haze Hunter Conference Center, Southern Utah University, Cedar City

MONDAY, SEPTEMBER 8^{TH}

8^{00} - 5^{00} pm	Pre-Meeting Field Trip?
3^{00} - 6^{00} pm	Registration
5^{00} - 7^{00} pm	Welcome social

TUESDAY, SEPTEMBER 9^{TH}

7^{00} - 8^{30} am	Dwarf Mistletoe Committee breakfast meeting (Dave Shaw)
7^{00} - 8^{30} am	Registration
8^{30} - 8^{45} am	Opening and Welcome from WIFDWC Chair Michael McWilliams
8^{45} - 10^{00} am	Student Introductions and Regional Reports
10^{00} - 10^{30} am	Break
10^{30} - 11^{30} am	Regional Reports (continued)
11^{30} - 12^{00} pm	Presentation by 2013 Outstanding Achievement Award recipient: Don Goheen
12^{00} - 1^{30} pm	Root Disease Committee lunch meeting (Blakey Lockman)
1^{30} – 3^{00} pm	Student papers (James Jacobs, moderator): Title TBA (Betsy Goodrich) Title TBA (Sara Ashiglar) Title TBA (Megan Dudley) Title TBA (Kathleen McKeever)
3^{00} - 3^{30} pm	Break
3^{30} – 4^{30} pm	Using Forest Inventory and Analysis (FIA) plots to assess root disease severity and hazard in N. Idaho and W. Montana (Blakey Lockman) A practical strategy for managing forest adaptation to climate change (Jim Worrall, Jerry Rehfeldt, Nick Crookston, Suzanne Marchetti)
4^{30} pm	Group photos, outdoors
7^{00}-9^{00} pm	Posters/ice cream social (Kelly Burns, poster session moderator)

WEDNESDAY, SEPTEMBER 10^{TH}

7^{00} - 8^{30} am	Hazard Tree Committee breakfast meeting (Pete Angwin)
8^{30} – 9^{15} am	Hazard tree topic (Speaker TBA) Evaluating Shore Pine Health in Southeast Alaska (Robin Mulvey)
9^{15} – 9^{30} am	Report on IUFRO Rusts of forest trees + IUFRO Breeding and genetic resources of five-needle pines + Strobusphere meeting (Kelly Burns)
9^{30} - 10^{00} am	Break
10^{00} - 12^{00} am	Panel: Physiological Ecology . . . (Sam St. Clair, moderator) Effects of wild and domestic ungulates on aspen regeneration and recruitment. Aaron Rhodes (Ph.D. Student, Brigham Young University): Legacy effects of fire size and severity on forest regeneration, recruitment and wildlife activity in aspen forests. Ho Yi Wan (Ph.D Student, Northern Arizona University): Mortality patterns along succession gradients of aspen-conifer forests. Sam St. Clair (Faculty, Brigham Young University):

12^{00} - 1^{30} pm	Rust Committee lunch meeting (Helen Maffei)
1^{30} - 3^{30} pm	Dendrochronology and past forest pest outbreaks (Susan Frankel, moderator) Scotty Strachan, Environmental Research, University of Nevada, Reno — Dendrochronology and climatic influences to forests Ann Lynch, USFS Rocky Mountain Research Station — A review of tree ring analysis: Insect outbreak patterns Cedar Welsh, Ecosystem Science and Management, Univ. of Northern British Columbia — Regional outbreak dynamics of Dothistroma needle blight linked to weather patterns in British Columbia Bryan A. Black, Marine Science Institute, University of Texas at Austin — Impacts of Swiss needle cast on overstory Douglas-fir forests of the western Oregon Coast Range: Results from a tree ring analysis
3^{30} - 4^{00} pm	Break
4^{00} - 5^{00} pm	Business meeting
6^{00} pm	Banquet and Announcement of Outstanding Achievement Award

THURSDAY, SEPTEMBER 11TH

7^{00} – 8^{00} am	Foliage and Twig Diseases Committee breakfast meeting (Harry Kope, moderator)
8^{00} am - 5^{00} pm	All-day field trip
5^{30}-7^{00} pm	Climate Change Committee meeting (Yankee Meadows conference room)
6^{30}-7^{30} pm	The Sages and the Whippersnappers – Retirees and greybeards meet young members to share advice and observations and answer any questions (Centro Pizzeria).

FRIDAY, SEPTEMBER 12TH

7^{00} – 8^{30} pm	Nursery Pathology Committee meeting (Will Littke)
8^{30} – 10^{45} am	Special papers (Amy Ramsey, moderator) 8:35 James Blodgett — Aspen conditions on national forests in the northern Rocky Mountain Region Armillaria in aspen 9:05 Robin Mulvey — Evaluating shore pine in Alaska 9:30 Danny Norlander — Forest health and technology 9:55 Kristen Chadwick — Bigleaf maple
10^{20} – 10^{35} am	Closing remarks from Chair Michael McWilliams

WIFDWC 2014 Outstanding Achievement Award: Charles G. Shaw III And Willis Littke

The Outstanding Achievement Award (OAA) Committee: **Paul Hennon, Mike Cruickshank, and Kathy Lewis**

We are honored to announce the joint recipients of the WIFDWC 2014 Outstanding Achievement Award.

Will and Terry had exceptionally productive and distinguished careers in forest pathology. Their breadth of experience, worldwide contributions to forest pathology, influence on colleagues and students, and service to WIFDWC have been unmatched. It's fitting that these two characters are awarded the Outstanding Achievement Award in the same year. Either recipient could and should have received the award alone, but due the number of outstanding people who deserve awards and who have not been honored, the awards committee suggested that a dual award was best. The committee also had great difficulty in choosing between either candidate because of their similar achievements and personal characters.

After graduating from UW in 1982, Will took a job at Weyerhaeuser allowing him to bring a unique industry point of view to WIFDWC. In his working career Will studied foliage diseases, black stain and laminated root rot, and nursery diseases, but these represent only a sliver of his pathology and forest management interests. Will never refused to commit his time, and is especially noted for his long term service in the WIFDWC Nursery Pathology Committee. He could often be found with his nose in a hand glass identifying fruiting structures on the sideline of field trips, often surrounded by students and colleagues anxious to learn what he had found.

Terry was exposed to plant pathology by his father Gardener, and he worked on blister rust control before entering graduate school. Terry studied Armillaria in graduate school at OSU and graduated in 1975. He started work for the US Forest Service shortly thereafter and studied details on the biology and disease management for dwarf mistletoe, shoot and root diseases, and mycorrihzae. Terry's successful shift to an administrator in Forest Service research allowed him to be involved in most all forest pathology projects in the west. Later in his career, Terry was focused on applying science in world of policy and forest planning.

Terry and Willis work hard and they play hard. Whatever they did to be recognized for their social achievements at WIFDWC in 1984 and 1991, respectively, stays in Taos and Carmel.

The West was not big enough for both them. Both Terry and Will also worked throughout the world. Terry left his mark in New Zealand, Australia, and Scotland; Will in Asia and South America.

Both Will and Terry have mentored countless graduate students and young forest pathologists, even though neither did so as directly from universities. Several support letters that we received from working pathologists described deep appreciation to Will and Terry because of their insights and guidance.

Every WIFDWC attendee will remember the contributions of these two sages at our meetings, often sitting quietly together off to the side, but then asking the most probing and sometimes unsettling questions. Most speakers breathed a sigh of relief after their presentation was finished. Their nonstop energy, insight, humor, and determination to get things right are unparalleled. Their love of frank and open discussion often stimulated new thinking and continues the spirit and tradition from the early days of WIFDWC.

Surely, there are no pathologists among us with a richer list of pathology and non-pathology stories than Will and Terry. We recommend that each of you sit and listen to a few of these colorful, animated tales this week.

We would like to thank each of you who wrote a letter of support for the nomination of a forest pathologist for this award.

2014 Outstanding Achievement Award Recipient Don Goheen

I wasn't able to attend the 2013 WIFDWC meeting and was surprised and shocked afterwards to learn that I was the recipient of this award. Of course, I was also extremely gratified. What an honor!

I had a wonderful career in forest pathology (and "wonderful" is a word you should never use lightly). My career was extremely interesting, challenging, full of new things, productive, and almost always singularly enjoyable. I spent all of it as an extension forest pathologist for the Pacific Northwest Region of the US Forest Service.

Nineteen seventy-five, when I was finishing my degree, was a prime year to be looking for work in forest pathology. There were numerous jobs being advertised in research, teaching, and extension with universities and colleges, federal and state agencies, and even private industry all hiring. When I applied for my extension position with the Forest Service, I knew very little about what such a job would actually entail. I tried for the job mainly because it was situated in the part of the country that I wanted to live in. Fortuitously, the job turned out to be just about perfect for someone like me, but it took a little while to figure out how to do justice to it.

When thinking about making this presentation, I decided it might be interesting to come up with a list of principals or, maybe a better term, suggestions that I would give in light of a long career to someone just beginning a government agency extension forest pathologist job, especially an imaginary person as clueless and naïve as I was when I started.

So with your indulgence, I list:

GOHEEN'S THIRTEEN SUGGESTIONS FOR A FULFILLING AND ENJOYABLE CAREER AS AN EXTENSION FOREST PATHOLOGIST IN THE FOREST SERVICE:

1. Be passionate about forest pathology. Don't hide your interest and enthusiasm. You're working in a fascinating field. Demonstrations of intense interest about dead and dying trees may make your clients think that you're slightly eccentric, but based on my experience, they will appreciate you all the more for that.

2. Spend as much time as you can in the field. For most extension activities, the field is the best setting for getting your message across. Besides, the field is almost always the most interesting place to be. I don't think I ever spent a day in the woods in which I didn't learn something new, but I spent more than a few days in the office that were absolutely bereft of any opportunities for expanding knowledge.

3. Be the last one back to the rig at the end of the day irrespective of weather. By this I don't mean that a forest pathologist should lurk in the woods until after everyone else has gone back to the vehicle. Rather, I'm suggesting that a good pathologist should stay in the field, involved with clients, as long as they remain interested and receptive.

4. Show your clients respect and give them good value.

a) Always be on time for appointments.
b) Become a good listener.
c) Determine your client's objectives and desired future conditions; give these

maximum consideration in formulating your recommendations; couch your advice in terms of alternatives if possible.

d) Never talk down to your clients.

e) Don't use 10 words where three will suffice; minimize jargon.

f) If a client asks you a question and you don't know the answer, say so; don't try to fake it; indicate that you don't know the answer now but will try to find it in the future and follow up on that promise.

g) If at all impressed with a client's skill and dedication, include mention of that in your report and circulate the report to the client's supervisor.

5. Emphasize client training in your program. High quality, well prepared forest disease training sessions may be considerable work to put on, but they produce highly valuable, long-lasting results. They really do give you the biggest bang for the buck. Management-oriented sessions done in the field are especially memorable to the participants.

6. Take advantage of opportunities for personal cross training and study in fields that interact with or are related to forest pathology. Gaining at least some expertise in such arenas as forest entomology, plant ecology, wildlife science, fire ecology, and silviculture will enable you to provide forest pathology recommendations to your clients in a better and more holistic context.

7. Recognize that tree diseases can be variable, sometimes highly variable, between different areas and among different sets of circumstances. Learn as much as possible about pathogens in your area and under the set of situations that you usually face, but also develop a perspective for what they may look like and do in different areas and situations. Keep an open mind and learn from other pathologists who have seen different things. Remember anomalies. Emphasize the implications of differences to your clients.

8. Keep up with new forest pathology literature, but don't neglect gray literature, office reports, and, especially, the historical literature. Computers make following new literature easy and relatively painless. However, even though it may take some effort to locate them, unpublished reports, and historical accounts are often of particularly great value to an extension pathologist. They're worth looking for. I certainly learned lessons without price from the writings of E. P. Meinecke, J. L. Mielke, Willis Wagener, and Toby Childs to name a few.

9. Recognize the crucial need for new research results in forest pathology. Support researchers. Work with them in partnerships, and encourage funding their efforts when appropriately directed. Be involved in properly designed applied research projects yourself where these are needed on specific important questions that are not being addressed by anyone else. However, be aware of how time consuming doing such applied research can become and budget your time accordingly.

10. Monitor results of recommended actions. Monitoring the results of recommended disease treatments provides real enlightenment about their value and whether or not they should continue to be used. Unfortunately, in the federal agencies, effectiveness monitoring, though always given substantial lip-service, is often shamefully neglected. A good forest pathologist will encourage clients to invest precious time in high quality effectiveness monitoring for projects that involve disease management. Pathologists should volunteer to do the actual monitoring on particularly interesting and/or novel projects. Remember, though, that like applied research, effectiveness monitoring is very time consuming. Be careful not to overbook yourself.

11. Participate in forest pathology meetings, conferences, and professional organizations. Involvement in these gives you valuable opportunities to interact with and learn from your peers. This is particularly worthwhile, and the more informal the interaction the better. My favorite forest pathology organizations have always been WIFDWC and the various tree-disease-associated IUFRO committees.

12. Be aware of emerging threats and concerns. Be vigilant for new problems that may involve forest pathology considerations, especially if they have potential to become significant issues to your own clients. The introductions of non-native invasive pathogens and possible roles of tree diseases in various climate change scenarios are examples that come immediately to mind.

13. Cherish your mentors and try to be a mentor yourself if the opportunity arises. When starting their careers, pathologists are particularly likely to benefit from the advice and council of members of their profession who have a breadth of experience and knowledge gained from years of study and time in the forest. I cannot think of those who mentored me without emotion. I owe them a priceless debt of gratitude. As my own career progressed, I had the good fortune and honor to be able to provide assistance to a number of promising young forest pathologists in turn. All have done well. I am proud of receiving the award that I have been accorded but I'm ten times prouder of the successes of the folks I've had the chance to mentor.

Well, there are my 13 suggestions. I realize that some people will consider 13 to be an unlucky number, so perhaps I should add one more:

14. Marry well. This is good advice for most anyone. Certainly I have been successful and consider myself among the most fortunate of men in this regard.

STUDENT PAPERS

Southwestern White Pine Regeneration Ecology Along Disease And Management Gradients In The Southwest United States

Betsy A. Goodrich[1] and Kristen M. Waring[1]

Southwestern white pine (SWWP) occurs across a range of habitats within mixed conifer forests of southwestern U.S. and northern Mexico. White pine blister rust (WPBR), a lethal disease caused by *Cronartium ribicola*, is spreading through host populations and has increased urgencies to understand SWWP regeneration ecology. In the southwestern U.S., not all mountain ranges are affected by the disease as it has only been established in the region for a few decades. Our research seeks to quantify SWWP regeneration across ranges of WPBR intensities and silvicultural strategies.

Fifty-five stands were surveyed; including stands without recent management and stands with recent multi-aged treatments (leaving two-aged and uneven-aged residual structures) across six mountain ranges in the Southwest. Seedling ages (by whorl count) demonstrate germination following treatments; multi-aged treatments successfully regenerate SWWP in areas with and without WPBR. Seedlings in two-aged structures had significantly larger average growth (height divided by whorl count) and recent height growth compared to seedlings in uneven-aged stands in the same mountain range. SWWP regeneration appeared to grow most successfully and was less likely to be infected with WPBR in two-aged structures. There is concern that light increases in stands where the majority of basal area is removed may increase the rust hazard of a site by stimulating *Ribes* (the major secondary host of the disease cycle) species densities. However, compared to non-managed stands, *Ribes* densities were higher in uneven-aged structures but were low in two-aged structures. We hypothesize that *Ribes* stems are outcompeted by other shade-intolerant species that increase following silviculture treatments that leave two-aged structures (i.e. shelterwood with reserves and clearcut with reserves regeneration methods). Models interpreting management, disease and other species presence on SWWP densities are in progress. Results will guide management efforts in sustaining SWWP in the presence of this non-native pathogen.

In: Murray, M. & P. Palacios (Comps). Proceedings of the 62nd Annual Western International Forest Disease Work Conference; 2014 Sept. 8-12; Cedar City, UT. [1]School of Forestry, Northern Arizona University, Flagstaff, AZ.

Influence Of Climate On The Growth Of Quaking Aspen (*Populus tremuloides*) In Colorado And Southern Wyoming

M.M Dudley[1], J. Negron[2], N.A.Tisserat[1], W.D. Shepperd[2], and W.R. Jacobi[1]

We analyzed a series of increment cores collected from 195 adult dominant or co-dominant quaking aspen (*Populus tremuloides* Michx.) trees from National Forests across Colorado and southern Wyoming in 2009 and 2010. Half of the cores were collected from dominant or co-dominant trees in stands with a high amount of crown dieback, and half from lightly damaged stands. We defined a 'lightly' or 'heavily' damaged stand based on stand survey data, in which lightly damaged stands had average crown dieback of 16%, and heavily damaged stands averaged 41%.

Upon analysis, two-thirds of the cores collected did not exhibit radial growth correlated with region-wide patterns (e.g. climate) and were classified as having a low cohesive response (LCR). The site variable most predictive of whether a stand exhibited high cohesive response (HCR) or low cohesive response was site elevation, followed by aspect, percent slope, and canopy closure. Sites with HCR stands were more likely to have aspen bark beetle damage, white rot, and *Cryptosphaeria* canker. We did not detect relationships between tree growth and growing season precipitation from 1900-2008, but there was a relationship between growth and annual precipitation. A predictive growth model included maximum May and July temperatures, as well as the current and previous year's annual precipitation.

In: Murray, M. & P. Palacios (Comps). Proceedings of the 62nd Annual Western International Forest Disease Work Conference; 2014 Sept. 8-12; Cedar City, UT. [1]Department of Bioagricultural Science and Pest Management, Colorado State University. Fort Collins, CO. [2]U.S.F.S. Rocky Mountain Research Station, Fort Collins, CO.

PANEL: DENDROCHRONOLOGY AND PAST FOREST PESTS

Dendrochronology And Climatic Influences To Forests

Scotty Strachan[1]

Figure 1. Introduction image showing the Snake Range, Nevada.

INTRODUCTION

It is difficult to think about processes in forested environments without including a perspective on past, present, and future climate drivers and effects. The long life of typical forest species in North America (centuries) places population and stand dynamics well within timescales of climatic influence. While dominant natural mechanisms modulating forest health are typically identified as disturbance, pathogenic, or competition processes, in the long term it is variability of the local climate regime which drives the speed and relative influence of each of these effects. In the context of forest management, therefore, it is highly advisable to follow a well-rounded approach which a) investigates the past; b) monitors present processes; and c) prepares for the future and tests hypotheses.

In: Murray, M. & P. Palacios (Comps). Proceedings of the 62nd Annual Western International Forest Disease Work Conference; 2014 Sept. 8-12; Cedar City, UT. [1]Department of Geography, Mackay School of Earth Sciences and Engineering University of Nevada, Reno, scotty@dayhike.net

"Ecosystem management, then, should be predicated on understanding disturbance processes…in the context of past, present, and future climate variability."

Swetnam and Betancourt,
Journal of Climate 1998

DENDROCHRONOLOGY: INVESTIGATING THE PAST

In order to obtain information about past conditions in forested environments, the science of dendrochronology may be applied. Dendrochronology is a method of scientific dating based on analysis of woody growth layers. Trees which contain seasonal/annual growth increments may be crossdated using various techniques within the discipline. Exact calendar dates are assigned to each growth layer, with micro, locally-absent, and false rings identified and accounted for. Tree-ring dating was recognized as far back as the 15th century, in the writings of Leonardo da Vinci, and was used as early as 1866 to document an insect outbreak.

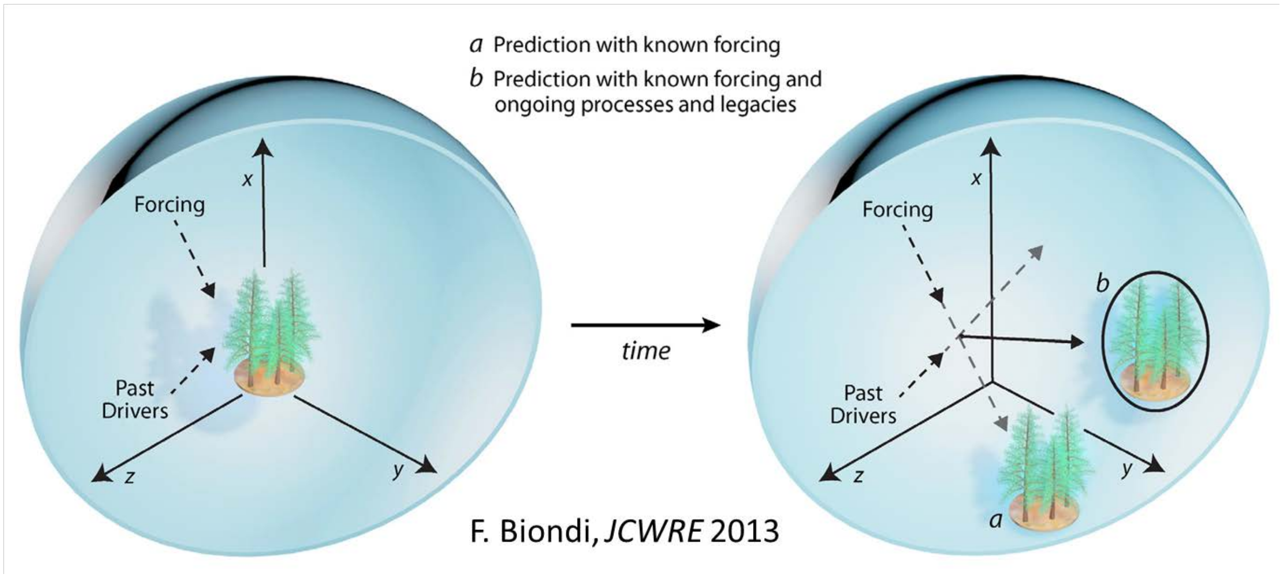

Figure 2. Future conditions cannot be predicted only from present conditions and forcing. F. Biondi, JCWRE 2013.

Figure 3. Extracting an increment core from *Juniperus occidentalis*.

The science of dendrochronology was formalized in the early 20th century through the efforts of Andrew Ellicott Douglass, an astronomer and professor at the University of Arizona. Douglass established the first tree-ring laboratory, using crossdating techniques to answer questions related to climate and human activity. Dendrochronology continues to expand in scope and application, with records being used to date archaeological sites, fix major disturbance events (such as floods or fires) in time, and refine variability estimates of drought, precipitation, temperature, streamflow, and other environmental processes.

As an example of placing the past in context, work performed by Cook et al (2004) on a synthesis of tree-ring chronologies in the western United States found significant fluctuations in total drought area over the last 12 centuries, highlighting time periods of general wet/dry conditions. This study noted that the last 400 years have been relatively wet compared to the 800 years preceding, indicating that long-term (i.e. millennial-scale) conditions are not stable. Tree-ring studies in specific watersheds/regions have found similar results applicable to their locales. Combining multiple lines of evidence such as past regional climate reconstructions and local fire history records enables forest managers to see what the possible ranges of variability are, as well as how the climate can influence frequency / spread / severity of disturbance events.

MONITORING THE PRESENT: WHAT SHOULD WE BE MEASURING NOW?

While regional climatic reconstructions serve as a first-approximation of variability at coarse scales, watershed-scale conditions are determined in large part by patterns of circulation which vary according to global regimes and may not be well understood. Annual climate related to water budget or energy balance in complex terrain (mountain systems) is much better resolved with local data, as it is increasingly apparent that topographic setting plays a large role in the long-term behavior of vegetative populations during times of greater variability (Dobrowski 2011). Characterization of local conditions relative to regional patterns is crucial when making management decisions or evaluating disturbances, especially in the context of defining natural processes. Long-term monitoring of crucial climate variables should be part of any management plan which spans years to decades of time.

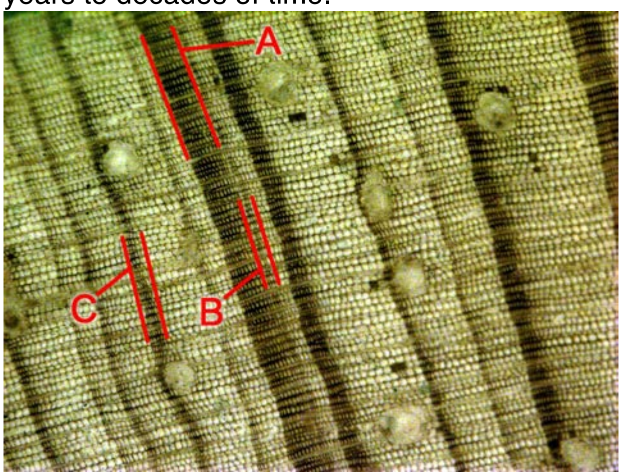

Figure 4. Decoding tree rings keeps the dendrochronologist's life interesting. In one image we can see multiple disparate anatomical features which can cause problems with crossdating: a) wide latewood; b) false latewood; c) micro ring.

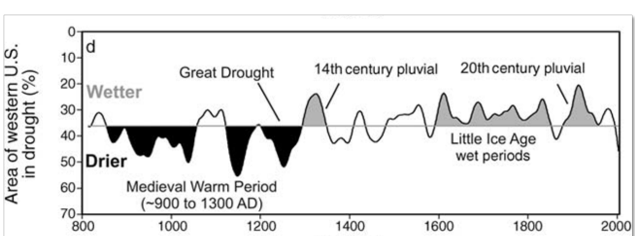

Figure 5. Area of the western U.S. in drought based on tree-ring data. Gray et al 2006; Cook et al 2004.

Figure 6. Geographic detail is crucial in complex terrain. How well are landscape models capturing this?

Examples of topoclimatic variability are spread throughout semi-arid portions of the intermountain west, and are most apparent than in the Great Basin region. Due to the Basin and Range landscape, many forest populations are marginalized on local scales and depend on highly-localized attenuation or enhancement of regional conditions for survival. In spite of significant swings in decadal- to century-scale climate modes, the area is rich with examples of species which maintain populations and live to great age across large elevational ranges.

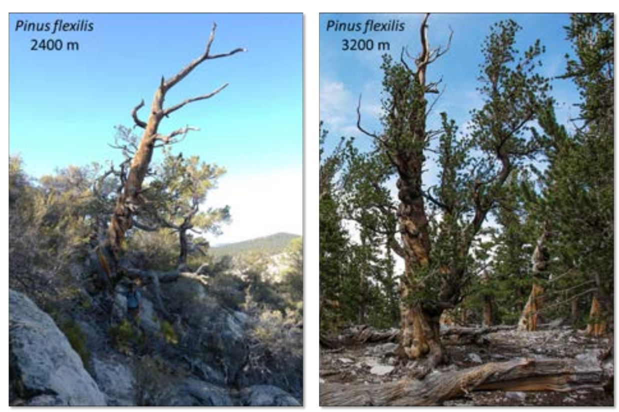

Figure 7. *Pinus flexilis* can live in dramatically different settings within the central Great Basin.

Figure 8. Placement of temperature and snow sensors within forest populations of interest allows researchers to evaluate the effectiveness of regional or gridded models for their sites.

Biogeographic history in the Great Basin will continue to fascinate researchers for many years to come, but even now studies are finding that local geographic detail matters when populations are subjected to episodic or sporadic disturbance events. By pursuing measurement of in-situ weather, soils, and hydrological variables now, we can ensure that future work is solidly backed with applicable science observations. Addition of monitoring schemes such as near-surface (~1.5 m) air temperature, humidity, and snow presence can give real information from point locations to serve as a check on remote sensing or modeling techniques which are often quite prone to error in complex terrain.

PREPARING FOR THE FUTURE: PLACE PREDICTIONS IN CONTEXT

It is critical to recognize that climate is not a general linear input or background noise source. Variability over decadal to multidecadal timescales can produce episodic behaviour and spatial complexity in range dynamics (Gray et al 2006). Applying this principle to long-lived species such as conifers with their associated reproductive lags, we find that predicting forest response to climatic and regime change comes with tremendous uncertainty. It is therefore important to recognize ecological inertia present in the system, and that trajectories observed today (or over the last few decades) are the product of both past processes and modern forcing. To apply only one without the other in analyses or management decisions is to leave half of the story out.

Figure 9. Change in forests and woodlands in the Western U.S. is occurring constantly at multiple spatial and time scales. We should be asking questions like, "what are the dominant mechanisms of change at a given scale?"

"Change is an inherent property of ecosystems...thus, the term 'novel ecosystem' essentially refers to any ecosystem, which suggests that we can dispense with its use."

D.M. Mateos, Science 2013

Matching our science to the scale of management is a useful goal for the next several decades. Managers need to know about the forest in general, but they essentially act on much smaller scales. "These trees", or "that hillslope," or "this sub-watershed" are terms more likely to come up when implementing a conservation or management activity. This means that observing processes at local, representative scales is just as important (if not more so!) as incorporating predictions from regional models. As we begin this process of expanding our knowledge using improved technology and investigative curiosity, we are likely to discover many cause/effect relationships between forests and climate processes that we had not been able to observe in the past.

Figure 10. This remote station in Nevada's Snake Range is monitoring climate variables such as precipitation, temperature, radiation, and humidity, as well as tree sap velocity for three species and soil moisture/temperature. General forest conditions are also qualitatively assessed using hourly imagery.

ACKNOWLEDGEMENTS

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NETWORK
PASSWORD
Auction
Scotty

CONTRIBUTED PAPERS

Bioclimatic Models Estimate Areas With Suitable Climate For *Armillaria* Spp. In Wyoming

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INTRODUCTION

Armillaria species range from beneficial saprobes to damaging root pathogens, and their ecological roles and impacts vary with environment and host. *Armillaria solidipes* [pending vote to conserve *A. ostoyae* (Redhead et al. 2011)] is known as an aggressive pathogen of conifers and causes tree mortality and significant growth loss in Wyoming and throughout the world. *Armillaria solidipes* also seems to exist in a non-pathogenic state under certain conditions that vary depending on environment, host, and community (unpublished data). In this case, *A. solidipes* can be difficult to differentiate from other *Armillaria* spp. The ecological role of *A. gallica*, *A. sinapina*, and *A. cepistipes* has been generally characterized as primarily saprophytic to weakly pathogenic. However, *A. gallica* has recently been described as highly pathogenic on hardwoods in some forests (Brazee and Wick 2009). On aspen, *A. gallica* and *A. sinapina* might be more aggressive pathogens than *A. solidipes* (Blodgett 2015, this proceedings, submitted). *Armillaria gallica* and *A. sinapina* are a common components of forest ecosystems and they have recently been found in areas where they were not previously known to occur (Klopfenstein et al. 2009, Kim et al. 2010, Kim and Klopfenstein 2011, Elías-Román et al. 2013, Nelson et al. 2013, Klopfenstein et al. 2014). Furthermore, all of these typically saprophytic *Armillaria* species are thought to be an important component of forest decline. Under the host/stress/saprogen concept, disease develops when these secondary pathogens, which are already on-site, invade host tissue after environmental stress (Houston 1992). These stressors can include climate, human disturbance, and/or insect/pathogen pests. This type of forest decline is believed to be increasing and generally more severe under climate change as trees become progressively maladapted to their environments (Kliejunas et al. 2009). In this study, we use DNA-based methods to confirm species identification and utilize location-specific climate data for bioclimatic modeling to predict where *Armillaria* spp. are likely to occur and cause disease and forest decline.

OBJECTIVES

The objectives of this study are to 1) determine suitable climate space (potential distribution) for *Armillaria* species in Wyoming and 2) predict which forest areas are at risk to disease and forest decline caused by *Armillaria* spp. in the state.

METHODS

Armillaria isolates were collected from previous studies of the distribution, species, and ecology of Armillaria in Wyoming (Blodgett and Lundquist 2011). From these studies, 221 Armillaria isolates were recovered from 180 plots. A total of 128 isolates from 102 plots were determined to be *A. solidipes*, 62 isolates

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from 50 plots to be *A. sinapina*, 21 isolates from 17 plots to be *A. gallica*, and 10 isolates from 7 plots to be *A. cepistipes*. All determinations were based on pairing tests against known haploid testers. Representative, subsets of these 221 isolates were then confirmed to species using DNA sequence-based species identification at the USDA Forest Service - Rocky Mountain Research Station, Forestry Science Laboratory in Moscow, Idaho (Kim et al. 2006; Ross-Davis et al. 2012). The 180 plot locations containing *Armillaria* were used in four Maximum Entropy (MaxEnt) species distribution models (Phillips et al. 2006). The models use the plot location of each species within and around Wyoming to map specific potential distributions, based on predicted suitable climate space. Nineteen bioclimatic variables were used in the models (e.g., annual mean temperature, maximum temperature of warmest month, annual precipitation, precipitation of wettest month, precipitation of coldest quarter, etc.). An interpolation grid of ca. 1-km^2 resolution was used, with data derived from 1950-2000 meteorological records (Hijmans et al. 2005).

CONCLUSIONS AND FUTURE WORK

Four MaxEnt models provided preliminary predictions of suitable climate space for *Armillaria* species in Wyoming. The predictive capacity will be improved by 1) continuing DNA-based identification of *Armillaria* species from additional field collections, 2) adding more locations confirmed to have Armillaria, and 3) adding additional predictive variables (e.g., soil types, solar radiation, etc.). This climate-based prediction window can also be used to examine how various climate-change scenarios may affect potential distribution and disease activity. Methods developed from this project can be used to model other important forest pathogens and examine the potential for invasive species to occupy new areas under climate changes.

ACKNOWLEDGEMENTS

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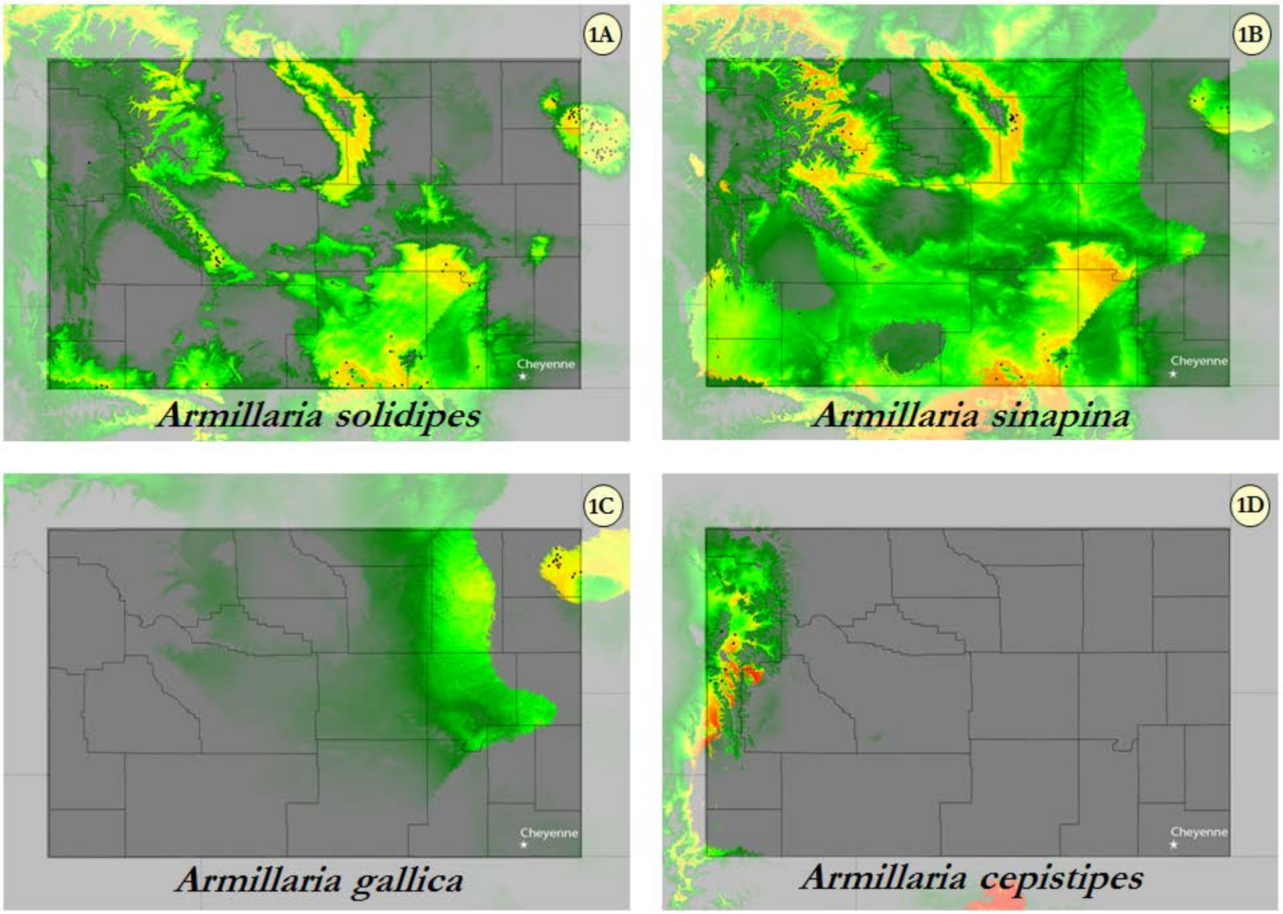

Figure 1. Occurrence locations of *Armillaria* spp. (depicted with small black dots). **1A**. *A. solidipes* (106 locations); **1B**. *A. sinapina* (51 locations); **1C**. *A. gallica* (17 locations); and **1D**. *A. cepistipes* (7 locations) from Wyoming surveys of Blodgett and Lundquist (2011), which are part of an ongoing USDA Forest Service Special Technology Development Project. Preliminary Maximum Entropy bioclimatic models of suitable climate space (potential distribution) for species in Wyoming based on occurrence points in Wyoming surveys of Blodgett and Lundquist (2011). Dark green represents predicted suitable climate space for Armillaria, with light green, yellow, orange, and red indicating increased suitability, respectively.

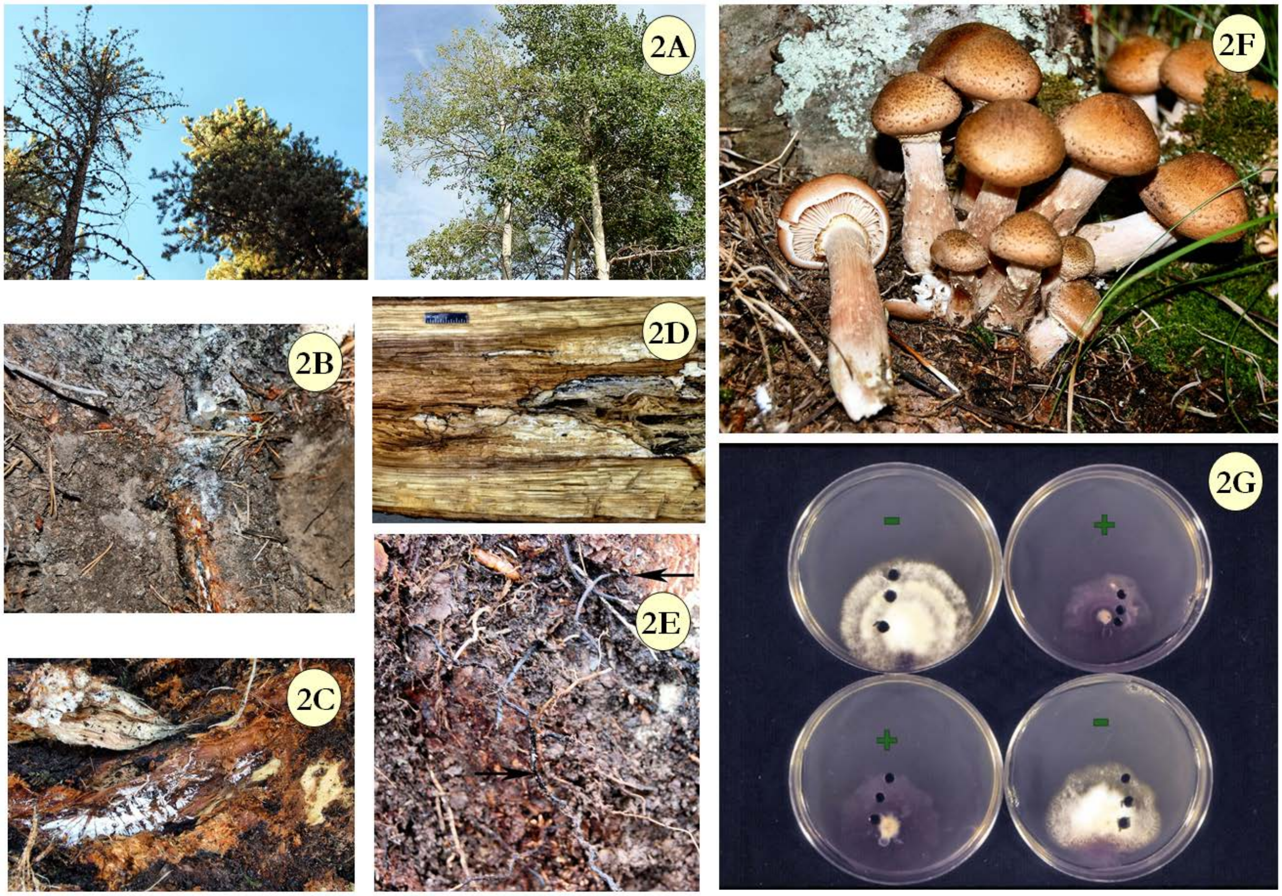

Figure 2. Armillaria collection photos: **2A**. Chlorotic foliage with extensive dieback is a typical symptom of lodgepole pine (*Pinus contorta*; left) and aspen (*Populus tremuloides*, right) with Armillaria root disease. **2B**. Lodgepole pine with Armillaria root disease showing resinosis at the root collar. **2C**. A diagnostic sign of Armillaria root disease is the characteristic mycelial fan, seen here on aspen. **2D**. Armillaria white rot with zone lines. **2E**. Rhizomorphs (gray to black, see arrows) in soil growing into a root and root collar are diagnostic signs of Armillaria root disease. **2F**. Fruiting bodies of an *Armillaria* sp. at the base of a paper birch (*Betula papyrifera*). **2G**. Species identification of unknown diploid isolates using haploid tester isolates in mating tests. Photos 2A, 2B, 2D, 2E, 2F, and 2G: James T. Blodgett, USDA Forest Service. Photo 2C: Daniel H. Brown, USDA Forest Service, Bugwood.org.

Shore Pine (*Pinus contorta* Subsp. *contorta*) Health In Southeast Alaska

Robin Mulvey[1]

Forest Inventory and Analysis (FIA) plot data from the measurement periods 1995-2000 (initial plot installation) and 2004-2008 (plot re-measurement) revealed a statistically significant 4.6% loss of shore pine biomass in Alaska (Barrett and Christensen 2011). Shore pine (Figure 1) is a distinct subspecies of lodgepole pine found in sand dunes, rocky cliff faces, and wetlands along the coast from northern California to Yakutat Bay in southeast Alaska. In Alaska, shore pine is most common in unproductive peatland bogs and fens with saturated, acidic soils. The loss of shore pine biomass from the national forest inventory plots highlighted significant gaps in our knowledge about this ecologically valuable, noncommercial tree at the northern extent of its range.

Figure 1. A shore pine stand on central Wrangell Island in southeast Alaska. Although shore pine trees are often stunted, this stand contains many large specimens. Note the person at the base of the middle tree for scale.

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Our study set out to gather baseline information about the biotic damage agents of shore pine and to assess its general health status through the establishment of a permanent shore pine monitoring network. Permanent plots make it possible to track long-term forest change and have become increasingly important given the projected increase in widespread tree mortality associated with climate change, invasive pests, and altered disturbance regimes. Broad scale inventory and monitoring plots can reveal otherwise undetected loss of tree biomass but are not designed to determine complex causes of tree death. Instead, detected changes in tree biomass can initiate focused forest health investigations.

Forty-six shore pine monitoring plots were established in Juneau/Douglas Island, northeastern Chichagof Island, Mitkof Island, Wrangell Island, and Prince of Wales Island using an adapted FIA plot layout (Figure 2). At these five sites, plot locations were randomly selected using Geographic Information System National Wetland Inventory layers for wetland types that reliably contain shore pine, as well as other criteria to ensure wetland access via road or trail. All plot trees >4.5ft (1.4m) tall were tagged for monitoring. Data collected from live trees included height, diameter at breast height (dbh), lower crown height, percent crown dieback, wound type and severity, and presence of conks, decay, or topkill. Size and decay class information was collected from snags. For shore pine, western gall rust (WGR) severity was quantified using a 0-6 scale similar to the Hawkworth dwarf mistletoe rating system. WGR bole galls and WGR-associated crown dieback (%) and topkill were recorded. Years of foliage retention and foliage length were estimated, and disease type and severity were determined when possible. Data was collected from 5,452 total trees (2,504 live and 361 dead shore pine), including 1,031 trees ≥5in (12.7cm) dbh.

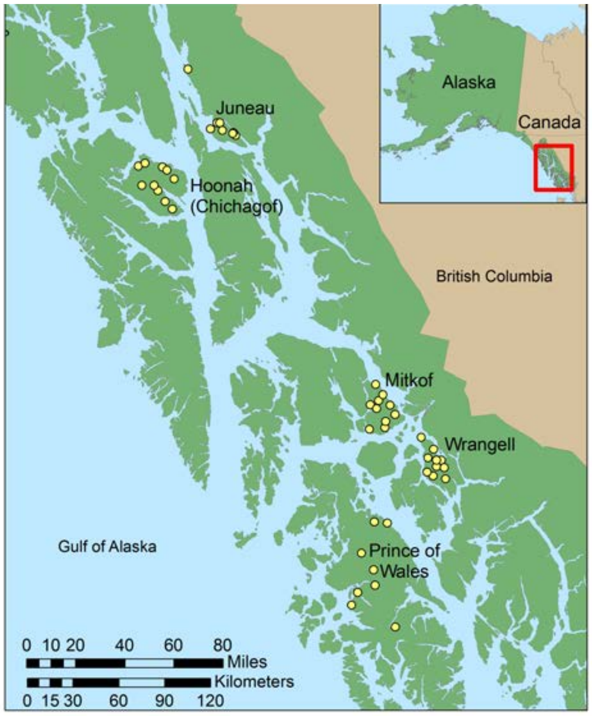

Figure 2. Forty-six permanent plots established in 2012 and 2013 to monitor shore pine health and survival in southeast Alaska.

The proportion of trees dead was higher for shore pine (13%) and yellow-cedar (14%) compared to other species (<5%). The largest size class of shore pine (>15in/40cm) had the highest proportion of trees dead (43%). Biotic damage agents detected on shore pine in this study are presumed to be native (Table 1), though some agents had not been previously reported in the state.

This short-term assessment of our long-term monitoring plots provided insight into the main damage and mortality agents of shore pine across southeast Alaska. WGR occurred in all subplots and affected 85% of live shore pine with varying severity. WGR bole galls were observed on 35% of live shore pine (9-78% of shore pine per plot). Crown dieback was positively correlated with WGR severity ratings, and bole gall presence was the best predictor of crown dieback. Wounds observed on shore pine included mechanical bole damage (specific cause unidentified), bole cankers, inactive bole galls below the live crown, frost cracks, porcupine feeding scars, antler rub scars, bear scratch scars, burls, and root exposure. Forty-seven percent of live shore pine had wounds; 26% had moderate to high severity wounds. Wound severity and the proportion of live shore pine wounded increased with tree diameter. Bole wounds were substantially more common on shore pine (32% of live trees) compared to associated tree species (1-6%). More work is needed to verify the causes of some forms of bole damage. Poor root anchorage in saturated soils, mossy mounds, or standing water was the most common wound recorded for non-pines, but may only harm trees when severe. Dothistroma needle blight was widespread and probably limited foliage retention, but did not cause mortality in study plots; however, a severe, localized Dothistroma outbreak since 2010 is killing shore pine north of the plot network in Gustavus, AK and adjacent areas of Glacier Bay National Park. Secondary bark beetles and galleries (*Pseudips mexicanus* and *Dendroctonus murryanae*) and associated blue stain fungi were observed on large dying and recently-killed pines in study plots.

Consistent with the pulse of mortality that FIA detected, our targeted plot network observed higher mortality among shore pine, especially the largest size class, compared to most other tree species. Shore pine had a very high incidence of damage. Despite their slow growth on stressful sites, shore pine trees may endure suboptimal growing conditions for centuries. It appears that shore pine succumb to injury and environmental stress directly over time (e.g., girdling bole wounds, root hypoxia from flooding, complete crown dieback associated with WGR) or that compounding stress and injury increase the susceptibility of large, weakened trees to secondary bark beetles, some carrying pathogenic stain fungi. Shore pine may gradually outgrow favorable microsites; alternatively, dynamic hydrologic conditions in forested bogs and fens may cause microsites on which trees have established to become more or less conducive to growth and survival. There are complex interactions between the most common damages, site stressors, and bark beetles.

Monitoring this plot network every 5 years will provide concrete information about the conditions and damage agents associated with mortality of trees that are currently alive. Despite the high incidence of damage, shore pine is surviving and regenerating in study plots. Long-term data from both our shore pine plot network and national inventory plots will allow us to track whether the loss of shore pine biomass continues or whether in-growth keeps pace with large tree mortality.

Table 1. Biotic damage agents of shore pine other than western gall rust detected in the study area in southeast Alaska and a description of the damage.

Foliar Pathogens & Insects	
Dothistroma needle blight (*Dothistroma septosporum*)	Widespread with variable severity; probably limits foliage retention of shore pine; not causing mortality in plots at time of survey, but localized epidemic near Gustavus, AK (2010-2014) is causing significant shore pine mortality (Mulvey, unpublished data)
Lophodermella needle cast (*Lophodermella concolor*)	Scattered discolored shoots, causes limited damage
Lophodermium needle cast (*Lophodermium seditiosum*)	Scattered discolored needles, causes limited damage
Defoliating weevils (*Magdalis* or *Scythropus* sp.)	Tentatively identified based solely on photographs of feeding damage, not insects (E. Willhite, USDA Forest Service, Personal communication, March 7, 2014)
Lodgepole pine sawfly (*Neodiprion nanulus contortae*)	Detected at all study locations; previously undocumented in Alaska; defoliation usually limited to scattered branches
Lodgepole needle miner (*Coleotechnites milleri*)	Identified based on circular exit holes on needles; apparently low populations at the time of survey
Bark Beetles (Coleoptera: Curculionidae) & Stain Fungi	
Pseudips mexicanus	Secondary bark beetle (Smith et al. 2009) collected from large dying pines; oviposition and overwintering galleries were evident on larger shore pine snags; associated with fungal stain; the most common bark beetle collected and identified
Dendroctonus murryanae	Secondary bark beetle collected from one large dying pine; not previously recorded in Alaska; known from *P. contorta* ssp. *latifolia* in British Columbia
Dryocoetes sp.	Most are secondary bark beetles; *D. autographus* and *D. affaber* are known to attack *Pinus* spp. and have been collected in Alaska, including Juneau, AK
Trypodendron lineatum	Ambrosia beetle associated with already dead trees

Leptographium sp.	Blue stain fungus associated with beetle galleries; sample collected from dying shore pine with nearest ITS sequence match (92%) to *L. wingfieldii*, considered a virulent pathogen; stain present on large dying shore pine and snags up to decay class 3
Heart Rot Fungi	
Porodaedalia pini	Only heart rot fungus detected on live shore pine; noted on 14 live and 6 dead shore pine; increment coring live shore pine without conks often revealed hidden white rot
Onnia spp.	Collected from two large shore pine snags in Hoonah (NE Chichagof Is.); *O. tomentosa* or *O. circinata*
Laetiporus sulphureus	Detected on one shore pine snag outside of study plot on Douglas Is., Juneau
Fungi & Insects in Western Gall Rust Galls	
Nectria cinnabarina	Red-orange circular fruiting bodies observed on 1/5 collected galls; significantly contributes to mortality of galled-branches
Dioryctria spp.(Lepidoptera: Pyralidae)	Most common insect detected in recently-killed galled-branches; larvae create extensive, wide galleries and coarse frass; 1/4 collected galls showed evidence of insect girdling; identification should be verified; cryptic species complex
Pityophthorus twig beetles (Coleoptera: Curculionidae)	Beetles or larvae occasionally found in gall tissue of recently-killed branches
Pseudips mexicanus bark beetles (Coleoptera: Curculionidae)	Beetles or larvae occasionally found in gall tissue of recently-killed branches

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Bigleaf Maple Decline: The Big Unknown

Kristen L. Chadwick[1]

Symptomatic bigleaf maples have been observed throughout western Washington and localized areas of western Oregon for the past several years. Symptoms are extremely variable in time and place and include thinning crowns (Figure 1), chlorotic leaves, reduced leaf size (Figure 2), premature foliage loss, marginal scorching (Figure 3), and crown dieback. The crowns of many older bigleaf maples are comprised entirely of epicormic branches with the main crown completely dead (Figure 4). Mortality is also occurring and is typically preceded by several years of visible crown decline. Symptomatic trees and mortality are found in both urban and natural forest settings, in trees of all sizes, and across a range of stand densities and sites.

Bigleaf maple decline and mortality were first observed about 20 years ago near Olympia and the Cowlitz Valley area of Washington by local residents and Washington Department of Natural Resources (DNR) pathologist, Ken Russell. In recent years, local land management agencies have been fielding an increasing number of calls from the public inquiring about declining and dying maples. In response, in 2011 Washington DNR undertook a large-scale effort to sample declining bigleaf maple throughout western Washington (Omdal and Ramsey-Kroll 2012). The focus of that study was to determine the role of *Verticillium albo-atrum* and *V. dahliae* in the decline. Verticillium wilt was reported as the cause of widespread mortality of bigleaf maple in Washington and Oregon as early as 1983 (Bedwell and Childs 1938). All samples were negative for *Verticillium* spp. in the 2011 survey. However, 15% of symptomatic maples had signs of other root diseases such as *Armillaria* spp. and *Ganoderma* spp.

Figure 1. Older bigleaf maple stand located with declining crowns. Photo taken August 2013 in Cowlitz Valley, Washington.

A small-scale investigation into the potential role of *Xylella fastidiosa* in the decline in the Cowlitz Valley area occurred in 2012–2013. *Xylella fastidiosa*, the cause of bacterial leaf scorch, was a suspect due to the prevalence of marginal leaf scorching. Large populations of leaf hoppers, the vectors of *Xylella fastidiosa*, were also observed in the area. To date all samples have been negative using real-time PCR and ELISA.

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Figure 2. Reduced leaf size in bigleaf maple.

Figure 3. Marginal leaf scorching. Photo taken mid-summer.

Currently, a larger scale Evaluation Monitoring project is underway to describe bigleaf maple symptomology across western Washington and Oregon and to determine the causal agents related to the decline. This effort involves collaboration with the following people: Beth Willhite, Holly Kearns, Dan Omdal, Amy Ramsey, Everett Hansen, Alan Kanaskie, Danny Norlander, and Wendy Sutton. Soil and plant samples will be taken from trees with varying symptoms to test for *Xylella fastidiosa*, species of Armillaria, *Phytophthora* species, and, potentially, the presence of viruses. Data for stand and site conditions will be described and analyzed to determine any trends.

Figure 4. Epicormic branching on bigleaf maple located in the same stand as the tree in figure 1.

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DNA-Based Characterization Of Wood-, Butt- And Root-Rot Fungi From The Western Pacific Islands

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INTRODUCTION AND METHODS

Although the islands of the western Pacific comprise a hotspot of species, including fungi, a large number of these species have not been catalogued or documented in the scientific literature on an island to island basis. Butt- and root-rot fungi were collected from infected wood and fruiting bodies of diverse tropical trees from forest, agricultural, and urban sites during an outreach/survey trip to USA-affiliated islands in the western Pacific including Palau, Yap, Guam, Saipan, Pohnpei, and Kosrae (Figure 1). Collections focused on the aggressive brown root-rot pathogen, *Phellinus noxius* (Figure 2), although other collections were made when possible. These fungi were subsequently cultured from fruiting bodies (e.g. Figure 3) or infected wood. DNA of each cultured isolate was extracted and partial sequences of the internal transcribed spacer (ITS1-5.8S-ITS2) region (hereafter ITS) were amplified with PCR at the Moscow Forestry Sciences Laboratory (USDA Forest Service-Rocky Mountain Research Station). PCR products were sequenced, and edited sequences were compared to the GenBank® database using the nucleotide BLAST®. All living collections made on these islands are currently archived at the Moscow Forestry Sciences Laboratory Fungal Culture Collection for ongoing genetic analyses.

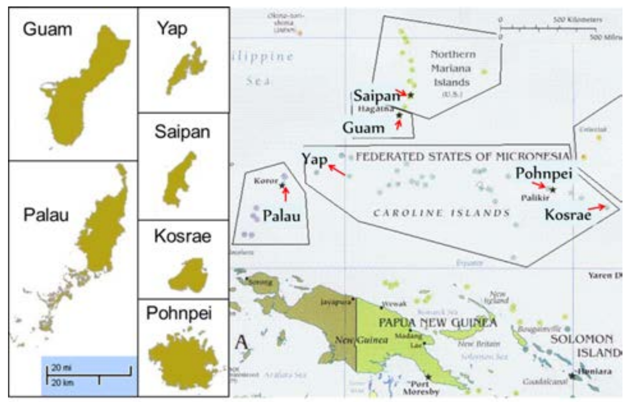

Figure 1. Fungi were collected from the U.S.A.-affiliated islands of Palau, Yap, Guam, Saipan, Pohnpei and Kosrae.

Figure 2. Basidiocarps of *Ganoderma australe* complex on *Casuarina equisetifolia* from Saipan (top left) and Guam (bottom left and right).

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Figure 3. Mycelial crust of *Phellinus noxius* and unidentified bracket fruiting body in Pohnpei.

RESULTS

Phellinus noxius was successfully isolated from 20 sites on 10 host species on all 6 islands sampled (Table 1). An additional 24 butt-, root- and wood-rot fungi were tentatively identified to species, genus or family from 31 sites across the 6 islands using the ITS region of rDNA (Table 2). In the process, non-targeted, tree/fungus-associated fungi from 28 sites across all islands were also tentatively identified to genus: *Lasiodiplodia*, *Rhytidhysteron*, Hypocrea /Trichoderma, *Fusarium*, *Valsa*, *Chaunopycnis*, *Pestalotiopsis*, *Conidiocarpus*, and *Pseudoallescheria*.

DISCUSSION & FUTURE WORK

DNA sequences of the ITS region of the rDNA proved useful to identify *P. noxius* isolated from infected wood and fruit bodies. These sequences also narrowed the identification of other fungi to the species, genus, or family level. Depending on how a species is defined, often entries with more than 2% difference in base pair identity are considered to be different species (e.g., see Lindner et al. 2011). We specifically targeted fungi with obvious fruit bodies or other morphological indicators, and still nine isolations obtained in this project did not meet the 2% criteria (i.e., maximum identity score was less than 98%). Many of the 'closest match' entries in GenBank® had no species-level or even genus-level names attached to them. While the ITS region cannot always differentiate species or even genera, it is useful in preliminary identifications because GenBank® has more fungal sequences of the ITS region than any other gene region. Using this tool, taxa were defined as well as possible into a table that could assist in prioritizing additional research needs.

Table 1. Collection and identification of *Phellinus noxius* on different hosts and islands.

Island	Host	Sites sampled	Highest Maxiumum ID Score	Closest GenBank Match Accession #
Guam	*Guamia mariannae*	3	98%	KF233592
Guam	*Macarenga thompsionii*	2	98%	KF233592
Guam	*Ochrosia mariannensis*	1	98%	KF233592
Kosrae	*Artocarpus altilis*	1	99%	JQ003227
Kosrae	*Sonneratia* sp.	1	98%	JQ717347
Palau	unknown stump	1	97%	HQ400705
Pohnpei	*Artocarpus altilis*	2	98%	JQ717347
Pohnpei	*Ficus tinctoria*	1	98%	KF233592
Saipan	*Delonix regia*	5	98%	KF233592
Saipan	*Mangifera* sp.	1	99%	JQ003227
Yap	*Mangifera* sp.	1	99%	KF233592
Yap	*Inocarpus sp.*	1	95%	KF233592

As time permits, the fruiting bodies collected in this project will be identified morphologically. Morphological identifications will be then connected to the ITS sequences from the fruit bodies or cultures and entered into GenBank®. Additional molecular work investigating the population genetics of *P. noxius* is also underway.

On islands dependent on global commerce, it is vitally important to have species lists for each island in order to avoid unwanted introductions of invasive species. Destructive species such as *P. noxius* should be tracked and monitored to prevent further spread within an island's shores as well as reduce island-to-island spread. Results from this project emphasize the need for further collection and identification efforts in the western Pacific to provide baseline information on current species distribution within and among islands. These efforts must combine morphological and molecular identification with subsequent entry into public databases such as GenBank®. Reliable long-term fungal databases for these biologically diverse regions are critical to monitor and manage species movements across the islands. Finally, if possible, maintaining living cultures of these diverse fungi should be maintained to expand options for future analyses as DNA-based and other technologies continue to improve and become more accessible.

Table 2. Collection and identification of wood-associated fungi on different hosts and islands.

Island	Tentative ID	Host	Sites sampled	Highest Max ID Score	Closest GenBank Match Accession #
Guam	Ganoderma austral complex	Casuarina equisetifolia	3	99%	GU213473
Guam	Ganoderma sp.	Casuarina equisetifolia	1	98%	AY569452
Guam	Phillimus sp.	Thespesia populnea	1	94%	EU035311
Kosrae	Ganoderma sp.	Terminalia carolinensis	1	*	
Kosrae	Rigidoporus vinctus	Artocarpus altilis	1	99%	HQ400710
Palau	Coriolopsis sanguinaria	Rhizophora spp.	1	98%	FJ627251
Palau	Fomitiporia sp.	Casuarina spp.	1	95%	GU461943
Palau	Fulvifomes sp.	Rhizophora spp. & unknown mangrove	2	99%	JX104683
Palau	Ganoderma austral complex	Unknown stump	1	99%	FJ582638
Palau	Ganoderma sp.	Rhizophora spp.	1	97%	JN234428
Palau	Psilocybe/ Deconica sp.	Unknown stump	1	91%	HM036648
Pohnpei	Ceriporia lacerata	Artocarpus altilis	1	99%	KF850375
Pohnpei	Earliella scabrosa	Unknown downed log	1	99%	FJ11056
Pohnpei	Phlebia sp.	Unknown stump	1	99%	KC492493
Pohnpei	Rigidoporus microporus	Ficus tinctoria	1	199%	HQ400708
Pohnpei	Rigidoporus vinctus	Artocarpus altilis	1	99%	HQ4000710
Pohnpei	Tinctoporellus epimiltinus	Artocarpus altilis	1	99%	FJ711050
Pohnpei	Wrightoporia sp.	Artocarpus altilis & unknown stump	3	95%	FJ904857
Saipan	Fulvifomes sp.	Casuarina equisetifolia	2	98%	JX104711
Saipan	Ganoderma austral complex	Casuarina equisetifolia	1	99%	FJ392286
Saipan	Phanerochaetaceae	Delonix regia	1	96%	HQ248216
Yap	Cerrena sp.	Areca catechu	1	99%	FJ010208
Yap	Lenzites/ Trametes sp.	Piper betle	2	100%	HQ248217
Yap	Psilocybe/ Deconica sp.	Cocos nucifera	1	92%	HM036648

*Imperfect sequence .Closest matches to Ganoderma spp.; also identified by collector as Ganoderma sp.

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Armillaria Spp. In Aspen On National Forests In Northern Wyoming And Western South Dakota

J.T. Blodgett[1]

INTRODUCTION

Armillaria root diseases are caused by a complex of species. Studies have confirmed the distinctness among species in: mating types, morphology, DNA sequences, nuclear DNA content, aggressiveness, host range, and ecology (Anderson 1986; Anderson and Smith 1989; Anderson et al. 1980, Bérubé and Dessureault 1988; Gregory and Watling 1985; Guillaumin et al. 1993; Jahnke et al. 1987; Kile et al. 1991; Kim et al. 2000; Rishbeth 1982; Roll-Hansen 1985; Ross-Davis et al. 2012; Rishbeth 1986; Shaw 1985; Worrall et al. 1986).

These species are responsible for considerable economic damage in western forests and throughout the world (Basham 1973; Cruikshank 2002; Cruickshank et al. 2011; Kile et al. 1991; Wargo and Shaw 1985; Whitney and Myren 1978), but are often found as saprotrophic colonizers of trees killed by other damage agents. Root disease is frequently attributed to host stresses induced by the environment or other damage agents. However, live-stressed trees are not always colonized by these pathogens. Alternatively, Armillaria root diseases are often found in trees with no other apparent damage agent or perceptible stress.

Another paper in these proceedings (Blodgett et al. 2015) found the correlation between *Armillaria* spp. frequencies and aspen tree mortality was not significant. This study examines Armillaria by species verses combining the distinct diseases. The objective of this study was to test if *Armillaria* species differ in aggressiveness in aspen.

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METHODS

Samples of *Armillaria* spp. were collected in 2008, 2009, and 2012 during an aspen survey in the Shoshone, Bighorn, and Black Hills National Forests (Blodgett et al. 2015; 2014). Armillaria pathogens were assessed as present or not found in 465 plots and frequencies were quantified for stands (155 stands). Trees were examined within 30 m of plot centers. *Armillaria* spp. were confirmed by examining three recent dead trees per plot (9 per stand) for the presence of mycelial fans and/or rhizomorphs. If recent dead trees were not present, trees with root disease symptoms were examined next and then healthy trees. If *Armillaria* sp. was found, root disease was confirmed by examining two live aspen trees per plot (6 per stand) for the presence of mycelial fans (Figure 1). Trees with root disease symptoms and/or near confirmed dead trees were preferentially selected.

Sixty samples were collected. Samples were collected from each forest with approximately half from stands where root disease was confirmed and the others from stands where root disease was not confirmed. Isolates were identified to species by mating tests (Harrington et al. 1992; Korhonen 1978; Wargo and Shaw 1985) and a subset was later confirmed using DNA sequences (Ross-Davis et al. 2012).

Figure 1. Root disease was confirmed by examining live aspen trees for the presence of mycelial fans.

RESULTS

Armillaria root diseases were killing trees independently and in combination with other damage agents. Although *Armillaria* spp. were found in 55% of the stands, Armillaria root disease was not always confirmed. When potential pathogens were found in stands, root diseases were confirmed 24% of the time. In the remaining 76% of the stands only saprotrophic colonization of aspen was observed. The most common species, *A. solidipes* (= *A. ostoyae*) caused disease less frequently than expected by chance and *A. sinapina* and *A. gallica* caused disease more frequently than expected by chance (Table 1).

Table 1. *Armillaria* species identified in aspen and percentage of times found causing root disease in Wyoming and South Dakota.

***Armillaria* species**	**Number of stands**[a]	**Root disease (%)**[b]
A. solidipes (= *A. ostoyae*)	33	27↓[c]
A. sinapina	22	68↑
A. gallica	5	80↑

[a]Number of stands in which Armillaria spp. were isolated from live or dead aspen trees and identified to species.
[b]Percentage of times root disease was confirmed in live aspen trees.
[c]Down arrows indicate less frequent than expected by chance and up arrows indicate more frequent than expected by chance based on Fisher's Exact Test (P = 0.0003).

SUMMARY AND CONCLUSION

Some *Armillaria* species were more damaging in aspen than others, suggesting host-specialization among the species. *Armillaria sinapina* and *A. gallica* root diseases likely contributed to the mortality reported for the most damaging agents in aspen including *Encoelia pruinosa*, *Cytospora* spp., *Agrilus liragus*, and *Ganoderma applanatum* (Blodgett et al. 2015). *Armillaria solidipes* root disease is the least damaging species found in aspen hosts, but is likely the most common species found in aspen in the northern Rocky Mountain Region. *Armillaria sinapina* and *A. gallica* are important pathogens in these forests and *A. solidipes* appears to be mostly a saprotrophic colonizer of aspen. Since *Armillaria* species differ in aggressiveness in aspen, knowing the species of root disease present is important when determining aspen forest health.

ACKNOWLEDGEMENTS

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Assessing Root Disease Presence, Severity And Hazard In Northern Idaho And Western Montana: Using Forest Inventory And Analysis (FIA) Plots And The USFS Northern Region VMap Database

Blakey Lockman[1], Renate Bush[2], and Jim Barber[3]

BACKGROUND

Forest Health Protection is responsible for assessing forest insects and diseases on public lands. Aerial detection surveys (ADS) provide data on insects, such as bark beetles and defoliators, but assessing root diseases cannot be accurately done through ADS, so other means need to be employed.

The 2012 National Insect and Disease Forest Risk Assessment (NIDFRA; Krist et al. 2014) includes models for risk from root disease, and is the best information available for incidence and severity of root diseases at the National scale. At the Regional scale, several efforts have used aerial photo interpretation to assess root disease hazard (or risk) in the Northern Region of the USFS (Hagle et al. 2000). More recently, root disease data collected on the Forest Inventory and Analysis (FIA) plots were used to assess the presence and severity of root disease in north Idaho and western Montana within the USFS Northern Region.

The main root diseases impacting forests in the Northern Region are armillaria root disease (*Armillaria ostoyae*), Heterobasidion root diseases (both *H. occidentale* and *H. irregulare*), laminated root rot (*Phellinus sulphurascens*), and schweinitzii root and butt rot (*Phaeolus schweinitzii*), and the Region is just beginning to record the presence and impact from tomentosus root rot (*Onnia tomentosa*). In north Idaho and western Montana, multiple root disease agents often exist on the same piece of ground and the impact from one is hard to separate from the impact by any other(s). Hagle (1985) established over 1200 permanent plots in north Idaho and western Montana to assess the collective presence and impact of these root disease. This current assessment is on the presence and severity of root diseases in north Idaho and western Montana, and developing a spatial depiction of root disease hazard across the same landscape.

METHODS

The root disease severity rating system is the basis for assessing root disease in this analysis. Hagle (1992) developed this system to rate the severity of root diseases on permanent plots installed in the western half of the Northern Region. The rating system assesses canopy loss due to root disease and/or the ground occupied by root disease pathogens. This is evaluated on above-ground symptoms, and takes into account what would normally occur on the site. For instance, a site that normally has a lower density due to poor growing conditions would be evaluated based on that lower density. Hagle (1992) also developed a similar system for rating root disease using aerial photos.

This method of rating root disease severity uses a 0 to 9 rating system that can be applied at the plot level or the stand level; it is meant to be a quick and easy way to assess root disease (Hagle 2011). A rating of zero means

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no evidence of root disease on the plot or near the plot. A rating of one means there is evidence of root disease near the plot and a rating of two means there is minor evidence of root disease on the plot with up to 10% canopy loss. Severity increases with increased canopy loss and/or ground occupied by root pathogens, with the highest rating of nine given to a plot that falls entirely within a root disease mortality pocket with all overstory trees dead due to root disease. Mortality rates for root disease-susceptible tree species have been positively correlated to root disease severity ratings (S. Hagle, unpublished data).

Root disease severity is collected at the subplot level by the FIA crews in the Northern Region. FIA is a statistically based, continuous inventory of forest resources in the U.S. The crews were first trained to collect this data in the 1990's and training continues at regular intervals. FIA's sample design and measurement schedule has changed over the years. In 2003, the annual inventory was implemented in Montana and was started in Idaho the following year. With the annual inventory, approximately 10% of all FIA plots in a state are re-measured each year, with a full measurement on all plots occurring every 10 years.

Annual plots were used for this analysis- it is the most complete statistically valid set of data that is available in the Northern Region at this time. Although the dataset does not yet include all 10 years, it provides a spatially and statistically sound sample across the Northern Region. Only the annual plots from the National Forests west of the Continental Divide were analyzed for this assessment. Although root disease is a significant agent in localized instances on forests east of the Continental Divide, less knowledge exists on how well the severity rating system reflects root disease activity in these biophysical environments.

Root disease severity ratings measured in the field were collapsed into 4 classes for this analysis: None (rating of 0), Low (ratings 1 and 2; up to 10% canopy reduction), Moderate (ratings 3 to 5; 10% and up to 50% canopy reduction) and High (ratings 6 to 9; 50% or greater canopy reduction) classes. The acres represented by each FIA plot were then calculated.

The root disease severity data collected by the FIA crews was, and continues to be, analyzed. The FIA data provides information on how many acres of root disease exists in the Northern Region and the severity of root disease, but the data cannot spatially depict root disease. In order to map root disease, the FIA root disease severity ratings were grouped by vegetation classes using the same classification system that is used in the regional potential vegetation and existing vegetation map unit designs. We used root disease severity collected on the FIA plots to develop a root disease hazard classification system applied to vegetation classes that could then be mapped. These vegetation classes are based on unique combinations of Bailey's ecoregions, the potential vegetation type (PVT), and existing vegetation (40% plurality dominance type).

Bailey's ecoregions are strata based on factors such as climate, physiography, water, soils, air, hydrology, and potential natural communities. Earlier analyses of root disease in the Northern Region detected a difference in root disease levels by ecoregion (Hagle et al. 2000).

Potential Vegetation Types (PVTs) are groupings of potential vegetation habitat types. PVT mapping units delineate areas having similar biophysical environments, such as climate and soil. PVT was modeled from spatially referenced field data having a reference to habitat type. Earlier work in the Northern Region documented a correlation between presence and severity of root disease and habitat type (Lolo assessment).

The existing vegetation type used was the 40% plurality dominance type classification (Barber et al 2011). Forty percent abundance of a single species is needed to be classified with a single species code; otherwise, mixed types are classified by species life form sub-class, such as hardwood mix, shade intolerant mix, and shade tolerant mix. Existing vegetation for the Northern Region is mapped using Vegetation Mapping Program (VMap), which is a database of existing vegetation derived consistently across the region with an associated accuracy assessment. It is a remote-sensing based product that uses Landsat and National Agriculture Imagery Program (NAIP) imagery and biophysical criteria. More detailed information on Northern Region VMap can be found at this website: http://www.fs.usda.gov/goto/r1/VMap.

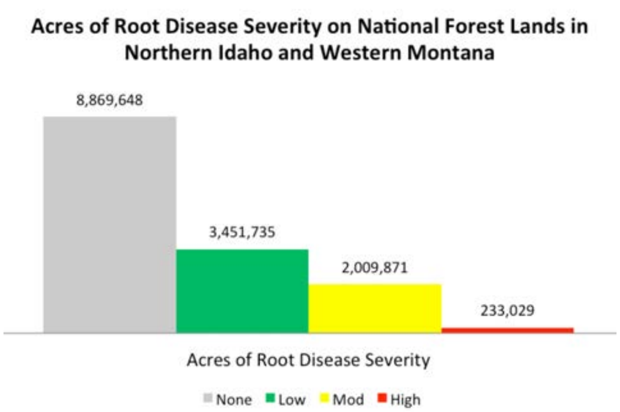

Figure 1. Acres of root disease severity on National Forest lands in north Idaho and western Montana, as determined by annual inventory data from the Forest Inventory and Analysis (FIA) plots, collected 2003 to 2007.

A rule set for assigning root disease hazard to the FIA plots was developed based on the percent of plots rated as None, Low, Moderate, and High root disease severity in each unique vegetation class. The resulting hazards for each unique combination of Bailey's ecoregion, dominance type and PVT were then mapped using VMap for the existing vegetation, overlaid with the regional PVT layer to map root disease hazard for western Montana and north Idaho.

RESULTS

Over 5.6 million acres of Northern Region National Forest (NF) lands west of the Continental Divide have some level of root disease, and nearly 2.3 million acres of NF lands are rated as having moderate or severe root disease (Figure 1). Moderate root disease severity means root disease is responsible for 10 to 50% canopy reduction, while high root disease severity means root disease is responsible for over 50% canopy reduction.

The spatial depiction of root disease was created by applying a root disease hazard rating to each unique combination of Bailey's ecoregion, 40% plurality dominance type and PVT across all ownerships. These unique combinations were then mapped using VMap for the existing vegetation and overlaid with the regional PVT layer. The spatial depiction of root disease hazard for western Montana and north Idaho can be seen in Figure 2; over 11.6 million VMap acres of National Forest lands have some level of root disease hazard (Figure 3).

Further analysis of the FIA data will occur when the next batch of FIA annual inventory data becomes available in 2015. Any adjustments to the spatial depiction of root disease hazard in northern Idaho and western Montana will be made at that time. This analysis is appropriate at a mid-scale planning level and would need to be used with caution at smaller scales. Guidance for incorporating these data into planning efforts at multiple scales is currently being developed.

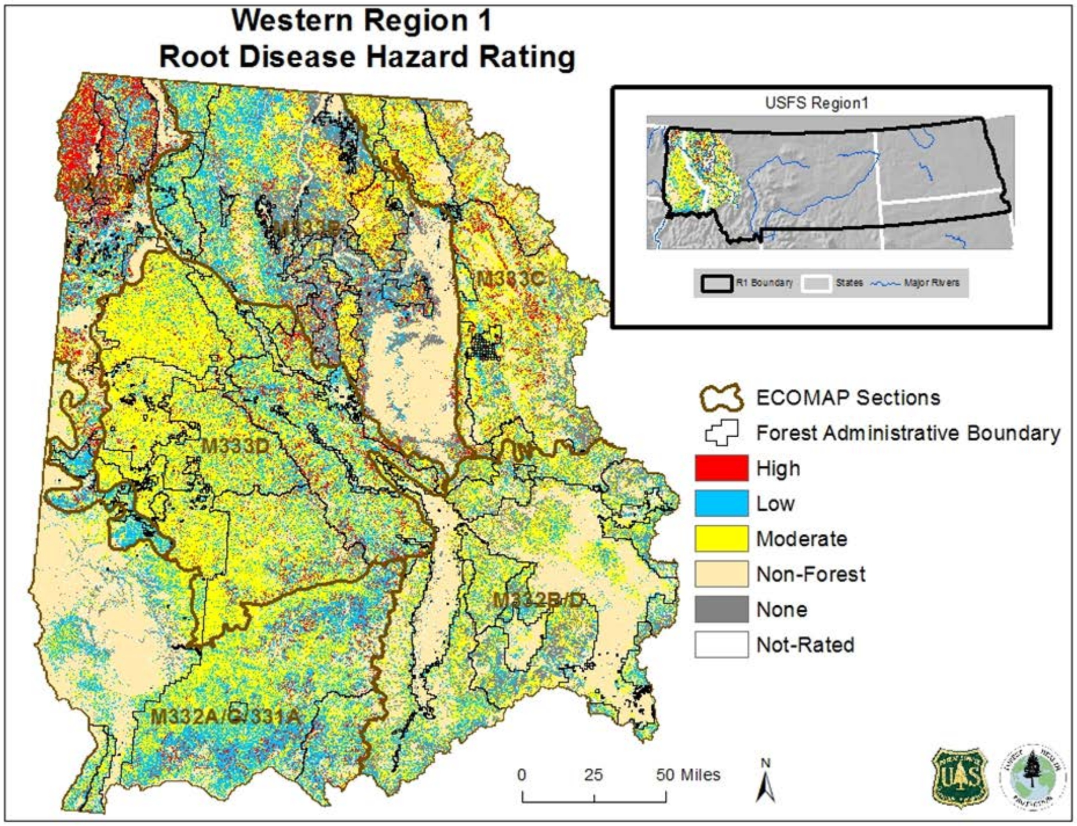

Figure 2. Root disease hazard for north Idaho and western Montana. Hazard developed using data collected on Forest Inventory and Analysis plots, then applied to unique combinations of cover type and potential vegetation type. The resulting hazard map was then created using the Northern Region existing vegetation layer as determined by Vegetation Mapping Program (VMap) overlaid with the regional PVT layer.

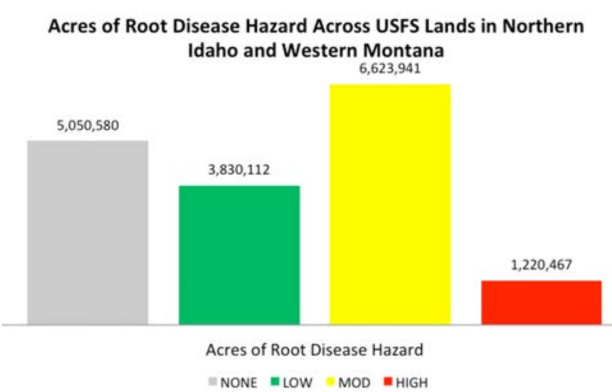

Figure 3. Acres of root disease hazard across National Forest in northern Idaho and western Montana, as determined by calculating hazard from root disease severity collected on Forest Inventory and Analysis plots, then applying to unique combinations of dominance type and potential vegetation type across the area.

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Recent Developments In Sudden Oak Death Management In Southwest Oregon: 2014

Alan Kanaskie[1], Everett Hansen[2], and Ellen Michaels Goheen[3]

BACKGROUND

Sudden Oak Death is caused by *Phytophthora ramorum*, a non-native pathogen that has become established in coastal California and a very small part of southwestern Oregon, and nowhere else in North America. It poses a great risk to tanoak (*Notholithocarpus densiflorus*) ecosystems in Oregon and California, and to forest ecosystems elsewhere in the U.S. and abroad. Quarantine regulations and loss of markets (due to perceived risk) impact both the nursery and forest industries.

The disease was first discovered in coastal southwest Oregon forests in July 2001. Mandatory eradication of *P. ramorum* by cutting and burning infected and nearby host plants began in the autumn of 2001 under the statutory authority of ODA. During the next several years an interagency team attempted to eradicate the pathogen through an aggressive program of early detection and destruction of infected and nearby host plants. By 2010 it was clear that compete eradication was not feasible, and the goal shifted to slowing spread. In 2013 the quarantine area was increased to 264 mi2 and a Generally Infested Area (GIA, 58 mi2) was established in which *P. ramorum* eradication is no longer required by the State. Trees have been dying at an alarming rate on private land inside the GIA, increasing the risk of wildfire and damage from falling trees.

Post-eradication monitoring has shown that cutting and burning host plants eliminated the pathogen from approximately 50 percent of infested sites. Cutting and burning new infestations before the disease can intensify also slows spread of disease across the landscape. Large treatment areas (300 to 600 ft buffer around infected trees) are more effective at slowing disease spread than smaller treatment areas. Because of the eradication program, the rate of disease spread in Oregon is slower than in similar areas in California where there is no comprehensive control program.

From the original infestations of 2001, sudden oak death has been found 20 miles to the north and 8 miles to the east, although the farthest of these infestations have been cut and burned and the pathogen may not have become established. The area in which the disease is established (the GIA) is approximately 10 miles north-south and six miles east-west (Figure 1). Maximum distance of natural spread (no evidence of human assistance) in any given year appears to be 3 to 4 miles.

In parts of Curry County where the disease was not treated, it has intensified dramatically, resulting in large areas of tanoak mortality. The high level of inoculum in these areas increases the probability of long-distance spread naturally and by people. In contrast, when all tanoak trees were cut and burned promptly with 300 to 600 ft of infected trees, disease did not intensify and in many cases was eradicated.

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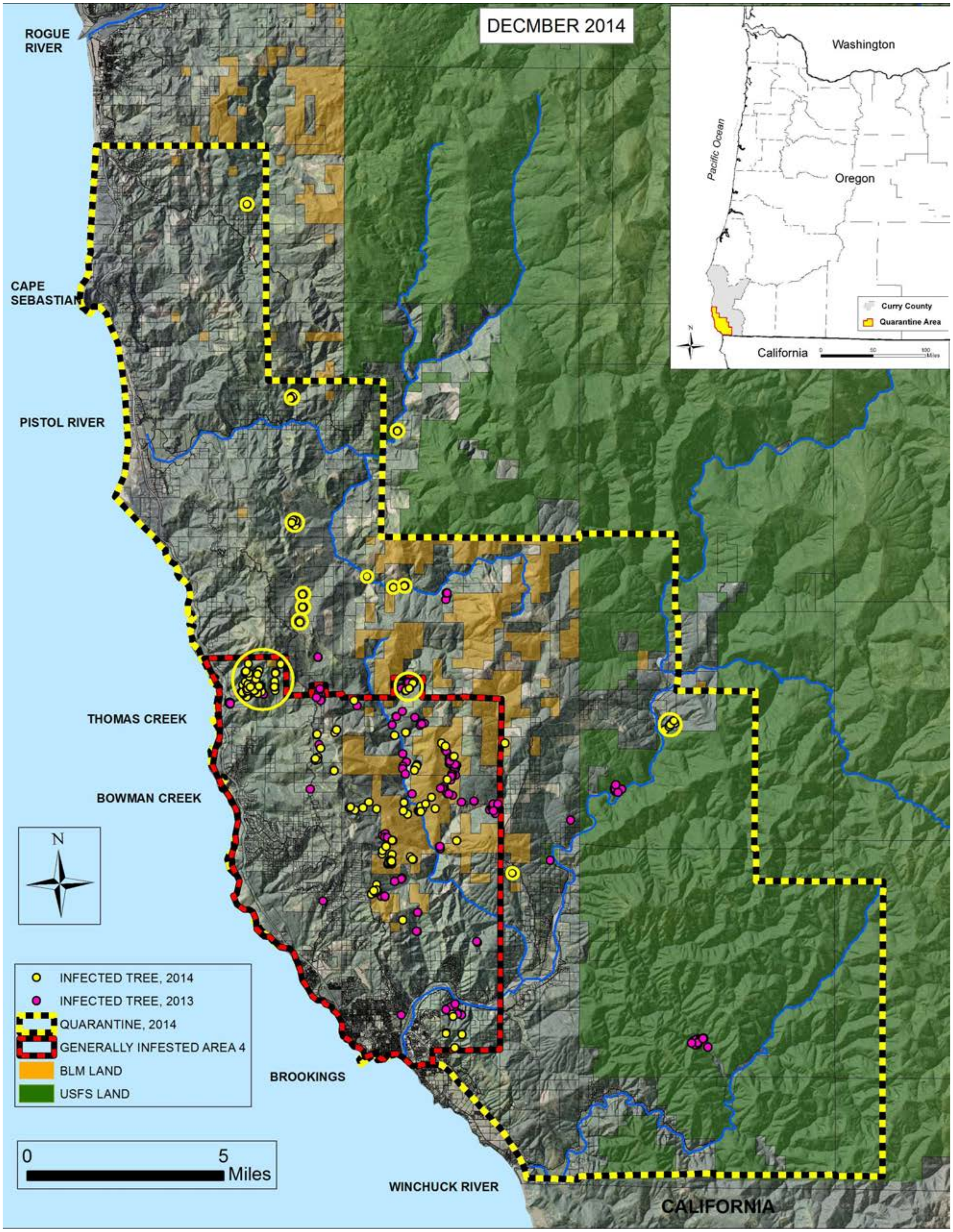

Figure 1. Location of sites infested with *Phytophthora ramorum* in southwest Oregon discovered in 2014. Sites enlarged for visibility.

From 2001 to 2014 the Oregon sudden oak death program in forests has cost more than $16 million (State, $3 million; Federal, $13 million). Economic analyses of the impact of *P. ramorum* on nursery and forest industry conducted by Entrix, Inc. and Oregon State University in 2009 concluded that every dollar spent on control or eradication results in a benefit of $2.70 to $19.67 to the industries. The benefit was due to delayed costs associated with compliance with quarantine regulations. The analyses did not consider ecological impacts, risk of wildfire, loss of markets, or costs associated with widespread tree mortality.

DISEASE SPREAD AND INTENSIFICATION IN 2014

Inside the GIA, disease has intensified dramatically on private land, the obvious result of stopping eradication treatments several years ago. In these areas tanoak mortality has gone from nearly zero to 50 percent in the 2012-2014 period. Elsewhere inside the GIA, on BLM land where eradication has been ongoing, disease intensification has been much slower.

Outside of the GIA, on private land we found two large infestations at the northern edge of the GIA and 12 infestations widely scattered mostly to the north. Several of these were 3 to 4 miles beyond any previously known infestations. Only one new infestation was found on USFS land. It is located along the Chetco River one mile inside the eastern boundary of the quarantine area (Figure 1).

ERADICATION TREATMENTS IN 2014

BLM and USFS are treating all infestations on their ownerships. Due to limited funds for treatments on private land (Figure 2), treating the large infestations at the northern edge of the GIA was impossible, so the GIA was expanded to include them. The remaining 12 infestations outside of the GIA are receiving modified treatments to stay within budget. The northernmost infestation received the full cut and burn treatment in a 300 ft radius from infected trees. On the next two infestations to the south, the central 50 ft radius was cut and burned and the remainder of the site was cut and lopped with no burning. All other sites will be treated minimally by cutting and burning tanoak within 50 ft (or less) of infected trees. The rationale for cutting smaller buffers, as opposed to doing nothing, is that cutting infected and nearby trees reduces the amount of pathogen inoculum available for intensification and spread.

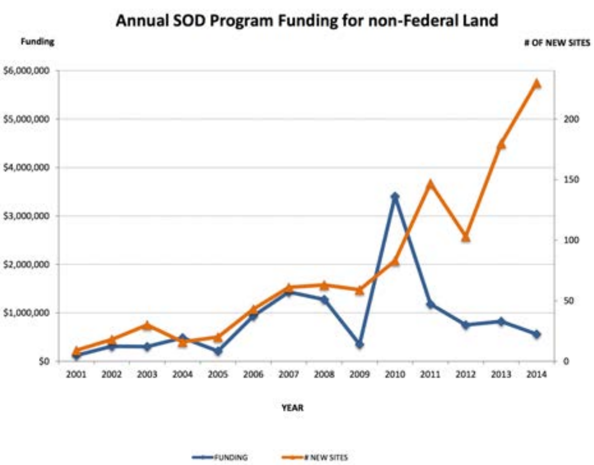

Figure 2. Total program funding for sudden oak death program non-federal land (detection, monitoring, administration, and eradication treatments) compared to amount of disease. Excludes eradication expenditures on federal lands (BLM and USFS).

STRUCTURE AND COST OF CURRENT PROGRAM

The current program slows disease spread using early detection and localized eradication to reduce natural spread, and quarantine regulations and landowner education to prevent human-assisted spread. On federal land, The BLM and USFS continue to treat new infestations by cutting and burning host plants within 300 ft of infected trees. On private land, where most new infestations have occurred, limited funding requires reducing the size of the treatment areas and other modifications. Treatments range from cutting and burning an infected tree and its nearest neighbors (1/10 acre) to cutting and burning all host plants within 300 ft of infected trees. The GIA is expanded when large infestations are found near its edge and there are insufficient funds to treat them.

Program functions are shared among 5 organizations: ODF (detection and monitoring lead, eradication on non-federal land, landowner assistance); USFS (eradication on USFS, detection and monitoring, assistance to federal agencies); OSU (laboratory diagnostics and support for all surveys); BLM (eradication and related work on BLM land), and; ODA (regulations, quarantine, monitoring).

ODF operations are managed by the forest pathologist in Salem, plus two foresters located in Brookings. Brookings staff conducts surveys, administers contracts, and assists landowners. USFS operations are managed by the zone pathologist in Medford, plus a forester in Gold Beach. BLM operations are managed by foresters in their Coos Bay office. OSU laboratory support is provided primarily by the Hansen group.

The annual cost in 2014 for the entire program of detection and eradication (all agencies combined) was $1.7 million. Average cost to cut and burn infested sites in 2014 ranged from $3,000-$5,000 per acre.

WHERE TO FROM HERE?

Sudden oak death is now firmly established in the tanoak forests of southwest Oregon and will be a long-term forest health problem. The current disease management program structure and funding schemes are a continuation of the emergency response that began in 2001, but they may not be appropriate from this point forward.

The consequences of continuing the current program at current funding levels are becoming clear. In areas where treatments have stopped, disease intensifies dramatically and kills most of the tanoaks in just a few years. As more inoculum is produced in the areas of uncontrolled disease, the leading edge of the main infestation expands northward and eastward, and the probability of human-assisted spread increases. Each year outlier infestations become more numerous and occur farther from the leading edge. Funding for eradication treatments on non-federal land is not sufficient to treat all outliers effectively. Scaling treatment area size to importance of an infestation allows the most important infestations to be cut and burned, which slows disease relative to no treatment. Under this scenario, it is likely that the disease will spread northward by as much as 3 to 4 miles per year, but eradication may delay establishment at those distances. The quarantine area will expand incrementally to maintain a 3 mile buffer between infested sites and the quarantine boundary.

If the current program is stopped, sudden oak death would become one of many forest health issues handled by agencies. Federal funding likely would decrease and agencies would reduce survey effort and no longer support cut and burn projects. Disease intensity and rate of spread would increase. The quarantine area would expand immediately to the entirety of Curry County. Agencies would provide technical assistance to landowners who want to know why their trees are dying and what they can do about it, give advice on how to reduce hazards from fire and tree fall, enforce quarantine regulations, and promote best management practices to make the most of a bad situation. Citizen science programs could help detect and track spread of the disease, providing data to researchers and graduate students. In short, we would rely on educating people to mitigate the effects of the disease and prevent spread to other susceptible forests. It would be much like what has happened in California.

The ecological and economic consequences of abandoning the sudden oak death program are disturbing. Tanoak is rapidly being eliminated from infested areas in California and in part of Curry County. Oregon will lose tanoak in at least the western portion of its range. Birds, mammals, insects and fungi dependent on tanoak will migrate or die. Loss of tanoak will impact Native American culture. The quarantine regulations would eventually expand to Coos and Douglas counties, causing all sorts of trade problems with species on the *P. ramorum* host list such as Douglas-fir, western hemlock, grand fir, and others. Forest, nursery, Christmas tree and other forest product operations that intend to ship material will need inspections and disease-free certifications, probably on a fee-for-service basis.

We presently are considering altering the sudden oak death program to one that focuses on preventing the disease from entering the adjacent Coos and Douglas-counties (to avoid the economic impact of quarantine regulations there), protecting selected important tanoak ecosystems, and providing long term conservation and adaptation of tanoak genes.

Aspen Health And Damage Agents On National Forests In Northern Wyoming And Western South Dakota

J.T. Blodgett[1], A.K. Ambourn, and K.K. Allen

INTRODUCTION

Long-term monitoring plots (Shaw 2004) and aerial detection surveys (Worrall et al. 2008) suggest extensive sudden decline and deterioration of aspen forests in the Rocky Mountains. Changes to the fire regimes since European settlement and heavy browsing (Bartos and Campbell 1998; Kay 1997; Romme et al. 1995; Sheppard et al. 2006), drought (Hogg et al. 2008; Worrall et al. 2008), and climate change (Rehfeldt et al. 2009; Worrall et al. 2013) have been suggested as factors contributing to decline and mortality. Several diseases and insects are associated with aspen mortality (Dudley 2011; Fairweather et al. 2008; Frey et al. 2004; Guyon and Hoffman 2011; Hogg et al. 2008; Hogg and Michaelian 2014; Marchetti et al. 2011; Rehfeldt et al. 2009; Steed and Kearns 2010; Worrall et al. 2010, 2013). Aerial surveys in Wyoming provide general information regarding the extent and location of aspen mortality, but not the condition of regeneration or specific damage agents associated with mortality.

In this study, damage agents and site variables were measured to determine factors contributing to aspen mortality. The objectives of the study were to: 1) evaluate tree and regeneration health, 2) quantify frequencies of damage agents, and 3) analyze tree mortality and regeneration stocking in relation to site, tree, climate, and damage agents.

METHODS

Permanent plots were selected in 2008/2009 in the Shoshone, Bighorn, and Black Hills National Forests (Figure 1). Sites were initially selected systematically, sight unseen, using a geographic information system. Polygons (representing stands) were selected that were designated as ≥ 50% aspen and ≥ 0.8 ha, with a minimum spacing among stands of 1.6 km. Stand size and composition were confirmed in the field. Three tree and three regeneration plots were installed per stand at 40 m spacing. For trees, 1/125 ha plots were used and 1/1250 ha plots were used for seedlings/saplings. Plots were reexamined in 2012.

Several variables were collected including location, altitude, slope, aspect, tree species and size, and percentage live crown. Trees were classified by condition (live, recent dead, or old dead). Recent dead trees had all their bark and at least some fine branches. Tree mortality rates per plot were calculated based on the number that died between 2008/2009 and 2012. A dominant or codominant tree at each plot was cored to determine approximate age, recent 10-year radial growth, and used to estimate site index. Eleven climate variables were derived using the Spline Model of Climate (Rehfeldt 2006) based on mean stand coordinates.

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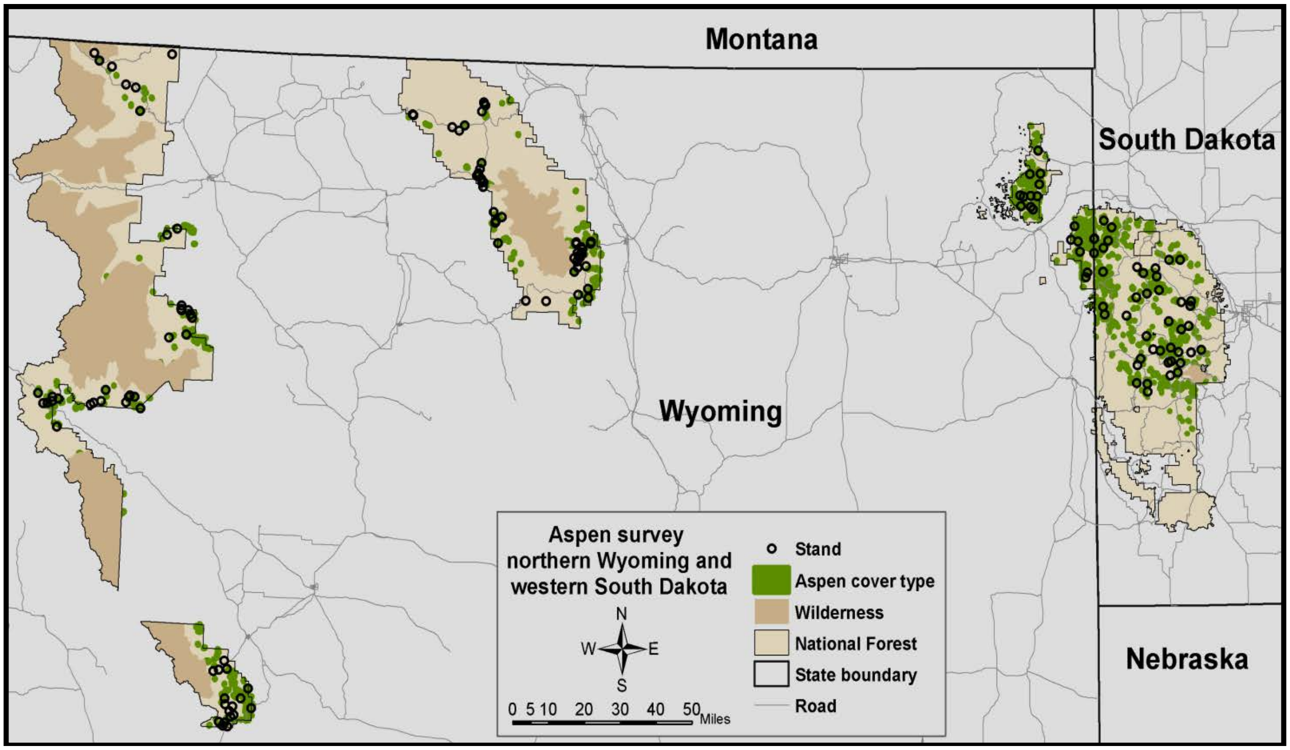

Figure 1. Location of stands and aspen cover type. Fifty, 45, and 60 stands were sampled in the Shoshone, Bighorn, and Black Hills National Forests, respectively.

Damage agents were recorded for each live and recent dead aspen tree, and were summarized as percentage of stems per plot. For most damage agents, any amount of damage was recorded. Foliage diseases and defoliating insects were only recorded if they damaged ≥ 25% of the crown. Animal and other physical damages to trees were only recorded if they damaged ≥ 25% of the crown or stem. Root diseases were assessed differently than other damage agent given the potential damage to live trees and the time required to assess root systems for signs of disease.

Root disease pathogens were assessed as present or not found in 3 approximately 1/3 ha plots per stand, centered at tree plot centers. White mottled rot (*Ganoderma applanatum*) was confirmed by examining 10 recent dead trees (30 per stand) for the presence of conks. If recent dead trees were not present, trees with root disease symptoms were examined next and then healthy trees. *Armillaria* spp. were confirmed by examining three recent dead trees per plot (9 per stand) for the presence of mycelial fans and/or rhizomorphs. If found, root disease was confirmed by examining two live aspen trees per plot (6 per stand) for the presence of mycelial fans. Trees with root disease symptoms were preferentially selected.

Regeneration (seedling and sapling) was classified by species and host condition (living or dead); and were 30 cm high and < 7.6 cm DBH. Damage agents were tallied for both live and dead aspen regeneration.

STATISTICAL ANALYSES

Stand means were calculated from the three plots per stand. Data was analyzed by linear regression, using SAS release 9.4; for all tests α = 0.05.

Table 1. Percentage of trees with damage agents in three National Forests.

Damage agent	Shoshone (%)	Bighorn (%)	Black Hills (%)
Cytospora canker (*Cytospora* spp.)	51 (0.50)[b]	41 (0.30)	50 (0.38)
Sooty-bark canker (*Encoelia pruinosa*)	22 (0.23)	10 (0.14)	39 (0.51)
Aspen trunk rot (*Phellinus tremulae*)	9	7	28
Bronze poplar borer (*Agrilus liragus*)	17 (0.32)	3	18 (0.30)
Poplar borer (*Saperda calcarata*)	17	7	17
Animal debarking	5	20	1
Black canker (*Ceratocystis fimbriata*)	7	4	9
Cryptosphaeria canker (*Cryptosphaeria lignyota*)	7 (0.32)	2 (0.10)	4 (0.16)
All other agents[c]	15	10	8

[a]Damage agents that could be rapidly assessed in individual trees. Root diseases were assessed by plot.
[b]Numbers in brackets represent R-square values for relationships that were significant based on linear regression.
[c]Twenty five damage agents found in <1% of the trees individually.

RESULTS

Thirty-three damage agents were found in trees with up to eight in an individual tree. However, most of these agents were found in <1% of the trees, thus were not contributing to significant mortality at the forest level. Only eight damage agents were common in the forests (Table 1). Mortality increased significantly with increasing levels of four of the common damage agents; however R-square values were small.

Thirty damage agents were found in regeneration with as many as seven in individual regeneration plots. Only three groups of damage agents were common in the forests (Table 2). None of the agents increased significantly with decreasing numbers of regeneration stems.

Mean aspen tree mortality rate was 6.2%/year (+/- 5.2% SD) and mean regeneration was 7708 stems/ha. White mottled rot (G. applanatum) was found in all forests (13% of stands). Mortality increased significantly with increasing levels of white mottled rot in both the Bighorn and Black Hills, but not the Shoshone, however the R-square value was very low (0.10). *Armillaria* spp. were common in all forests (55% of stands) and were found causing root disease in some stands, but the correlation with tree mortality was not significant.

Other variables with a low but significant correlation with 2012 aspen tree mortality were percentage live crown, 10-yr growth, and recent and old dead trees the first year (R-square = 0.75, 0.10, 0.26, and 0.12, respectively). Live crown and 10-yr growth were negatively correlated; recent and old dead trees the first year were positively correlated. The correlations were not significant between tree mortality and any other variable. None of the variables had a significant correlation with number of regeneration stems.

Table 2. Percentage of seedling and sapling stems with damage agents in three National Forests.

Damage agent	Shoshone (%)	Bighorn (%)	Black Hills (%)
Animal browsing	10	27	32
Cankers	15	13	24
Foliage diseases	1	5	4
All other agents[a]	3	5	4

[a]Twenty seven damage agents found in <1% of the trees individually.

SUMMARY AND CONCLUSION

Most of the stands in the three forests are healthy. For trees, 75% of the stands had ≤8% mortality. Aspen mortality rates around 8% could be considered normal in mature stands, and most stands were close to the average (6%). Overall, aspen regeneration was common and relatively dense across the forests. For regeneration, 80% of the stands had ≥2500 stems/acre; many of the remaining 20% had high levels of competing vegetation (63%) and/or were very dense stands (53%). Regeneration levels of 2500 stems/acre could be considered high.

Many damage agents were observed, but only five agents were correlated with tree mortality (Figure 2). The cankers and borer causing tree mortality in the three forests are associated with aspen mortality throughout the region (Dudley 2011; Guyon and Hoffman 2011; Fairweather et al. 2008; Marchetti et al. 2011; Steed and Kearns 2010).

Sooty-bark canker is likely the most damaging agent, but Cytospora canker, bronze poplar borer, and white mottled rot (*G. applanatum*) are contributing significantly to mortality. Sooty bark canker has been suggested as a major mortality agent in previous studies (Hinds 1985). Trees found with this disease during the first sampling year were often dead in 2012. Although Cytospora canker was more common and is causing mortality, the majority of the cankers were small, already healed, or likely to heal. Although not observed in all stands, white mottled rot was an important mortality agent of mature aspen, consistent with earlier findings (Ross 1976; Hinds 1985). Bronze poplar borer was a significant mortality agent in two of the forests, and is a common pest of stressed aspen (Furniss and Carolin 1977). Other damage agents did cause tree mortality, but their correlations with mortality were not significant or they were infrequent. Consequently, damage agent aggressiveness, tendency with mortality, and frequency should all be considered when determining potential impacts on forest health at the landscape level.

Figure 2. The four most common damage agents correlated with tree mortality were Cytospora canker (*Cytospora* spp.), sooty-bark canker (*Encoelia pruinosa*), bronze poplar borer (*Agrilus liragus*), and white mottled rot (*Ganoderma applanatum*) from top to bottom and left to right, respectively.

Although none of the damage agents were significantly correlated with the number of regeneration stems, browsing is often cited as a factor preventing successful aspen regeneration (Bartos and Campbell 1998; Kay 1997; Romme et al. 1995). Jacobi and Shepperd (1991) also found canker diseases to be a factor associated with low regeneration in clearcuts. Both of these damage agents were common on regeneration in the northern Rocky Mountain Region. In these forests, there was a high frequency of cankers in aspen regeneration. Most were associated with browsing damage. Thus, browsing damage is a likely entry point for the damaging canker pathogens.

The relationships (R-square) between mortality and damage agents were low. The low R-square values are likely due to: 1) multiple damage agents contributing to mortality, 2) different frequencies of damage agents in different stands, 3) low overall mortality in the forests, and 4) varying environmental conditions among stands (thought no significant correlation was found for climate variables). Damage to live trees was included when tallying damage agents, which did not contribute to 2012 mortality. Therefore strong correlations were not expected. Still, five agents were significantly correlated with mortality, suggesting they contribute to mortality in the northern Rocky Mountain Region.

ACKNOWLEDGEMENTS

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Preliminary Survey Of Wood-Associated Fungi In Southeast O'ahu Of Hawai'i Using DNA-Based Identification

S.M. Ashiglar[1], F. Brooks[2], Phil G. Cannon[3], and N.B. Klopfenstein[4]

INTRODUCTION

Hawai'i is a biological hotspot with a variety of climates and habitats. While fungal species diversity has been more extensively studied in Hawai'i than other Pacific Islands (e.g. see Gilbertson et al. 2002), there remain many species unreported in the literature. This project attempted to capture a small portion of Hawai'i's fungal diversity in southeast O'ahu by identifying fruit bodies using molecular techniques. The efficacy of using the internal transcribed spacer (ITS) and large subunit (LSU) regions of the nuclear ribosomal DNA (rDNA) to identify Hawai'ian fungi is discussed.

METHODS

Fungi were collected from the Honolulu Mauka trail system, Maunawili, and Waikiki in southeast O'ahu. Samples from most collections were cultured on potato-dextrose agar (PDA) and benomyl-dichloran-streptomycin (BDS) medium, which were sent with the accompanying fruiting bodies to the Rocky Mountain Research Station (RMRS) for DNA-based identification. The RMRS extracted DNA from each collection and conducted PCR and sequencing using fungal ITS and LSU primers. Sequence data were compared to similar sequences in the NCBI GenBank® database and specimens were tentatively identified using the closest named match in the database. Sequences that matched non-wood associated fungi and were not similar to morphological identifications of fruiting body collections were not further analyzed.

RESULTS

We tentatively identified 15 specimens using the ITS region, LSU region, or both. Of those specimens where both ITS and LSU sequences were successfully obtained, 75% matched species-level identifications. The other 25% were identified as different but related genera, depending on the region of the rDNA sequenced (Table 1).

DISCUSSION

Fungal LSU and ITS sequences are well represented in GenBank®, making them useful in preliminary identifications of fungi. This study targeted fungi with distinctive fruit bodies (Figure 1) and all samples had at least a strong genus-level match to similar sequences in GenBank®. Due to low sequence variation for some taxonomic groups in the ITS and LSU regions, such as species in the genus *Ganoderma* (Moncalvo et al. 1995 A & B), species-level identification using these regions is not always conclusive. However, these regions did provide relatively quick and easy taxonomic delineations and could lead to more precise molecular and morphological studies on relevant specimens.

Comprehensive, updated species lists are useful to land managers, allowing them to track species composition and movement over time. Currently, molecular tools are the most practical means of identifying fungi for non-

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mycologists. The increasing availability of more advanced tools in the field of metagenomics could allow managers to quickly understand species composition of larger communities. To use molecular tools to full advantage, however, reference materials identified by taxonomic experts and relevant, easily searchable DNA sequence databases must be maintained. It is likely only a fraction of Hawai'ian fungi have been recorded and for many species there are no preserved specimens or DNA records. This study tentatively identified four species previously unrecorded in Hawai'i: *Microporus xanthopus*, *Inonotus rickii*, *Panus* spp. and *Coriolopsis rigida*. Further morphological and molecular analyses are needed to confirm these identifications.

Table 1. ITS and LSU identifications of O'ahu fungi. Yellow highlighted rows indicate a species match in both regions, white indicates no match, and gray indicates incomplete data.

	ITS1 +5.8S + ITS2 regions			LSU D-Domain region		
Isolate ID	*Closest GenBank Match*	*Maximum Identity Score*	*Closest GenBank Match Accession Number*	*Closest GenBank Match*	*Maximum Identity Score*	*Closest GenBank Match Accession Number*
FB1	***Fuscoporia gilva***	**95%**	**FJ481039**	***Fuscoporia gilva***	**99%**	**HQ328525**
FB2	***Earliella scabrosa***	**99%**	**JN164992**	***Earliella scabrosa***	**99%**	**JN164793**
FB3	***Microporus xanthopus***	**98%**	**JX290074**	**Not Available**		
FB7	**Not Available**			***Fuscoporia gilva***	**99%**	**HQ328525**
FB8	***Microporus xanthopus***	**98%**	**JX290074**	***Microporus xanthopus***	**99%**	**JX290071**
FB9	***Physisporinus vitreus***	**95%**	**JN182920**	***Rigidoporus microporus***	**100%**	**AY333795**
FB13	***Earliella scabrosa***	**99%**	**JN165006**	***Earliella scabrosa***	**100%**	**JN164793**
FB14	***Ganoderma gibbosum***	**99%**	**EU273513**	***Fomes fomentarius***	**98%**	**DQ208419**
FB17	***Physisporinus vitreus***	**95%**	**JN182920**	***Rigidoporus microporus***	**99%**	**AY333795**
FB19	***Inonotus rickii***	**96%**	**GU111921**	**Not Available**		
FB21	***Inonotus rickii***	**96%**	**KC479129**	**Not Available**		
FB22	***Panus sp.***	**99%**	**KJ195662**	**Not Available**		
FB23	***Polyporus arcularius***	**99%**	**AF516524**	***Polyporus arcularius***	**99%**	**AF393067**
FB24	***Coriolopsis rigida***	**99%**	**JF894112**	***Coriolopsis rigida***	**99%**	**KC867454**
FB25	***Trametes sanguinea***	**99%**	**JN164981**	**Not Available**		

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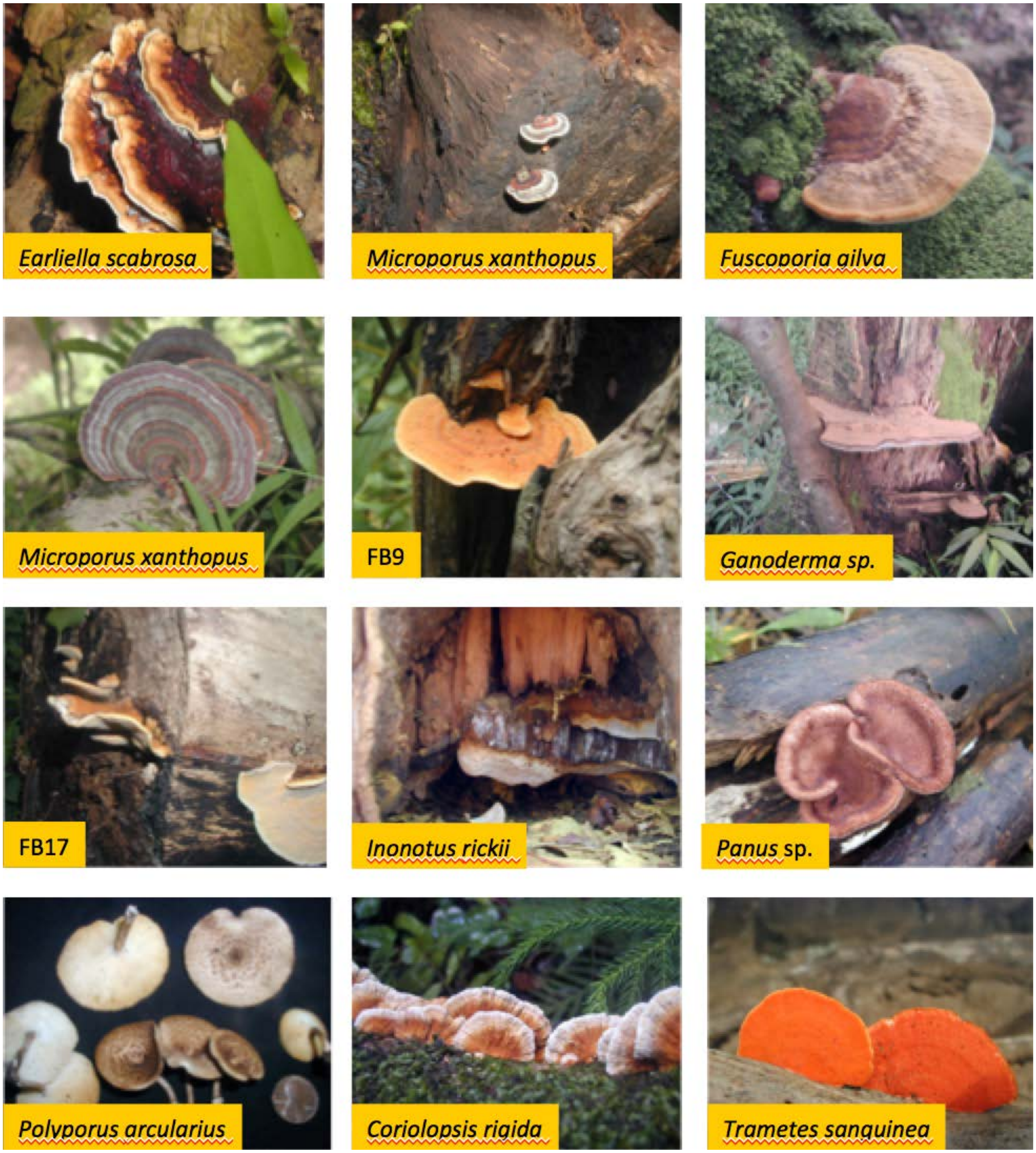

Figure 1. Wood rotting fungi from O'ahu and corresponding ITS- and LSU-sequence based identifications. Fungi that resulted in different GenBank species matches between ITS and LSU gene regions are denoted by sample number only (Photos by F. Brooks).

Schweinitzii Root And Butt Rot: Challenges In Hazard-Tree Identification

Josh Bronson[1]

Phaeolus schweinitzii is the cause of schweinitzii root and butt rot of conifers in western forests. It is especially common affecting large, old Douglas–fir in southwest Oregon. Significant decay may be indicated by butt swell and occurrence of a conspicuous fruiting body, referred to as the "cow-pie fungus" or "velvet-top fungus." Trees with extensive butt rot are often damaged in high-wind events and commonly fail near the ground line leaving a shattered stump.

When Schweinitzii root and butt rot is encountered in developed sites, it takes considerable effort to thoroughly assess the amount of decay that is within the stem and roots of the affected tree. The Pacific Northwest region of the US Forest Service has developed a region-wide policy for identification and mitigation of hazard-trees in developed sites. According to the policy, qualified examiners need to determine the sound-rind thickness of the stem and/or determine the percentage of structural roots with advanced decay. Mitigation is dependent on estimating the potential damage to a specified target, identifying a specific failure indicator (i.e. schweinitzii root and butt rot), and determining the failure potential for the tree (high, medium, or low). Summarized below are some of the difficulties that an examiner might encounter during an inspection.

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- Decay caused by *P. schweinitzii* is typically associated with large, old trees. These trees may have heritage status and are often prized in frequently visited campground sites. In addition, these trees may provide valuable wildlife habitat. These factors need to be considered before felling a tree that has been deemed a hazard.
- Appearance of fruiting bodies seems to have little correlation with the amount of decay present. Conks can be easily moved and displaced, and replaced elsewhere. It is important to assess the combination of signs and symptoms in all situations.
- Determination of sound-rind thickness on large trees requires the examiner to scrape off thick bark, and requires the use of a long increment borer, both of which take considerable time to accomplish.
- Treatment decision for trees with high damage potential often depends on the determination between "little decay present" and "decay in less than 50 percent of the structural roots" (low and medium failure potential, respectively.)
- The location of decay can be found in any combination of the structural roots, fine roots, and stem.
- Advanced decay that occurs in more than half of the structural roots is typically less difficult to identify; often times when the decay is this extensive it will extend into the stem where measuring sound rind thickness is much easier. Determining if a tree has high failure potential such as this can be much less time-consuming.
- Utilizing several tools is often necessary to accomplish a thorough investigation. A Pulaski and increment

borer is standard; employing an electric drill with a drill bit or borer attachment can also be useful and less time-consuming. Decay extending into the stem on high-value trees can be measured using a tomograph, however access to these machines is limited.

- Considerable excavation is required on at least 50 percent of structural roots. This disturbance may introduce new decay or exacerbate decay in previously infected roots and butts.
- What does decayed wood look like in drill bit shavings/increment bore? We know *P. schweinitzii* causes a brown cubical rot, however this can be difficult to identify when taking a small sample of decayed wood.
- What is the shape and position of structural roots? Deciding which roots to drill into and where to drill on the root can be confusing. It's best to start drilling in the stem where it is easier; and if no decay is found move to the largest roots and drill at the root collar.

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Using A Metagenomic Approach To Improve Our Understanding Of Armillaria Root Disease

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INTRODUCTION

Metagenomics has illuminated our understanding of how microbial communities influence health and disease. Researchers are beginning to characterize what constitutes healthy microbiota in terms of structure, function, and diversity in a variety of environments. Although investigation lags behind the more well-studied human microbiome, a growing body of research is using next-generation sequencing tools and advances in bioinformatics to explore how microbiota and constitutive microbiomes in soils and plant tissues can affect crop and forest diseases (Damon et al. 2012, Bonito et al. 2014, Penton et al. 2014, Qiu et al. 2014, Štursová et al. 2014). Disease suppression in agricultural systems has been fairly well-studied, with suppression attributed to diverse microbiota that affect pathogen survival, growth, and infection. In these systems, management practices such as no-till and stubble retention, which supply higher levels of available carbon, have been shown to favor diverse microbial communities. Our understanding of disease suppression in forest soils is minimal, even though these ecosystems are home to some of the most complex microbial communities (Fierer et al. 2012) that play essential roles in biogeochemical cycles (Van Der Heijden et al. 2008) and account for considerable terrestrial biomass (Nielsen et al. 2011). Armillaria Root Disease is one of the most important diseases of trees in temperate regions, yet it remains difficult to manage. Results of biological control research suggest that components of the forest soil microbiota may affect Armillaria Root Disease (e.g., Reaves et al. 1990, Reaves and Crawford 1994, Filip and Yang-Erve 1997, Becker et al. 1999, Chapman et al. 2004, Shapiro-Ilan et al. 2014).

Our objective with this work is to evaluate the efficacy of using a metagenomic approach to characterize forest soil microbial communities within a small subset of Forest Inventory and Analysis (FIA) plots established in the Priest River Experimental Forest (PREF), Idaho, USA. This information can be used to design and implement studies to examine how forest soil microbiota relate to Armillaria Root Disease, with the ultimate goal of informing management decisions that manipulate the environment in ways that favor disease suppression.

PILOT STUDY

DNA and RNA isolated from forest soil cores taken from replicates of contrasting habitat types (relatively wet-mesic vs. relatively dry-mesic) within PREF are being analyzed via amplicon sequencing coupled with metatranscriptomics. FIA plots (6 within each contrast) established within PREF have been sampled (Figure 1). Each plot was randomly selected, controlling for canopy cover, mean canopy height, and elevation. Soil was sampled at two time points (autumn 2013 and spring 2014) and three depths (0, 7.5, and 15

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cm below the forest floor, as well as from a composite sample) at the midpoint between the bole and drip line of the nearest mature Douglas-fir (*Pseudotsuga menziesii*) or grand fir (*Abies grandis*) at a measured distance and azimuth from the geolocated plot center. These trees were surveyed and sampled for the presence of *Armillaria* species, which were identified using a combination of somatic pairing and tef1α sequence variation (Ross-Davis et al. 2012). RNA and DNA have been isolated from each soil subsample using the RNA PowerSoil Total RNA Isolation and PowerLyzer PowerSoil DNA extraction kits, respectively (MoBio, Carlsbad, CA). Barcoded amplicons are being sequenced via the Illumina MiSeq system, and RNA will be sequenced on the Illumina HiSeq system through the IBEST Core Facility (University of Idaho, Moscow, Idaho). Composition of soil microbial communities and their respective levels of gene expression will be compared among samples to determine if and how forest soil microbial communities differ between habitat types, across fine spatial and temporal scales, and to examine how these communities relate to their environment.

PRELIMINARY RESULTS AND FUTURE DIRECTIONS

Compared to wet-mesic plots, dry-mesic plots had lower canopy cover, more diverse ground vegetation, more variable soil moisture and temperature profiles (with higher temperature means and maxima, and lower temperature and moisture minima), much earlier Spring warming (i.e., soil temperatures in dry-mesic plots reached > 0 °C in mid-March compared to mid- to late-April in the wet-mesic plots) and were less prone to harbor pathogenic species of Armillaria (Tables 1, 2, and 3). Three species of Armillaria were detected, mostly collected as rhizomorphs. Mycelial fans of *A. solidipes* were present in 2 of the 12 sampled plots (both wet-mesic). Analysis of the forest soil microbiota is on-going.

Table 1. Characteristics of Surveyed FIA Plots at Priest River Experimental Forest, Idaho, USA.

Plot		Habitat Type*	Canopy (%)	Slope (°)	Aspect (°)	Ground Vegetation (% Cover, Richness)
WET-MESIC	3136	TSHE/CLUN - CLUN PHASE	91.74	32	310	5, 1
	3161	TSHE/CLUN - CLUN PHASE	89.66	32	18	22, 4
	3104	TSHE/CLUN - CLUN PHASE	90.96	20	286	trace, 2
	3147	TSHE/CLUN - CLUN PHASE	77.67	24	320	20, 9
	3139	TSHE/CLUN - CLUN PHASE	92.26	28	320	2, 4
	3146	THPL/CLUN - CLUN PHASE	91.74	24	183	44, 9
DRY-MESIC	3111	ABGR/PHMA - PHMA PHASE	55.25	38	322	76, 12
	3317	ABGR/PHMA - PHMA PHASE	90.70	43	138	47, 10
	3106	ABGR/CLUN - PHMA PHASE	84.96	32	215	18, 11
	3381	ABGR/CLUN - PHMA PHASE	89.13	12	132	26, 10
	3276	PSME/PHMA - PHMA PHASE	84.96	28	212	100, 11
	3128	PSME/PHMA - SMST PHASE	39.62	8	158	63, 7

*TSHE = *Tsuga heterophylla*; CLUN = *Clintonia uniflora*; THPL = *Thuja plicata*; ABGR = *Abies grandis*; PHMA = *Physocarpus malvaceus*; PSME = *Pseudotsuga menziesii*; SMST = *Maianthemum stellatum*.

Table 2. Soil Moisture and Temperature Profiles of Surveyed FIA Plots.

Plot		Soil Moisture m^3/m^3 Mean (Min - Max)	Soil Temperature °C Mean (Min - Max)
WET-MESIC	3136	0.116 (0.0322 - 0.3518)	6.21 (-1.727 - 16.272)
	3161	0.151 (0.0519 - 0.2414)	6.74 (-2.044 - 17.201)
	3104	0.166 (0.0366 - 0.3148)	6.57 (-0.563 - 17.605)
	3147	0.189 (0.0330 - 0.3279)	6.61 (-0.004 - 17.153)
	3139	0.151 (0.0402 - 0.3373)	6.43 (-1.986 - 16.320)
	3146	0.094 (0.0010 - 0.2501)	6.69 (-2.918 - 18.319)
DRY-MESIC	3111	0.114 (0.0010 - 0.2356)	7.89 (-2.363 - 19.080)
	3317	0.116 (-0.0142 - 0.2443)	9.11 (-6.105 - 24.026)
	3106	0.121 (0.0003 - 0.2632)	7.80 (-3.866 - 32.846)
	3381	no data	no data
	3276	0.118 (-0.0150 - 0.2625)	9.54 (-2.654 - 23.833)
	3128	0.158 (-0.0273 - 0.3431)	10.21 (-2.131 - 26.769)

Table 3. Disease Data and Associated Fungi of Surveyed FIA Plots.

Plot		Armillaria*	Host*	Other fungi	Host*
WET-MESIC	3136	No	.	No	.
	3161	*A. altimontana* – R	ABGR	*Heterobasidion irregulare*	TSHE
		A. solidipes – F	ABGR		
	3104	*A. solidipes* – F	PSME	*Perenniporia subacida*	PSME
	3147	*A. altimontana* – R	**ABGR**	*Leptodontidium* sp.	**ABGR**
				Leohumicola sp.	**ABGR**
	3139	*A. gallica* – R	ABGR	No	.
	3146	*A. gallica* – R	PSME	No	.
DRY-MESIC	3111	No	.	No	.
	3317	No	.	No	.
	3106	*A. altimontana* – R	PSME	*Phialocephala fortinii*	PSME
				Phellinidium sulphurascens	PSME
	3381	*A. gallica* – R	**ABGR**	in progress	**ABGR**
	3276	*A. gallica* – R	PSME	*Penicillium* sp.	PSME
	3128	*A. gallica* – R	PSME	No	.

* TSHE = *Tsuga heterophylla*; ABGR = *Abies grandis*; PSME = *Pseudotsuga menziesii*; R = rhizomorph; F = mycelial fan; hosts in bold were dead.

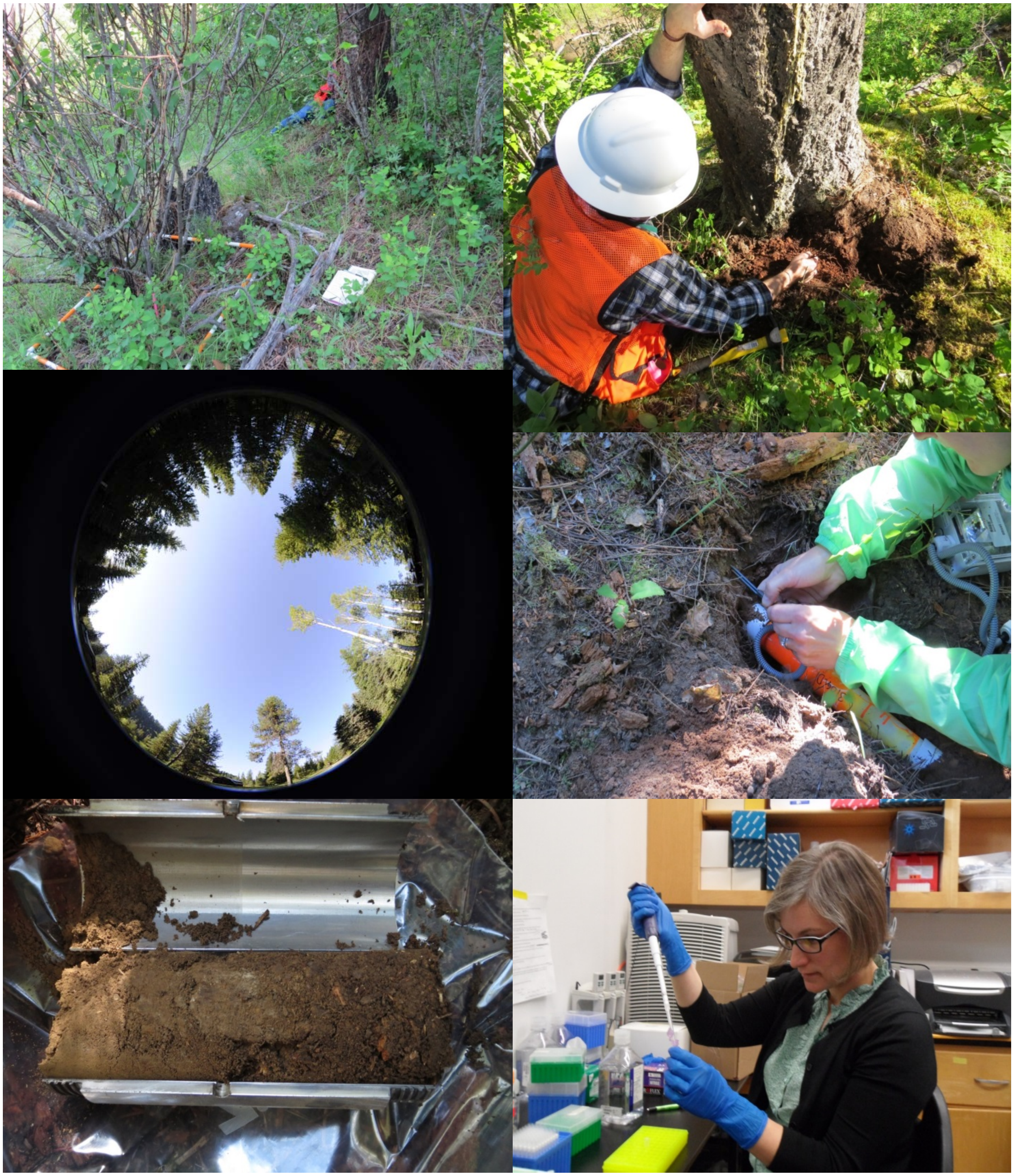

Figure 1. **A**: Sampling vegetation within a 1m2 plot; **B**: Surveying for Armillaria; **C**: Digital canopy analysis; **D**: Installing data loggers to measure soil moisture and temperature; **E**: Coring soil to sample at set depths below the forest floor; and **F**: Isolating DNA from soil samples.

Future applications of this approach to FIA plots will promote an understanding of how biotic communities and their relationships to the environment drive forest ecosystem processes. As information accumulates across diverse spatial and temporal scales, we will better understand the roles of climate change, fire, management practices, biotic communities, and physical attributes of a site on forest productivity, sustainability, resilience, carbon sequestration, and other ecosystem functions. Further, metatranscriptomic studies could be used to decipher how these communities respond to changes in their environment by examining gene expression under different conditions.

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Aggressive Root Pathogen *Phellinus noxius* And Implications For Western Pacific Islands

Sara M. Ashiglar[1], Phil G. Cannon[2], and Ned B. Klopfenstein[3]

INTRODUCTION

Phellinus noxius is an aggressive root rot pathogen affecting tropical and subtropical forests. Causing much damage in tropical Asia, Africa, Taiwan, Japan and the Pacific Islands, its wide host range encompasses more than 200 plant species representing 59 families (Ann et al. 2002). It can devastate agricultural plantations of tea, rubber, cocoa, avocados, and oil palm; tropical fruit trees such as longan, breadfruit, litchi, carambola, and loquat; timber trees including hoop pine (*Araucaria*), eucalypts, and mahogany (**Swietenia**); as well as many ornamental trees and woody shrubs. Also susceptible are woody fruit trees such as persimmon, peach, pear, plum and grapes cultivars (Ann et al. 2002, Brooks 2002, Sahashi et al. 2012). Some taxa including citrus cultivars show resistance to the disease (Ann et al. 2002). Impacts of the fungus on native forests are less known, though native species have been reported vulnerable (Brooks 2002). *P. noxius* appears to attack regardless of initial host health, and can maintain itself on dead host root tissue for years after it has killed its host.

SIGNS AND SYMPTOMS

Many early symptoms of *P. noxius* infection are comparable to those of other root diseases. As the fungus cuts off the water supply to the tree crown, leaf chlorosis, wilt and branch dieback quickly follow. Time from infection to tree death can be very quick, particularly in young trees (Ann et al. 2002, Sahashi et al. 2012). Frequently, no sporocarps develop on diseased trees, and thus identification of the fungus is largely dependent on finding a dark brown to blackish mycelial crust covering the base stem and root collar of the tree—often denoted as a 'black sock' (Figure 1A). The margin of this crust is bright white during the wet season (Figure 1B) and mycelial mats can be found between the infected bark and sapwood. *P. noxius*-decayed wood exhibits honeycomb-shaped zone lines of reddish-brown to black hyphal strands (Figure 1C). The brownish rough sporocarps can be shelf-like or resupinate, with a gray-brown fertile spore surface (Figure 1D). The disease is largely spread from root-to-root contact, and likely through infection of stumps or damaged trees by wind-dispersed basidiospores.

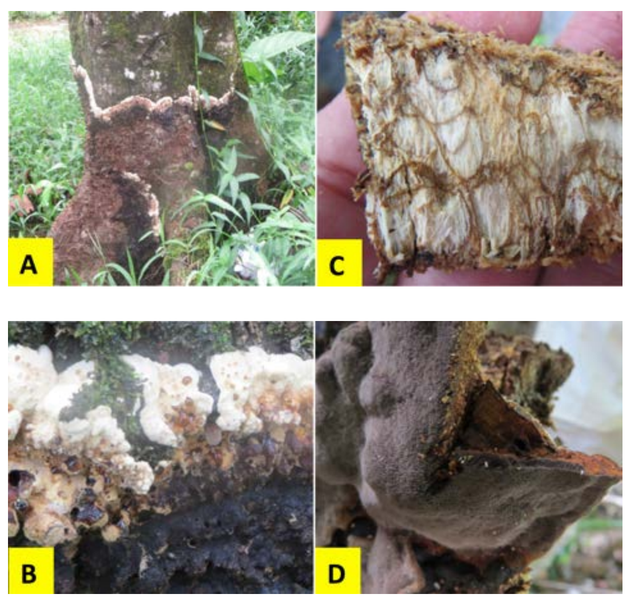

Figure 1. **A**) Phellinus noxius mycelial crust, **B**) white margin of mycelial crust, **C**) mycelial mats and reddish-brown hyphal zone lines between the infected bark and sapwood, and **D**) gray sporocarp pore surface.

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Figure 2. Native plant used as local remedy to treat *Phellinus noxius* in Pohnpei.

PHELLINUS NOXIUS AND THE PACIFIC ISLANDS

P. noxius is considered non-native to many Pacific islands, but this is not well documented. Although it has been found to infect native trees in this region, the fungal pathogen is primarily associated with non-native agricultural crops and areas disturbed by humans (Brooks 2002, Hodges and Tenorio 1984; also see Ann et al. 2002, Sahashi et al. 2012 for more discussion on invasive distribution). Its establishment on western Pacific islands is thought to be fairly recent and thus far the damage is only moderate at introduction sites. For example on the Northern Mariana Islands of Saipan and Rota, Hodges and Tenorio (1984) postulate that *P. noxius* was introduced to a port of entry through infected plants or wood. This could have happened after World War II when extensive relief supplies were delivered to the Rota airport. Infected wood in packing crates or infected agricultural plants may have allowed the fungus to escape onto these islands from these airport infection foci. The authors of this proceedings paper also speculate that within-island, and island-to-island transport of the host species breadfruit, known as "the staff of life" for many Pacific island residents, may have accelerated the spread of *P. noxius*. Suckers of this very vulnerable species are commonly collected and transported for propagation.

Further expansion of this fungus could be detrimental to uninfected areas due to its aggressive nature, economic impact, and wide host range. There are few practical options for management of this disease due to its long-term survival in the soil and on wood, high application cost and low effectiveness of fungicides, insufficient testing of biocontrol agents, and difficulty of cultural applications such as stump removal or long-term flooding of infected areas (Sahashi et al. 2012). Planting resistant species or cultivars is one option, though resistant cultivars capable of growing in these climates have not been thoroughly examined. The current primary mechanism to manage this species is to prevent future spread of infected wood or living plant material.

RESEARCH NEEDS

P. noxius must be monitored across the western Pacific, eastern Asia, and Australia, while preventing its spread to uninfested islands (i.e., to our knowledge there have been no reports of *P. noxius* on the Hawaiian Islands, the Marshall Islands, Caroline Islands, French Polynesia, and Cook Islands, to name a few island systems with comparable climatic conditions and susceptible host species). Extensive scientific and/or citizen surveys should be conducted on each island using input from pathologists, local forestry staff, and villagers. Distribution maps for each island should be created, along with approximated size of infection foci. Isolates should be collected and field trials conducted to determine the most aggressive isolates of *P. noxius* as well as identify locally important susceptible and resistant host species/cultivars. Practical local remedies such as placing mangrove mud or other native plant extracts (e.g. Figure 2) on infected hosts should also be tested under controlled settings to evaluate their effectiveness. Eventually island-wide *P. noxius* management plans incorporating the above-mentioned information should be developed.

In addition to surveys, molecular research on the population genetics of this fungus would be helpful in conveying the spread of *P. noxius* on the Pacific Islands. The molecular differentiation of genotypes combined with a literature review and local oral accounts would reveal how the species has travelled from island to island, and which areas of the world are more at risk to future introduction.

Finally, in order to reduce future spread of *P. noxius*, suitable habitat for this species must be delineated. While it has a large host range that spans across tropical and temperate species, *P. noxius* appears susceptible to cold temperatures and has not yet been found in high elevations of tropical areas or in higher latitudes with cold winters. Modeling both current and future climate habitat for *P. noxius* would significantly assist in prioritizing which islands and other areas of the world should be most protected from the introduction of this species (for more details, see: Cannon 2015).

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Decay Of Living Western Redcedar: Brief Overview Of A Synthesis & Proposed Research

Rona Sturrock[1] and Elisa Becker[1]

Despite WRC wood having a reputation for decay-resistance, live WRC is well-known for its extensive heartwood decay, which negatively impacts the yield of harvested trees. To reduce WRC volume losses to decay organisms we need to better understand infection dynamics, i.e., 'who' the key decay organisms are, how and when they get started in living WRC, what their incidence is, how they interact with forest management activities and what their actual impact is on volume.

A literature review we conducted in 2013/14 indicates that more than two dozen different species of decay fungi occur on living WRC trees, with the following five proposed to be the most common and/or causing the most significant damage to coastal and interior cedar: *Phellinus weirii*, *Physisporinus rivulosus*, *Perenniporia subacida*, *Porodaedalea pini*, and *Postia sericeomollis*. Research we have initiated and/or propose to conduct to better understand decay dynamics in WRC include inoculation and screening trials, identification of decay organisms using traditional and molecular techniques, and improved quantification of decay-caused volume losses.

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POSTERS

Limber Pine Stand Conditions After Mountain Pine Beetle Outbreaks In The Rocky Mountains

Kelly S. Burns[1], James T. Blodgett[2], Christy Cleaver[3], Marcus Jackson[4], and William R. Jacobi[3]

INTRODUCTION

Mountain pine beetle (MPB) and white pine blister rust (WPBR) threaten ecologically and culturally valuable limber pine stands of the Rocky Mountains. MPB kills mature trees rapidly and limber pine is a preferred host. The added impacts of WPBR can be severe in some areas since small trees are killed quickly by rust. The purpose of this study is to gather information on the current status of limber pine to facilitate the development of appropriate recovery plans and restoration strategies. The specific objectives are to:

- determine the extent and severity of mortality from MPB;
- assess stocking, composition, structure, and health of remaining trees and regeneration;
- assess WPBR impacts on remaining limber pine trees; and
- use stand data for aerial detection surveys accuracy assessment to improve predictive models of mortality.

METHODS

From 2011 to 2013, we reassessed 81 long-term monitoring plots originally established in 2006 and 2007 in three study areas extending from northern Colorado to central Montana (northern CO and southern WY, n=36; northern WY, n=29; and central MT, n=16) (Figure 1). Stands were sampled using methods adapted from the Whitebark Pine Ecosystem Foundation (Tomback et al. 2004, Burns et al. 2009). Plots (200 ft by 50 ft) were divided into three sections with a 1/100 acre regeneration and understory vegetation subplot at the center point of each section. Plot data collected included elevation, slope, aspect, slope position, stand structure, common shrubs, abundance and health status of white pine regeneration, and presence or absence of alternate hosts. Data collected for all trees within the plot included species, health status, DBH, crown class, crown ratio, cone abundance by crown third, and damages with damage severity. Measurements were also taken to quantify blister rust impacts by crown and stem third and to determine the timing of MPB impacts and/or mortality. All plots are permanently monumented and will be revisited every 5 to 7 years.

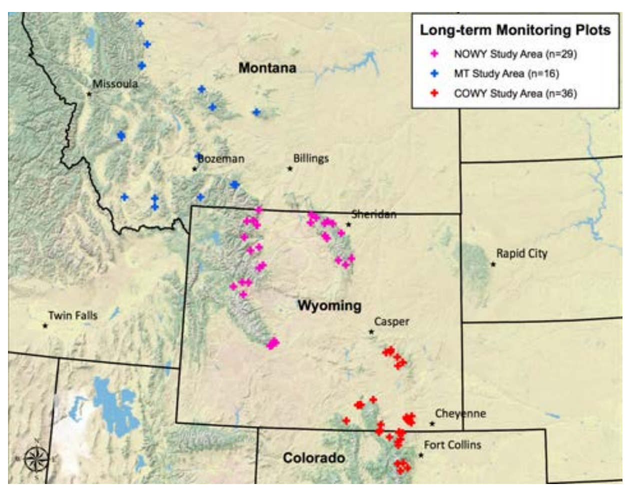

Figure 1. Location of long-term monitoring plots; NOWY = northern Wyoming, MT = central Montana, COWY = northern Colorado and southern Wyoming.

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PRELIMINARY RESULTS

Bark beetle activity increased in all study areas and was the leading cause of mortality. The incidence of bark beetle-caused mortality in limber pine ranged from 0 to 63%. Beetle activity has slowed since 2010 with most mortality occurring between 2006 and 2010.

Blister rust was observed in all study areas and was the second most common cause of mortality and the most common damaging agent identified on declining and dying trees. The incidence of rust in living limber pines has remained the same or is slightly higher in most plots despite the loss of many infected trees to MPB and other bark beetles.

Limber pine regeneration is present in most plots. Density ranged from 0 to 2,367 trees per acre. The percentage of regeneration plots with limber pine and WPBR increased slightly in the second measurement; blister rust incidence ranged from 0 to 50% in regeneration plots.

ACKNOWLEDGEMENTS

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Monitoring Of Blister Rust Resistance, Pathogen Virulence And Genetic Adaptability Of Western White Pine At Six Sites In Western Washington

Amy Ramsey[1], Richard A. Sniezko[2], Robert Danchok[2], Dan Omdal[1], Angelia Kegley[2], and Douglas P. Savin[2]

INTRODUCTION

Western white pine (*Pinus monticola* Dougl., WWP) is a wide ranging, long-lived native conifer species in western North America. It is highly susceptible to the introduced fungal pathogen *Cronartium ribicola* J.C. Fisch., causative agent of white pine blister rust (WPBR). The impacts of the blister rust have reduced the incidence of WWP in natural ecosystems as well as led to a reluctance in using the species in both restoration and reforestation. Research and operational programs to develop genetic resistance to WPBR have been ongoing for more than five decades, with regional programs based in Oregon (OR), Idaho (ID) and British Columbia (BC). Progeny of thousands of parents trees have been screened for rust resistance in short-term artificial inoculation trials and several types of resistance have been uncovered. Seed orchards have been established using the products of the earlier resistance work and breeding to increase the level of genetic resistance continues.

This series of field trials examines WWP families and orchard seedlots from a wide array of geographic origins (BC, ID, OR, Washington (WA)) at six diverse sites in western WA. The group of families and orchard seedlots includes materials that should encompass most (if not all) of the known types of resistance to white pine blister rust in WWP, and represents among the best resistant seedlots currently available from the three operational screening programs working to develop resistance to WPBR. In addition to testing the efficacy of the different types of resistance in the field, these sites can help increase our understanding of the dynamics of rust infection over time, refine rust hazard guidelines and determine whether seedlots from other breeding zones are adapted to sites in western WA.

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OBJECTIVES

The objectives for this study included:

- Assessing the current rust incidence and impacts. Establishing baseline for long-term monitoring.
- Examining current growth, general vigor and reproductive status of western white pine (WWP). Establishing baseline for long-term monitoring.
- Assessing impacts of abiotic and biotic agents on diverse WWP seed sources.
- Monitoring durability of major gene resistance (MGR).
- Providing updates to landowners and aerial surveyors in western WA on the levels of rust incidence and field resistance currently available.

METHODOLOGY

Six, three-acre sites were established in 2006 across western Washington. A total of thirty-six seedlots were planted across the sites, with 1269-1365 individual seedlings planted at each site. The study design consisted of seven blocks, or reps, per site and three to seven seedlings per seedlot per block. The seedlots originated from many areas across the region, including the Gifford Pinchot National Forest (NF), Mt. Baker/Snoqualmie NF, Olympic NF, Wenatchee NF and Colville NF in Washington; Mt Hood NF, Umpqua NF, Confederated Tribes of Warm Springs in Oregon; British Columbia; and the Bingham seed orchard in Idaho.

White pine blister rust incidence and severity assessments were made in 2010, 2011 and 2013. During the assessments tree damage, tree vigor, rust severity, including the number of white pine blister rust cankers, were measured. During the 2013 assessments, tree height and reproductive status were also measured. Onset HOBO weather stations were installed at each site in 2013 to measure temperature and relative humidity.

RESULTS AND DISCUSSION

In 2013 overall survival, taking into account all mortality agents, including root disease and animal damage, was 90% or greater, even in the known WPBR-susceptible seedlots. WPBR mortality was generally less than 1% across all sites, with the greatest amount of mortality from rust at sites Cayuse and Rocky Raccoon. As expected, WPBR infection levels were higher than the mortality rates, with most seedlots having less than 25% of the trees infected, except at Shuwah Jigsaw. Shuwah Jigsaw was the most infected site (mean infection 47%, mean # infections per infected tree = 4.3). The susceptible control had the highest overall infection (45%) and was the family with the highest percentage infection on four of the six sites. Less than 10% of the trees on most sites had pollen or cones, but the trees on Shuwah Jigsaw stand out again, as 50% of some seedlots had reproductive features. The height data shows that generally the fast growing seedlots at one site are also fast growing at other sites; trees were notably shorter at the Caveman site. Six similar sites will be established in eastern WA in 2015.

Phytophthora ramorum Detection And Monitoring In Western Washington Waterways, 2013

Daniel Omdal[1] and Amy Ramsey[1]

PROJECT OBJECTIVES

Detect *Phytophthora ramorum* outside of plant nurseries, eradicate *P. ramorum* when detected in landscape and forested ecosystems and reduce the ecological threat that *P. ramorum* could pose on landscape and forested ecosystems in western Washington.

INTRODUCTION

Phytophthora ramorum, an exotic plant pathogen, is the causal agent of Sudden Oak Death (SOD), ramorum leaf blight and ramorum dieback. The pathogen can move aerially through landscapes with wind and wind-driven rain, such as in the forests of Oregon and California. The pathogen can also be moved long distances in nursery stock.

Western Washington is at risk for *P. ramorum* caused diseases and *P. ramorum* spread due to: hosts in the natural environment, suitable climatic conditions (moist weather and mild temperatures) and the presence of plant nurseries with *P. ramorum* infected host stock and soils. To date, the pathogen has only been detected in locations that are either at or near plant nurseries in western Washington.

The Washington Department of Natural Resources (WA DNR) has been conducting aquatic monitoring and forest and nursery perimeter surveys since 2003. Until 2006, *P. ramorum* had only been detected in western Washington nurseries. In 2006, an aquatic detection was made in a stream running through a *P. ramorum* positive nursery, resulting in positive *P. ramorum* samples from the water. Since 2006, detection and monitoring efforts for *P. ramorum* have focused on waterways associated with nurseries containing *P. ramorum* plants.

Since aquatic sampling began in 2005, *P. ramorum* has been detected in water samples from seven waterways in western WA: two in King County and one in Clallam, Clark, Lewis, Pierce, and Thurston counties. Diseased plants have only been found associated with one of the waterways in 2010 (Pierce County) and were destroyed.

METHODS

Eleven initial waterway sampling sites were established in January 2013. They were selected based on their proximity to previously reported positive detection locations. Eleven additional sites were sampled following a positive *P. ramorum* detection early in the survey season. Replicate samples were collected from January to October. Sampling included a mix of traditional stream baiting with a mesh bait bag placed in the water way for one to several weeks and the bottle of bait (BOB) detection method.

BOB required only one visit to each site for each set of samples. Multiple individual water samples were collected at each site and combined together in a large bottle. Rhododendron leaves were then placed into the bottles or were hole-punched into tiny pieces and those small pieces were placed into the collected water. The leaves and the water incubated for 72 hours. Then the leaves and

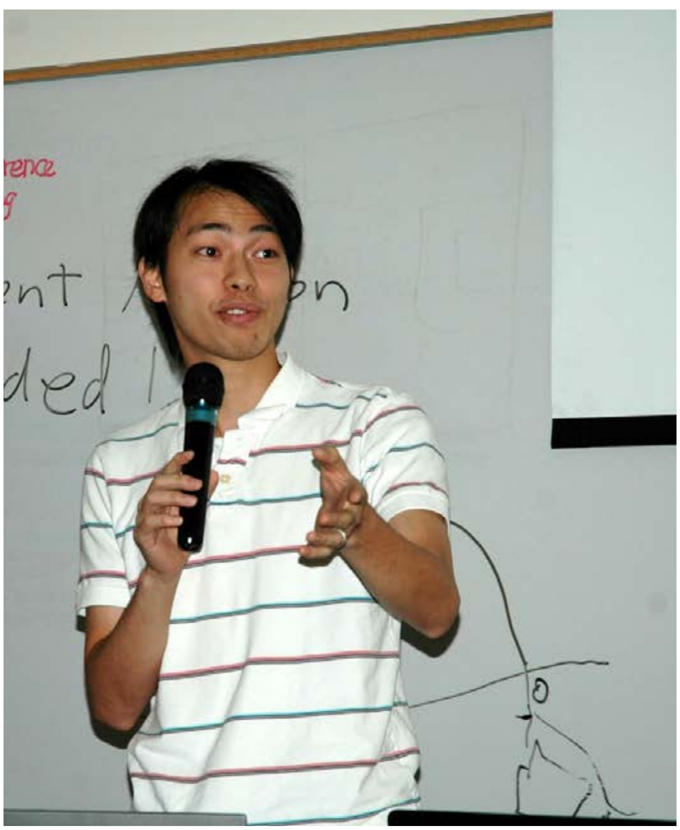
In: Murray, M. & P. Palacios (Comps). Proceedings of the 62nd Annual Western International Forest Disease Work Conference; 2014 Sept. 8-12; Cedar City, UT. [1]Forest Health, Washington Department of Natural Resources, Olympia, WA.

leaf pieces were submitted to a lab for analysis and potential detection of *P. ramorum*.

RESULTS AND CONCLUSIONS

Positive samples were found in two waterways, one in Clallam County and one in Thurston county. Eleven additional sites were repeatedly sampled in Clallam County to try and determine the origin of the detected *P. ramorum* inoculum and all samples were negative or inconclusive for the pathogen. *P. ramorum* aquatic monitoring and detection work continued in 2014 and resulted in two positives, both in Kitsap County.

COMMITTEE REPORTS




NETWORK:suu-conference
PASSWORD:homecoming

Foliage and Twig Breakfast meeting October 9, 2014

Presented by Dave Shaw on behalf of the SNC Cooperative

An update on Swiss Needle cast - There has been a major increase, over the past 2-3 years, in the area affected by SNC in Oregon; it is now encroaching into areas where the disease had not been seen in the past. Surveys in northern California turned out negative which suggests some other factor other than weather is influencing disease outbreaks, since the weather patterns and climate are similar between the southern Oregon and northern California.

More information is available at this link http://sncc.forestry.oregonstate.edu/

Presented by Harry Kope

An update on Septoria Canker - The risks to hybrid and native Poplar in British Columbia should the exotic poplar disease *Septoria musiva* become established. *Septoria musiva* Peck (*Mycosphaerella populorum* G. E. Thomps.) on *Populus* species causes leaf blight but more importantly, necrotic lesions that often result in stem breakage. Since 2007 *S. musiva* has been repeatedly detected in leaf spots and cankers on hybrid *Populus* in the Fraser River of British Columbia (B.C.). How *S. musiva* was introduced into BC has not been determined, though movement of infested plant material is suspected. Some hybrid poplar clones are known to be highly susceptible, and in the Fraser Valley of 21 hybrid plantations assessed, 16 (76%) were infested (187 trees sampled, 105 infested; ~56% incidence). Since 2008 *S. musiva* has been repeatedly isolated from leaf spots and cankers of *P. trichocarpa* in riparian areas along the Fraser River. *S. musiva* under favourable conditions can infect multiple families of *P. trichocarpa*. The impact that *S. musiva* could have on *P. trichocarpa* growth and ecology is currently unknown.

Presented by Alan Kanaskie

The occurrence of an assumed unknown leaf blight (looks like torched and burned, leaves and small twigs) of *Crataegus sp*. in Oregon. Please don't send samples!

WIFDWC Nursery Disease Committee Meeting
Will Littke - Chair

OVERVIEW

Over the past three decades there has been a consistent trend within WIFDWC of reduced interest in nursery seedling disease. This partly reflects a decline in Federal policies regarding timber harvest and regeneration. Through this time period, government agencies (Canada and U.S.) have stepped back from funding nurseries, nursery research and training of pest management personnel. Many university forestry curricula no longer emphasize pathology or entomology disciplines let alone seed biology. Meanwhile, most States and Provinces in combination with private industrial forestry companies have taken up the challenge to keep seedling regeneration issues at the forefront. However, one positive footnote is the recent republication of the USDA Nursery Disease Handbook.

As we go forward, regeneration issues will again become one of the most important tools for silvicultural and forest management agencies addressing climate change, response to catastrophic wildfires, assisted species migration, regeneration and afforestation. Impediments to meeting these objectives include basic biology of seed stratification, germination, pathology, and nursery production. These challenges will be met with trained personnel equipped with modern pathological tools such as PCR to quickly sort out a myriad of seedling pathogens, and select appropriate but environmentally safe pesticide applications.

MEETING NOTES

In the late 1990's the Montreal Protocol identified methyl bromide (MB) as a key greenhouse gas. Over the nearly 2 decades of research to find alternatives, few cost effective treatments to replace MB have been identified. USDA ARS has taken the lead to fund and direct agricultural research through programs like the MB Area Wide Research program. This program emphasizes research in both agricultural and forestry production systems gathering data on pathogen control, weed management, and crop economics. Benefits of this program include focus on identifying specific pathogen groups within disease complexes using PCR, especially how they react to fumigant treatments, disease epidemiology, and production losses.

Historically, nursery pathology has addressed the greatest disease challenges from seedling "pathogens" like *Fusarium*, *Phytophthora*, *Pythium* and more recently *Cylindrocarpon*. Advances in PCR have allowed for the first time to resolve these pathogens to an extent where pathogenic and saprophytic species can be separated. Several presentations at this WIFWDC Nursery Committee meeting demonstrate the current state of knowledge and application of pathology research to solving issues of seedling health and production.

Will Littke (retired Weyerhaeuser) presented a blend of classical pathology and adaption of PCR techniques on identifying cultural attributes of *Cylindrocarpon*. *Cylindrocarpon* has long been reported as a serious nursery root pathogen of many bare-root and container grown western conifers. More recently, *Cylindrocarpon* has emerged as a tough species to control even with soil fumigation. Isolated with standard Komada's *Fusarium* media from soil and roots it can be a dominant component of late production soils nearing fallow or fumigation. Despite numerous attempts to complete Koch's postulate *Cylindrocarpon* remains a strong candidate pathogen in large scale stunting events in many PNW conifer nurseries. PCR evidence shows *C. destructans* and *C. liriodendri* compose the majority of isolates from seedling species like Douglas-fir.

Figure 1. Two-celled macroconidia and terminal chlamydospores produced by *C. destructans*.

Figure 2. Larger 3-4 septate macroconida and chlamydospores of *C. liriodendri*.

Traditional charac-terization of isolates by microscopic examination of these two species was presented. Isolates vary in colony morphology, color, and shape of chlamydospores and macroconidia. *C. destructans* on potato glucose or similar media consistently produces 2-3 celled macroconidia with terminal chlamydo-spores (Figure 1). *C. liriodendri* is differentiated by forming pale to white colonies and 3-4 celled macroconidia and intercalary chlamdospores (Figure 2).

Anna Leon presented her PhD dissertation research (WSU-Gary Chastagener) utilizing PCR methods for enumeration of *Fusarium commune* colonies in soil. Standard soil-dilution based assays for Fusarium still form the basis for soil fumigation decision making purposes. However, soil dilution plates isolate many species of *Fusarium*, some not pathogenic to conifers. This new method seeks to focus on a specific portion of the soil *Fusarium* population thought to be contributing to seedling disease. PCR based soil assay will greatly facilitate understanding of pathogen behavior over field crop rotations and post-fumigation events.

John Browning and Anna Leon (Weyerhaeuser Research) presented ongoing research on alternative soil fumigant treatments. Over the last several decades of research it was discovered that many alternative chemical fumigants can control soil pathogens, but resulting seedling growth is somehow "stunted" when compared to similar MB treated soils. One hypothesis being investigated is that agents like chloropicrin result in less nutrient turnover when compared to MB. Foliar and soil nutrient data from a previous Douglas-fir seedling transplant trial (Mima Nursery WA) showed that phosphorus might be the most likely candidate for testing. Typically, newly fumigated nursery soil does not receive incremental phosphorus during the first production year, although in subsequent years additions will be made. This may be a legacy of many years of basing soil nutrition decisions based on post-fumigation using MB. The study design will include pathogen sampling, and periodic soil and foliar nutrient sampling at periodic seedling growth measurements. Successful transition from MB to other fumigants will require the integration of our understanding of both pathology, and seedling soil interactions like nutrition.

NURSERY MEETING NOTES

Discussion on (Blodget) work to obtain Limber pine seed sources for nursery production. Very few limber pine sources. Trying to keep small population alive. Basic biology of seed maturation and storage for this species is also needed, and seedling specifications for nursery production.

Whitebark pine grafts (blister rust resistant)-seedlings grown in standard potting mix. Grafted into to 1-gallon pots with canker down graft, seedlings with small needles, and root growth poor in container. Water every two weeks. While there may be many causes to poor roots, container watering cycles are often a contributing factor for root growth and seedling diseases. Irrigation cycles are best established by weighing seedling growing blocks between irrigation events and keeping block weights within $\pm$ 80% of saturation weights. Media selection can also be a factor with media containing excessive material fines contributing to low oxygen tension.

Will discussed the process of doing seed quality assays including the new digital x-ray camera system. Filled seed counts, insect damage and other attributes of seed quality (embryo development etc.) are vastly improved with digital vs traditional film x-ray.
Josh (Stone Nursery, OR): Discussed the new Forest Service Pest Manual. Ongoing mortality of 1st year Douglas-fir, is probably linked to *Fusarium* pending further isolation work and PCR analysis. Phytophthora on 2+0 sugar pine, noted standing water in tractor path.

John (Turner Nursery, OR): Mentioned drain tiling of very wet block at Turner. This block has as long history or *Pythium* and *Phytophthora*.

Alan: Discussed selling of OR state nursery. He also mentioned dealing with outplant issues due to cold damage. The winter of 2013-2014 produced some very cold arctic cold air events throughout the PNW. These events produced LT50 levels of damage.

SYNTHESIS

Advances in nursery pathology mirrors many other fields with the advent of techniques like PCR. Recent results refine and in some cases change our perspective of pathogen-host interactions. Our task will be to use these methods to design better experiments and hypotheses to test. Likewise, understanding disease control and proper seedling growing conditions through application of integrated pest management will provide insight to solve future regeneration issues. We need additional emphasis on seed diseases of conifer and other plant species outside of traditional forest timber species.

Root Disease Committee

Sept. 9, 2014 lunch meeting

In attendance: Blakey Lockman (chair), Dave Shaw, Cedar Welsh, Amy Ramsey, Ellen Goheen, James Jacobs, Helen Maffei, Ann Lynch, Don Omdal, Greg Filip, Terry Shaw, Jim Worrall, Mary Lou Fairweather, Meg Dudley, Betsy Goodrich, Anna Leon, James Blodgett, John Hanna, Sara Ashiglar, Stefan Zeglen, Harry Kope, Elisa Becker, Suzanne Marchetti, Gabriela Ritokova, Angel Saavedra, Marcus Jackson, Brennan Ferguson, Rob Cruz, Kelly Burns, Alan Kanaskie, Danny Norlander, Bill Woodruff, Mike McWilliams.

Blakey provided overview and welcome and she handed out the attendance sign-in sheet.

PRESENTATIONS

1) Blakey Lockman (USFS FHP, Missoula, MT): Heterobasidion hybrid update. Blakey and her family found a distinct root disease pocket in alpine larch (*Larix lyallii*) in the Bitterroot National Forest of western Montana while on a recreational hike in 2010. She collected and sent a sample to Matteo Garbelotto, UC Berkeley, since her literature review indicated this would be the first report of *Heterobasidion* sp. on alpine larch. Matteo returned with an identification of *H. occidentale* X *H. irregulare* hybrid. Matteo presented the finding at IUFRO, 2011 in Italy, and it was published as an APS Plant Disease Note in 2014 (Plant Disease July 2014, Volume 98, Number 7: 1,003.3). Matteo will be traveling to Montana next week to meet Blakey and Gregg DeNitto for a backpack trip to the site to collect spores and fruiting bodies and to collect other data for further investigation. The question was asked if it had ever been seen on western larch. Blakey noted that she has seen *Heterobasidion* sp. on western larch, but not in well-defined pockets. Terry Shaw noted this was a good example of the importance of networking at WIFDWC.

2) Blakey Lockman: National Root Disease Paper/Maps update. This is a national effort to address root diseases across the continental U.S. and Alaska and to elevate the profile of root diseases at the national level. Blakey felt it was important to include distribution and damage maps. Maps were sent out for review and updates have been sent to John Winthrow (contractor with USFS Forest Health Technology Enterprise Team, Fort Collins, CO) but not all updates have been fully incorporated. Reporting units are at the county level to make compatible with the PER (USFS, FHP Pest Event Reporter) and to use all available data. She showed current state of each map:

Armillaria – there appears to be inconsistency in damage (red) versus presence (yellow) in the Northeast Area and the Southern Region. This will be discussed further with these two regions.

Heterobasidion – Blakey thinks. *H. occidentale* map is pretty close. *H. irregulare* has some problems in the east, which are being resolved. Dave Shaw asked if Heterobasidion identified in shore pine-Blakey says it's not currently listed as a host for this mapping effort- Blakey is wondering it should it be. In response to Greg Filip, Blakey noted that FHTET is trying to "marry" PER reports of these diseases with this mapping effort in order to map these agents as best as possible. Also, Greg very recently submitted some changes that were not reflected in the maps being presented (there was no time to incorporate prior to WIFDWC). Angel Saavedra asked about McCall County in Idaho. Blakey lit up the county for presence of *Heterobasidion irregulare* due to the field trip in ponderosa pine during the Boise WIFDWC in 1993.

Leptographium Root Diseases – Separate map for each of the three varieties of black stain root disease: *wageneri*, *ponderosum* and *pseudotsugae*. Jim Blodgett noted *L. terabrantis* found in western South Dakota. Helen Maffei noted it is not damaging in South- it's there but not damaging. (This comment was already sent in for update with Greg Filip's edits, but have not been incorporated). Helen noted a "degrading" problem when turning whole county red. Blakey noted that Eric Smith pretty adamant that damage needs to be expressed on map, as well as distribution and that she would like to move this forward. Extensive discussion about the purpose of the map – Blakey stated that the intention of the National Root Disease paper is to provide clear message to law-makers, policy-makers, etc….it's not a precision map for pathologists and land managers. Helen M. noted that the message should show current status and if nothing is done, it will get worse. Blakey emphasized that this is a baseline map and we should plan for periodical updates. Cedar Welsh commented that her work with Dothistroma, damage is noted as low, moderate, and high severity. (Blakey noted in her presentation later in the meeting, that root disease damage in the USFS Northern Region is recorded that way.) Jim B. noted that Wyoming survey looked at specific stands and there was some discussion on differences in how 'damage' is defined by each contributor. Brennan noted that there would be changes in damage with time and stand conditions. Blakey described how she instructed contributors to differentiate between presence and damaging- the disease needed to be damaging at the stand level before it could be recorded as damaging in each county.

Schweinitzii and *tomentosus* – Blakey showed host probability maps for *schweinitzii* and *tomentosus*. Jim B. suggested that all host (100%) should be represented by solid blue. Mary Lou noted that Gilbert's *Onnia circinata* list needs to be added. Blakey noted that those, as well as the Montana finds for *O. circinata,* will be included in the update.

Ganoderma trunk rot (this will be changed to "white mottled rot" in the final map/paper) – This disease was important for Jim B. to have in the paper due to its importance in the Rocky Mountain Region, even though it's a problem on a hardwood, while all other diseases are important agents on conifers. This distribution and damage map can be updated with the Region 6 publication, Hardwood Diseases, being led by Greg Filip.

Phytophthora cinnamomi – this map will not be the total distribution of *P. cinnamomi*, but will be maps for littleleaf disease and sand pine root disease, which *P. cinnamomi* is a major agent.

Port-Orford Cedar – Ellen asked why damaging in western Washington counties. It appears these are only in planted trees and since these are only in planted trees there should be no damage recorded in those counties. (This has been corrected with the edits submitted by Greg Filip.)

Blakey sees the maps staying with FHTET and being updated as needed. Mike McWilliams noted that if housed at FHTET then only USFS will be able to access them. Walt Thies cautioned that we may end up with laws that we can't live with. Blakey noted that the current discussion has her thinking that maybe only the maps that have better consensus should be included in the National Root Disease Paper. Terry Shaw encouraged Blakey to consider staying in control of the maps rather than handing them over to FHTET. These are all good points that Blakey will take into consideration and discuss with the ad hoc committee for writing the National Root Disease Paper.

ROUND ROBIN

Greg Filip (USFS FHP, Portland, OR)
1) In the process of updating Armillaria FIDL (*ostoyae* only).
2) Submitted article to Forest Science on the 30 year old precommercial thinning plots (Douglas-fir, hemlock, true fir).
3) Oregon Field Guide (Oregon PBS TV station) doing a story on the "Humungous Fungus". Greg visited Glenwood, Washington armillaria area with Dan Omdal, and it's now being filmed. Watch for the film debut of these budding stars!

Helen Maffei (USFS FHP, Bend, OR) Helen on a team led by Gregg DeNitto to do pest risk assessment for Hawaii. With Jessie Glaser, Helen put together a list of Armillaria root diseases, mapping where it is and where it can be expected to show up. The assessment should hopefully be coming out soon.

John Hanna (USFS Rocky Mtn. Res. Station, Moscow, ID) – working on species distribution of Armillaria in the Rocky Mtn. Region. They are still looking for samples. Blakey mentioned that she has several areas she hopes to get samples from to send to RMRS.

Sara Ashligar (USFS Rocky Mtn. Res. Station, Moscow, ID)– Working with Phil Cannon on the tropical fungus, *Phellinus noxious* (cause of Black Sock), that kills more than 200 species. It is currently killing big trees in Hong Kong and is jumping across Pacific Islands, but not currently known in Hawaii. They are working with many collaborators to investigate if there is more than one species causing this disease. Dave Shaw noted that this disease is emerging in many plantations across Asia.

Jim Blodgett (USFS FHP, Rapid City, SD) – He recently completed a *Ganoderma* and an *Armillaria* chapter for the Diseases of the Great Plains publication. In addition, he's helped entomologists look at bark beetles and *Armillaria* and has worked with the Rocky Mountain Research Station in identifying Armillaria in aspen stands. Jim is also working with Jared LeBoldus, NDSU, to conduct a riparian root disease assessment along the Missouri River.

Harry Kope (BC Ministry of Forests, Victoria, BC)– In July, he looked at a stumping project with private contractors and licensees. District and Region examined stump material and found Armillaria where young Douglas-fir was planted next to stumps. This exposed licensees who were not completing the required work.

Bill Woodruff (USFS FHP, Susanville, CA) – Noted that seeing *H. irregulare* on blown over trees with heavily decay roots, but no crown symptoms. He discussed the history with the stump connection on Jeffrey pine being made in 1942, but even today just scratching the surface. Blakey noted that she has found *H. irregulare* more on the tap roots on the Flathead Indian Reservation. She and Sue Hagle concluded that infections often occurred through the tap roots prior to stumps being produced through logging. Bill was also wondering about the large number of microbes in soils and how they affect root disease. Blakey noted that she's been looking into mining regional root disease data and merging with available regional soils data.

Mike McWilliams (USFS FHP, La Grande, OR) – In northeast Washington, stumps greater than 14 inches are treated to prevent *H. occidentale* if wanting to keep trees. Mike noted that there are places with larch and pine where it may be best to not treat stumps to allow the disease to kill white fir…maybe borax isn't always necessary. Stump treatments have been a Regional policy. Maybe it would be acceptable to allow the disease to get rid of the biggest weed tree.

Blakey closed the committee meeting with the reminder that she would like any and all comments on the root disease maps.
Notes transcribed by Marcus Jackson (thanks Marcus) and edited by all.
***Submitted electronically by Ned Klopfenstein, who could not attend WIFDWC:

Ned Klopfentstein (USFS Rocky Mtn. Res. Station, Moscow, ID)- Ned Klopfenstein, Amy Ross-Davis, John Hanna, and Sara Ashiglar are continuing collaborations with USDA FS Forest Health Protection (FHP), Region 2 (Jim Blodgett, Kelly Burns, Jim Worrall, and others) to identify Armillaria root disease pathogens, and conduct bioclimatic modeling for predicting geographic areas with suitable climate space for *Armillaria* spp. (see: Blodgett et al., this proceedings). Collaborative work led by Northern Arizona University (Bob Mathiasen, Christ Hoffman, Richard Hoffstetter), USDA FS FHP, Region 3 (Mary Lou Fairweather), and USDA FS-RMRS, Forest Analysis and Inventory (John D. Shaw) evaluated the influence of plant associations on *A. solidipes* (=*A. ostoyae*) in Arizona. International collaborative work confirmed the presence of *A. gallica* in association with multiple hosts in three Mexican states (Dionicio Alvarado-Rosales, Ruben D. Elías-Román, Rosario Medel-Ortiz) and characterized an unknown *Armillaria* sp. in Serbia (Nenad Keča).

Amy Ross-Davis is leading collaborative efforts that use soil metagenomics to identify 1000s of soil microbes present in a small (e.g., 1 g) soil sample, and determine the potential influence of environmental factors (e.g., temperature, moisture, soil properties, plant species, and plant associations) on soil microbial populations. These studies are aimed toward determining interactions among soil microbes and root disease (see: Ross-Davis et al., this proceedings).

Ongoing collaborations with USDA FS FHP, Region 5 (Phil Cannon), University of Guam (Bob Schlub), University of Hawaii (Fred Brooks), Japan (Yuko Ota, Norio Sahashi), South Korea (Mee-Sook Kim), and several others continue to characterize root-, butt-, and wood-rot pathogens of Pacific islands, with a focus on *Phellinus noxius* (see: three papers by Ashiglar et al., this proceedings).

RECENT PUBLICATIONS

Cannon, P.; Falanruw, M.; Ruegorong, F.; MacKenzie, R.; Friday, K.; Ross-Davis, A.L.; Ashiglar, S.M.; Klopfenstein, N.B.; Liu, Z.; Golabi, M.; Iyekar, C.T. 2013. Chapter II. The causes of mangrove death on Yap, Palau, Pohnpei and Kosrae. pp. 11- 32 in: P. Cannon; Forest Pathology in Yap, Palau, Pohnpei, Kosrae, Guam and Saipan, Sept. 2013; Trip Report, USDA Forest Service, Region 5, Forest Health Protection, Vallejo, CA, USA. 91p.

Cannon, P.; Klopfenstein, N.B.; Kim, M.-S.; Ota, Y.; Sahashi, N.; Schlub, R.L.; Brown, R.; Ashiglar, S.M.; Ross-Davis, A.L.; Hanna, J.W. 2013. Chapter III. Characterizing forest root- and butt-rot fungi in Yap, Palau, Pohnpei, Kosrae, Guam and Saipan. pp. 33-41 in: P. Cannon; Forest Pathology in Yap, Palau, Pohnpei, Kosrae, Guam and Saipan, Sept. 2013; Trip Report, USDA Forest Service, Region 5, Forest Health Protection, Vallejo, CA, USA. 91p.

Cannon, P.; Klopfenstein, N.B.; Kim, M.-S.; Ota, Y.; Sahashi, N.; Schlub, R.L.; Santos, G.; Samuel, R.; Ruegorong, F.; Nithan, M.; Charley, B.; Waguk, E.; Quitugua, R.; Lehman, A.; Engleberger, K.; Guerrero, V.; Cabrerra, S.; Tenorio, M.; Route, A. 2013. Chapter IV. *Phellinus noxius* in Guam, Saipan, Yap, Palau, Pohnpei and Kosrae. pp. 42-57 in: P. Cannon; Forest Pathology in Yap, Palau, Pohnpei, Kosrae, Guam and Saipan, Sept. 2013; Trip Report, USDA Forest Service, Region 5, Forest Health Protection, Vallejo, CA, USA. 91p.

Cannon, P.; Ruegorong, F.; Liegel, P.; Guerrero, V.; L. Schlub, R.L.; Sigrah, L.; Nithan, M.; Charley, B.; Ashiglar, S.M.; Klopfenstein, N.B.; Kim, M.-S.; Gavenda, B.; Friday, K.; Waguk, E.; Ota, Y.; Sahashi, N.; Santos, G.; Samuel, R. 2013. Chapter X. Next Logical Steps in Forest Pathology Activities for Guam, Saipan, Yap, Palau, Pohnpei, and Kosrae. pp. 86-88 in: P. Cannon; Forest Pathology in Yap, Palau, Pohnpei, Kosrae, Guam and Saipan, Sept. 2013; Trip Report, USDA Forest Service, Region 5, Forest Health Protection, Vallejo, CA, USA. 91p.

Klopfenstein, N.B.; J. W. Hanna; P.G. Cannon; R. Medel-Ortiz; D. Alvarado-Rosales; F. Lorea-Hernández; R.D. Elías-Román; M.-S. Kim. 2014. First report of the Armillaria root-disease pathogen, *Armillaria gallica*, associated with several woody hosts in three states of Mexico. Plant Disease 98: 1280.

Hoffman, C.; Mathiasen, R.; Hofstetter, R.; Fairweather, M.L.; Shaw, J.D.; Hanna, J.W.; Klopfenstein, N.B. Survey for *Armillaria* by plant associations in northern Arizona. Journal of Arizona-Nevada Academy of Sciences 45: 76-86.

Keča, N.; Klopfenstein, N.B.; Kim, M.-S.; Solheim, H.; Woodward, S. 2014. Initial characterization of unidentified *Armillaria* isolates from Serbia using LSU-IGS1 and TEF-1α genes. Forest Pathology <u>in</u> <u>press</u>.

Hazard Tree Committee Meeting

Committee Chair- Pete Angwin
Notes- Angel Saavedra

Approximately 36 people attended the WIFDWC Hazard Tree Committee Breakfast. The meeting was chaired by Pete Angwin and Angel Saavedra took notes. Six items were on the formal agenda:

1. Planning For the 8th Western Hazard Tree Workshop in 2016 – Pete Angwin

Pete Angwin opened the formal part of the meeting with a discussion of the 2016 Western Hazard Tree Workshop. Pete is currently asking for volunteers to serve on the workshop organizing committee and is soliciting suggestions for the Workshop location. Several people volunteered to help and several locations were suggested, including Boise, ID, South Lake Tahoe, CA or Reno, NV, and Sisters, OR. The first planning committee conference call will be held in the spring of 2015 to finalize the location and discuss field trip and presentation/panel topics. *Suggestions for the Workshop location and participation in the planning committee are encouraged- call or e-mail Pete Angwin if you have suggestions or would like to be part of the committee (phone 530-226-2436 or e-mail pangwin@fs.fed.us).*

Mike McWilliams asked about the objective of the Hazard Tree Workshop. Pete made it clear that the intent of the meeting is to gather specialists from a variety of fields to discuss issues and technologies concerning hazardous trees in different environments, but with a focus on forested settings.

Note- During the WIFDWC Business meeting, it was pointed out that because the 2016 WIFDWC will be held in Alaska in the late spring of 2016, the usual time for the Western Hazard Tree Workshop (June) would not work. A non-binding vote was taken to determine whether the WIFDWC members preferred to have the Hazard Tree Workshop in the late summer/early fall of 2016 or to postpone it until June of 2017. Near-unanimous support was given for late summer/early fall of 2016.

2. Failure Potential of Forked Trees - Mike McWilliams

Mike McWilliams brought up several questions for discussion, with a PowerPoint presentation to illustrate his points:

- Do forks represent a danger on developed-recreation sites (particularly on ponderosa pine and Douglas-fir)? Mary Lou Fairweather and Dave Shaw asked Mike and the rest of the participants whether they have a history of fork breakage in developed-recreation sites in their various locales.
- Mike introduced and explained several definitions of forks. He also presented and explained Region 6 Hazard Tree Rating System, which uses a failure potential score of 1-4. Pete mentioned the Region 5 Hazard Tree Guidelines, which uses a scale of 1-3.
- Mike brought up the concepts of “U” and “V” shaped forks. A lively discussion ensued regarding the particulars of whether forks represent a hazard on developed-recreation sites. This was followed by a discussion on the relationship between defect potential and the proximity of forks to the ground. Are they dangerous or not?

The discussion closed without reaching consensus. However, all agreed that at the very least, local history and conditions should be taken into account when assessing the defect potential of forked trees.

3. Special Technology and Development Project (STDP) Proposal- Hazard Tree Management & Mobile App for Smartphones and Tablet Computers – Robin Mulvey

Robin Mulvey presented the idea of developing and field testing an application for smartphones and tablets that can be used for recording data on hazardous trees in the field Copies of the STDP proposal (Project Number R10-2015-1) were distributed. The application will allow an examiner to collect hazard tree assessment data on a mobile device and download it into common computer software packages, such as Microsoft Excel. If the project is approved, a contractor will design and develop this application according to specifications from Robin and Lori Winton.

Robin requested input from the committee members, including ideas for future improvements to the application. While she was particularly interested in discussion and input during the Hazard Tree Committee meeting, she also welcomes later input by phone or email.

The committee discussed what types of data should be included with the application (e.g. GPS location, date of survey, recommendations, etc.). Kristen Chadwick asked whether a similar application is already in use for IPad. She asked Robin and the committee to present advantages of using the proposed IPhone application over the IPad application.

A lively discussion followed regarding the cost and availability of smart phones and tablets for US Forest Service employees, as this would affect how broadly an app could be implemented. At the very least, it would be helpful if the app could be used on a variety of devices.

Mary Lou Fairwheather asked about the potential availability of the proposed app to other Regions of the Forest Service and collaborators. Robin answered that one of the objectives of the STDP is to develop an app that is versatile and could be adopted broadly.

James Jacob questioned the potential high cost of developing and implementing the proposed application. He also questioned the merit of the application, raising the argument that there is no difference between recording data using pencil and paper than with an IPhone application. A discussion of pros and cons followed.

The discussion closed with Robin requesting that committee members and other interested parties continue to share their ideas and comments with her.

4. Development of a "Storm Form" For Rapid Response to Storm Damage in Recreation Areas - Paul Zambino

Paul Zambino started the discussion by describing events that prompted him to think about making a Region 1/4 "storm form" for the rapid data collection and assessment of post-storm hazardous trees. The week prior to Labor Day Weekend, 2013 there was a severe wind event, with winds over 50 mph across northern Idaho, with storm damaged trees as tip-outs and breakage of both sound and decayed trees across the region. Rapid assessment was needed at 27 Forest Service recreation sites, to determine which campgrounds or areas of campgrounds could be left open, which areas could be mitigated quickly, and which needed to be closed. At one campground, a large western hemlock with sound roots had tipped out and caused one fatality and one serious injury at a campsite. All available personnel with experience in hazard tree assessment were recruited to flag trees and record them on forms and sketch maps, and information conveyed to feller crews to accomplish the mitigation. Two campgrounds, including the one with the fatality, were closed for the holiday. Between the closures and rapid response, further incidents were avoided. However, the efforts were slowed by use of a form more appropriate for standard hazard tree assessments that was considered too complicated for rapid triage.

There have been two additional wind events (October 2013, and in August 2014) at one of the 27 campgrounds previously affected. Winds or gusts of 50+mph again caused patches of blowdowns and closure of portions of the campground, and showed a further need for a system for rapid response.

Paul distributed copies of the existing Region 1Tree Hazard Evaluation Form for Northern Idaho and a proposed "Post-Storm Danger Tree Triage" form. He initiated discussion and requested comments regarding both forms. He would like to find out from the committee whether the form is useful. Among the comments was a response from Mary Lou Fairweather that the Triage Form appeared to be too detailed to enable rapid assessment/response. She argued that under the circumstance, it could be faster and more effective to just mark and cut obviously hazardous trees, and document the treatment as a whole rather than with a detailed tree-by-tree assessment, which would come later. In response, Paul stressed that the felling crew may not be on site for days after the triage assessments, so there was a need for records that would rapidly inform the Forest Supervisor of hazards as well the felling crew of not only trees that needed removal but those that posed a danger for approaching. Also, for campgrounds that were still open, this form would document if trees were identified that needed immediate closing of specific campsites or portions of the campground. Paul reminded people that the proposed form is a work in progress and requested that the committee continue to share their ideas and comments.

5. Hazard Tree Training for Tree Fellers - Marcus Jackson

Marcus Jackson had a simple question to ask the committee members: Has anyone taught hazard tree identification and management as part of sawyer training? Marcus asked this question because he has been asked by the fire community in his field office area to present a two hour session on hazard trees at an upcoming C-Faller training. Marcus wanted to know if anyone on the committee could share their experiences.

Kristen Chadwick and Danny Norlander said they had limited experience with hazard tree training with sawyers and could provide additional information to anyone who is interested. Kristen is a member of the Hazard Tree Subcommittee of the National Wildfire Coordinating Group. The group is currently in the process of getting approval of updated A, B, and C Sawyer guidelines. Kristen noted that as pathologists, we bring a different perspective than that which is usually held by sawyers. They tend to focus on safely making the felling cut (i.e. hinge wood) without fully considering situations where the tree or tree parts could fall on their own. We bring the latter consideration into focus, greatly enhancing safety.

6. Preparing For Depositions - John Guyon

John Guyon shared his experiences on being deposed in connection with a hazard tree tort case he was involved with. His overall advice was to be well prepared, follow the Office of

General Council (Forest Service) lawyer's advice as closely as possible, be wary of the opposing council, be truthful and accurate but don't volunteer anything, pause before answering any questions, don't comment outside of your area of expertise, don't bring any documents to the deposition, ask for clarification frequently, watch out for repeated questions, ask to see any documents that the opposing council reads from to ensure that questions regarding the document are not taken out of context, and above all, don't get annoyed. In addition to this advice, John highly recommends the following article:

Davis, Tom H. 1992. Tools of the trade: ABCs of preparing clients for deposition and trial. Trial 28: 42-47.

Climate Change Committee Report

Moderators: Susan Frankel, USDA-Forest Service, Pacific Southwest Research Station, Albany, CA; sfrankel@fs.fed.us; Charles G. "Terry" Shaw, Western Wildland Environmental Threat Assessment Center, Prineville, OR.; and David Shaw, Oregon State University.

For the 2014 meeting, the WIFDWC Climate Change Committee organized: "What can dendrochronology tell us about past forest pest outbreaks? Scotty Strachan, University of Nevada – Reno, provided a general talk on climate change adaptation that explained how tree rings are used to understand past climate (see paper, this Proceedings). With that as a foundation, Ann Lynch, USDA Forest Service, Rocky Mountain Research Station, reviewed tree ring studies that have been used to understand outbreak patterns of conifer defoliators (Lynch, 2012) and bark beetles. The panel continued with two tree ring studies for forest diseases: outbreak dynamics of *Dothistroma* needle blight linked to weather patterns in British Columbia by Cedar Welsh, University of Northern British Columbia (Welsh et al., 2014), and impacts of Swiss needle cast on overstory Douglas-fir forests of the western Oregon Coast Range, presented by Bryan A. Black, now at the University of Texas at Austin (Black et al., 2010).

The committee is planning a panel on "drought and tree mortality" for the 2015 WIFDWC in Newport, OR.

At the Climate Change Committee meeting, discussion centered on the importance and need for long-term plots to elucidate the effects of climate change on forest tree diseases. Also discussed were possible dendrochronology studies to improve understanding of pathogen impact and distribution.

Change in leadership. To assume leadership for the WIFDWC Dwarf Mistletoe Committee, David Shaw stepped down as climate change co-chairperson. Alex Woods, BC Ministry of Forests has agreed to replace him. We thank Dave Shaw for his many years of service to the Climate Change Committee.

REFERENCES

Black, B.A., D.C. Shaw, and J.K. Stone. 2010. Impacts of Swiss needle cast on overstory Douglas-fir forests of the western Oregon Coast Range Forest Ecology and Management 259(8):1673–1680.

Lynch, A.M. 2012. What tree-ring reconstruction tells us about conifer defoliator outbreaks. Pages 126-154 In: Barbosa, Pedro; Letourneau, Deborah K.; Agrawal, Anurag A., eds. Insect Outbreaks Revisited. Hoboken, NJ: Blackwell Publishing Ltd.

Welsh, C., K.J. Lewis, and A.J. Woods. 2014. Regional outbreak dynamics of *Dothistroma* needle blight linked to weather patterns in British Columbia, Canada. Canadian Journal of Forest Research 44:212–219.

Dwarf Mistletoe Committee Report
David Shaw, Committee Chair

NEW PUBLICATIONS

Mehl, H.K., S.R. Mori, S.J. Frankel, and D.M. Rizzo. 2013. Mortality and growth of dwarf mistletoe-infected red and white fir and the efficacy of thinning for reducing associated losses. Forest Pathology 43:193-203.

Agne, M., D. Shaw, T. Woolley, and M. Bolanos. 2014. Effects of dwarf mistletoe on stand structure of lodgepole pine forests 21-28 years post-mountain pine beetle mortality in Central Oregon. PLoS ONE 9: e107532. Doi: 10.1371/journal.pone.0107532.

Smith, L., R. Hofstetter, and R. Mathiasen. 2013. Insect communities associated with Douglas-fir dwarf mistletoe witches' brooms in Northern Arizona. The Southwestern Naturalist 58(4):395-402.

Thomas Nicholls' Fraser Experiment Forest DM Vector Study has Been Published!

Nicholls, T. 2014. Evolution of a short-term study of lodgepole pine dwarf mistletoe vectors that turned into a long-term study of the remarkable gray jay on the Fraser Experimental Forest, Colorado, 1982-2009. Chapter 11, in; Hayes, D.C., S.L. Stout, R.H. Crawford, A.P. Hoover (eds.). USDA Forest Service Experimental Forests and Ranges. Research for the Long Term. Springer.

GENERAL GOINGS-ON

1. The committee will sponsor a panel at WIFDWC in the future!
2. OSU *Phoradendron villosum* in *Quercus garryana*: Avian Mistletoe Project. WEBSITE: http://avianmistletoe.forestry.oregonstate.edu/
3. Dave Shaw has taken over as Coordinator of the International Union of Forest Research Organizations (IUFRO) Working Group 7.02.11 Parasitic Plants of Forest Trees. We are tentatively planning a meeting in Ashland for July 2016.
4. WIFDWC members continue to work on dwarf mistletoes all around the west.
5. Robert Mathiasen has an active program going at NAU.

Two presentations of on-going research and monitoring were presented to the committee meeting:

1. Impact and spread of Douglas-fir dwarf mistletoe in SW Oregon, a 20-year study. Josh Bronson. SW Oregon Forest Insect and Disease Service Center, J.H. Stone Nursery, Central Point, OR jjbronson@fs.fed.us

2. Remote detection of dwarf mistletoe in Douglas-fir using high resolution remote sensing. Helen Maffei, Nancy Grulke, Sean Schroder, Brent Oblinger, Greg Filip and Paul Deignan. Western Wildland Environmental Threats Assessment Center, and R6 Forest Health Protection.

2014 Student Awards Committee Report
(Holly Kearns, Robin Mulvey, Dave Shaw, Alex Woods)

With proceeds from the 2013 Silent Auction in Waterton Lakes, Alberta we provided one $500 Student Travel Award to Cedar Welsh at the University of Victoria.

Thank you to everyone who participated so generously in our fifth annual Silent Auction, which raised $1,335 through the sale of individually donated items. We want to sincerely thank the many people who brought historic documents and books, wood turning objects, homemade food items, and handmade cloth and knitted items, jewelry, etc. to be auctioned.

At the 2013 WIFDWC Business Meeting a motion was passed that committed $15 of each regular member registration fee to the Student Travel Award. As a result, $585 was added to the Student Travel Award fund through registration fees of 39 regular members. The balance in the Student Award Fund is now $3,160, which will provide assistance to several students for the 2015 meeting in Newport, Oregon.

Harry Kope joined the Student Awards Committee replacing Holly Kearns.

Business Meeting Minutes
Secretary (acting) Stefan Zeglen

The WIFDWC business meeting was called to order by Conference Chair Michael McWilliams at 3:50 pm on September 10, 2014. Twenty-nine people were in attendance.

Meeting Secretary Michael Murray sent his regrets at not being able to attend this year.

A moment of silence was observed to remember those WIFDWC members who have passed in the last year - Jim Stewart, Fred Peet and Yasu Hiratsuka.

OLD BUSINESS

A motion to adopt the 2013 business meeting minutes without revision was made by Ellen Goheen (Walt Thies second). Motion passed. The Treasurer's report was not available in time for the business meeting (will be published in the proceedings) but Holly Keams assures us that WIFDWC is solvent.

Dave Shaw confirms that the 2015 WIFDWC will be held in Newport, OR during the week of September 21-25. There will also be a Whitebark Pine Ecosystem Foundation meeting the week prior in Ashland, OR at Southern Oregon University. Robin Mulvey confirms that the 2016 WIFDWC will be held in Alaska, possibly Sitka, sometime in May.

As always, lively discussion ensued around the subject of having a joint meeting with the entomologists as proposed during the 2013 business meeting. Debate around the relevant motions was deferred until discussion of the 2017 meeting location during new business.

It was confirmed that upon Fred Baker's retirement that Kristen Chadwick was managing the WIFDWC mailing list.

NEW BUSINESS

The Railroad Committee presented its slate of candidates for the 2015 meeting executives: Alan Kanaskie (Conference Chair), Amy Kroll (Secretary), Kristen Chadwick (Interim Program Chair) and Dave Shaw (Local Arrangements). Ellen Goheen made a motion to accept the slate (Greg Filip second). Motion passed.

Robin Mulvey suggested that a bulletin board service be added to the WIFDWC website to facilitate ride and room sharing prior to the next meeting. Since the website resides on a USFS server, the Chair will approach the WIFDWC Webmaster (not in attendance) to explore the possibility of starting a bulletin board given concerns around access and security. In the meantime, the next Local Arrangements person will provide a phone number on the web page for people to use for last minute contact info.

Walt Thies inquired if it was possible to pay for spouses or other non-members separately on the electronic payment site. Holly says that it is possible and that will be clarified on the website.

Terry Shaw questioned the process for paying for approved guest speakers. Kristen read the relevant section (Article 5) from the bylaws.

Much discussion ensued around the old business item regarding holding a joint meeting with the entomologists, the last of which was San Diego in 2004. A joint conference requires a much bigger venue than needed for a typical WIFDWC limiting potential meeting sites in 2017 and requiring a possible adjustment to dates since WFIWC is usually held in March. There is also the issue of whether US government agencies would send multiple staff from the same office to a joint meeting in Canada. To clarify the desire for a joint meeting, Stefan Zeglen made a motion to invite the entomologists to a joint meeting in 2017 (Dave Shaw second). Motion defeated. Instead, the Conference Chair will send an invitation to the WFIWC Chair to hold a joint meeting in 2018 at a location in the US.

Discussion then turned to possible sites for an entomologist less meeting in 2017. Stefan Zeglen extolled the virtues of Vancouver Island as a location since the last time WIFDWC was held there was 1987. Campbell River was proposed as a location since the fishing is fine in September. Ellen Goheen made a motion to accept Campbell River as the host location for 2017 (Blakey Lockman second). Motion passed.

Holly Kearns requested a replacement for herself as she is resigning from the Student Scholarship Committee effective immediately. Harry Kope volunteered to replace Holly. Motion was made and passed.

The Awards Committee requires a new Chair to replace the outgoing Paul Hennon. Ellen Goheen volunteered as the new junior member and was appointed by the Conference Chair.

Pete Angwin reported that if the Hazard Tree Committee was going to maintain its schedule of hosting a workshop every three years he was going to need some help. Also, the workshop dates might conflict with the 2016 WIFDWC. Pete proposed a motion to switch the workshop date to 2017 (Dave Shaw second). Motion defeated. Based on a straw poll, Pete decided to hold the workshop in the fall of 2016 instead.

At the close of new business, Greg Filip made a motion to end the business meeting (Terry Shaw second). Motion passed. The business meeting ended at 4:39 pm.

Treasurer's Report, 62nd WIFDWC

Holly Kearns

The 62nd annual WIFDWC in Cedar City, Utah had 53 attendees including 39 regular members, 5 students, 4 retirees, 1 single day attendee, and 4 guests. The following is a summary of transactions for the WIFDWC accounts from 1/1/2014 through 12/31/2014. The WIFDWC Federal Tax Identification Number is available upon request.

	Income / Expense	Balance	Total Account
All WIFDWC Accounts balance 12/31/13			**$46,264.18**
WIFDWC Meeting Account balance 12/31/13		$27,473.24	
Total registration	14,763.69		
Hotel meeting rooms, meals & breaks	-6,029.90		
Field trip transportation	-1,590.00		
Field trip supplies and snacks	-121.35		
Souvenirs and awards	-1,149.06		
Speaker expenses	-800.00		
Regular member registration fees to STA Fund	-585.00		
Other Account Activity			
2013 Proceedings (printing and formatting)	-2,225.41		
2013 Proceedings (postage and envelopes)	-316.73		
Deposits made for 2015 WIFDWC in Newport, OR	-700.00		
WIFDWC Meeting Account balance 12/31/14		**$28,719.48**	
Hazard Tree Committee Account balance 12/31/13		$7,666.94	
No Activity			
Hazard Tree Committee Account balance 12/31/14		**$7,666.94**	
Student Travel Award Fund balance 12/31/13		$1,740.00	
2014 Student Travel Awards	-$500.00		
2014 Silent Auction Proceeds	$1,335.00		
2014 Regular registration Fees (39 @ $15)	$585.00		
Student Travel Award Fund balance 12/31/14		**$3,160.00**	
International Sponsorship Fund balance 12/31/13		$9,384.00	
No Activity			
International Sponsorship Fund balance 12/31/14		**$9,384.00**	
All WIFDWC Accounts balance 12/31/14			**$48,930.42**

WIFDWC Outstanding Achievement Award Recipients

Year	Recipient	Meeting	Comments
2000	Lew Roth	Kailua---Kona, HI	For pioneering work on *Phytophthora lateralis*, *Armillaria* and dwarf mistletoes, and for inspiration and leadership of a generation of play pathology students and colleagues.
2000	Duncan Morrison	Kailua---Kona, HI	For long-standing contributions to forest pathology research, especially in relation to roots diseases and tree hazard.
2001	Bob Gilbertson	Carmel, CA	For contributions to the taxonomy and identification of wood-inhabiting basidiomycete fungi.
2002	No award given.		
2003	Everett Hansen.	Grants Pass, OR	For strong leadership in forest pathology including research on the biology and management of tree and seedling diseases of western conifers
2004	Bob James	San Diego, CA	For strong leadership in forest pathology especially technology transfer and research on the biology and management of forest nursery diseases for growers and nursery pathologists throughout the West.
2005	Walt Thies	Jackson, WY	For sustained long---term high quality research on laminated root rot and other root diseases of forest trees.
2006	Bart van der Kamp	Smithers, BC	In recognition of outstanding lifetime contribution to tree disease research and for inspiring a generation of students and colleagues in the field of forest pathology.
2006	Alan Kanaskie	Smithers, BC	For outstanding leadership, as a practicing forest pathologist, in the management of Swiss Needle Cast.
2007	Richard Hunt	Sedona, AZ	In recognition of his valuable research and extension efforts on white pine blister rust, along with many other contributions to forest pathology and biology.
2008	No award given		
2009	Bill Jacobi	Durango, CO	In recognition of your 30-plus years as an educator, researcher, organizer, advocate and practitioner of forest pathology.
2009	Bob Edmonds	Durango, Co	In recognition of 40-plus years as an educator, researcher, organizer, advocate and practitioner of forest pathology and ecology
2010	Paul Hennon	Valemount, BC	For sustained, significant contributions to our knowledge and understanding of forest disease dynamics and ecology.
2011	Susan Frankel & Ellen Goheen	Leavenworth, WA	For leadership in the science and practice of forest pathology and for critical contributions to the management of Sudden Oak Death.
2012	John Schwandt	Lake Tahoe, CA	For the energy, enthusiasm, and integrity which he has invested in the professions of forest pathology and forest management.
2013	Don Goheen	Waterton Lakes, AB	In honor of your 35 years of dedicated service to forest pathology as a researcher, leader and mentor of others.
2014	Terry Shaw III	Powell Butte, OR	In recognition of broad western U.S. and international experiences, and dedicated mentoring and storytelling
2014	Willis R. Littke	Fall City, WA	In recognition of a valuable industry perspective, support for WIFDWC Nursery Committee, international experience, mentoring and storytelling.

Standing Committees and Chairs, 1994—2014

Committee	Chairperson	Term
Hazard Trees	J. Pronos	1994—2005
	P. Angwin	2006—2015
Dwarf Mistletoe	R. Mathiasen	1994—2000
	K. Marshall	2001—2003
	F. Baker	2004—2013
	D. Shaw	2014—present
Root Disease	G. Filip	1994—1995
	E. Michaels Goheen	1996—2005
	B. Ferguson	2006—2009
	M. Cleary	2010—2011
	B. Lockman	2012—present
Rust	J. Schwandt	1994, 2005
	R. Hunt	1995—2004
	H. Kearns	2006—2011
	H. Maffei	2012—present
Disease Control[a]	B. James	1995—2002
Nursery Pathology	B. James	2002—2005
	K. Mallams	2007—2010
	W. Littke	2011—present
Foliar and Twig Diseases[b]	H. Kope	2007—present
Climate Change[c]	S. Frankel	2007—2008
	S. Frankel & D. Shaw	2009—present

[a]Disease Control committee was disbanded in 2002.
[b]Foliar and Twig Diseases committee was made full charter member in 2009.
[c]Climate Change committee was made full charter member in 2010.

Past Annual Meeting Locations and Officers

Meetings and Officers, 1953—2014

Annual	Year	Location	Chairperson	Secretary-Treasurer	Program Chair	Local Arrangements
1	1953	Victoria, BC	R. Foster			
2	1954	Berkeley, CA	W. Wagener	P. Lightle		
3	1955	Spokane, WA	V. Nordin	C. Leaphart	G. Thomas	
4	1956	El Paso, TX	L. Gill	R. Davidson	V. Nordin	
5	1957	Salem, OR	G. Thomas	T. Childs	R. Gilbertson	
6	1958	Vancouver, BC	J. Kimmey	H. Offord	A. Parker	
7	1959	Pullman, WA	H. Offord	R. Foster	C. Shaw	
8	1960	Centralia, WA	A. Parker	F. Hawksworth	J. Parmeter	K. Shea
9	1961	Banff, AB	F. Hawksworth	J. Parmeter	A. Molnar	G. Thomas
10	1962	Victoria, BC	J. Parmeter	C. Shaw	K. Shea	R. McMinn
11	1963	Jackson, WY	C. Shaw	J. Bier	R. Scharpf	L. Farmer
12	1964	Berkeley, CA	K. Shea	R. Scharpf	C. Leaphart	H. Offord
13	1965	Kelowna, BC	J. Bier	H. Whitney	R. Bega	A. Molnar
14	1966	Bend, OR	C. Leaphart	D. Graham	G. Pentland	D. Graham
15	1967	Santa Fe, NM	A. Molnar	E. Wicker	L. Weir	P. Lightle
16	1968	Couer D'Alene, ID	S. Andrews	R. McMinn	J. Stewart	C. Leaphart
17	1969	Olympia, WA	G. Wallis	R. Gilbertson	F. Hawksworth	K. Russell
18	1970	Harrison Hot Springs, BC	R. Scharpf	H. Toko	A. Harvey	J. Roff
19	1971	Medford, OR	J. Baranyay	D. Graham	R. Smith	H. Bynum
20	1972	Victoria, BC	P. Lightle	A. McCain	L. Weir	D. Morrison
21	1973	Estes Park, CO	E. Wicker	R. Loomis	R. Gilbertson	J. Laut
22	1974	Monterey, CA	R. Bega	D. Hocking	J. Parmeter	
23	1975	Missoula, MT	H. Whitney	J. Byler	E. Wicker	O. Dooling
24	1976	Coos Bay, OR	L. Roth	K. Russell	L. Weir	J. Hadfield
25	1977	Victoria, BC	D. Graham	J. Laut	E. Nelson	W. Bloomberg
26	1978	Tucson, AZ	R. Smith	D. Drummond	L. Weir	R.Gilbertson
27	1979	Salem, OR	T. Laurent	T. Hinds	B. van der Kamp	L. Weir
28	1980	Pingree Park, CO	R. Gilbertson	O. Dooling	J. Laut	M. Schomaker
29	1981	Vernon, BC	L. Weir	C.G. Shaw III	J. Schwandt	D. Morrison R. Hunt
30	1982	Fallen Leaf Lake, CA	W. Bloomberg	W. Jacobi	E. Hansen	F. Cobb J. Parmeter
31	1983	Coeur d'Alene, ID	J. Laut	S. Dubreuil	D. Johnson	J. Schwandt J. Byler
32	1984	Taos, NM	T. Hinds	R. Hunt	J. Byler	J. Beatty E. Wood
33	1985	Olympia, WA	F. Cobb	W. Thies	R. Edmonds	K. Russell
34	1986	Juneau, AK	K. Russell	S. Cooley	J. Laut	C.G. Shaw III
35	1987	Nanaimo, BC	J. Muir	G. DeNitto	J. Beatty	J. Kumi
36	1988	Park City, UT	J. Byler	B. van der Kamp	J. Pronos	F. Baker
37	1989	Bend, OR	D. Goheen	R. James	E. Hansen	A. Kanaskie

Meetings and Officers, 1953—2013 (cont.)

Annual	Year	Location	Chair-person	Secretary	Treasurer	Program Chair	Local Arrangements	Historian	Web Coordinator
38	1990	Redding, CA	R. Hunt	J. Hoffman	K. Russell	M. Marosy	G. DeNitto		
39	1991	Vernon, BC	A. McCain	J. Muir	K. Russell	R. Hunt	H. Merler		
40	1992	Durango, CO	D. Morrison	S. Frankel	K. Russell	C.G. Shaw III	P. Angwin		
41	1993	Boise, ID	W. Littke	J. Allison	K. Russell	F. Baker	J. Hoffman		
42	1994	Albuquerque, NM	C.G. Shaw III	G. Filip	K. Russell	M. Schultz	D. Conklin T. Rodgers		
43	1995	Whitefish, MT	S. Frankel	R. Mathiasen	K. Russell	R. Mathiasen	J. Taylor J. Schwandt		
44	1996	Hood River, OR	J. Kliejunas	J. Beatty	J. Schwandt	S. Campbell	J. Beatty K. Russel		
45	1997	Prince George, BC	W. Thies	R. Sturrock	J. Schwandt	K. Lewis	R. Reich K. Lewis		
46	1998	Reno, NV	B. Edmonds	L. Trummer	J. Schwandt	G. Filip	J. Hoffman J. Guyon	D. Morrison	
47	1999	Breckenridge, CO	F. Baker	E. Michaels Goheen	J. Schwandt	J. Taylor	D. Johnson		J. Adams
48	2000	Waikoloa, HI	W. Jacobi	P. Angwin	J. Schwandt	S. Hagle	J. Beatty		
49	2001	Carmel, CA	D. Johnson	K. Marshall	J. Schwandt	A. Kanaskie	S. Frankel		
50	2002	Powell River, BC	B. van der Kamp	H. Maffei	J. Schwandt	P. Hennon	S. Zeglen R. Diprose		
51	2003	Grants Pass, OR	E. Hansen	B. Geils	J. Schwandt	H. Merler	E. Michaels Goheen		
52	2004	San Diego, CA	E. Goheen	B. Lockman	J. Schwandt	H. Merler K. Lesiw	J. Pronos J. Kliejunas S. Smith		
53	2005	Jackson, WY	M. Fairweather	H. Merler J. Guyon	J. Schwandt	K. Burns	J. Hoffman F. Baker J. Guyon		
54	2006	Smithers, BC	K. Lewis	M. Jackson	J. Schwandt	B. Lockman	A. Woods		
55	2007	Sedona, AZ	S. Zeglen	M. McWilliams	J. Schwandt	J. Worrall	M. Fairweather B. Geils B. Mathiason		
56	2008	Missoula, MT	G. DeNitto	F. Baker	J. Schwandt	W. Littke	B. Lockman M. Jackson		

Bylaws passed in 1998 WIFDWC Business Meeting identify officers as chairperson and secretary elected at annual business meeting and treasurer and historian, elected every five years.

Meetings and Officers, 1953—2013 (cont.)

Annual	Year	Location	Chair-person	Secretary	Treasurer	Program Chair	Local Arrangements	Historian	Web Coordinator
57	2009	Durango, CO	G. Filip	J. Adams	J. Schwandt	D. Shaw	K. Burns B. Jacobi J. Worrall R. Mask J. Blodgett		
58	2010	Valemount, BC	R. Sturrock	M. Fairweather	J. Schwandt	D. Goheen	M. Cleary R. Reich		
59	2011	Leavenworth, WA	P. Angwin	S. Zeglen	H. Kearns	A. Kanaskie	G. Filip A. Saavedra A. Ramsey-Kroll D. Omdal	R. Sturrock	J. Adams
60	2012	Tahoe City, CA	A. Woods	J. Browning	H. Kearns	P Hennon	P. Cannon B. Woodruff		
61	2013	Waterton Lakes National Park, AB	R. Reich	K. Chadwick	H. Kearns	B. Lockman	T. Ramsfield		
62	2014	Cedar City, UT	M. McWilliams	M. Murray	H. Kearns	J. Worrall	J. Guyon		

Bylaws passed at 1998 WIFDWC Business Meeting identify officers as chairperson and secretary elected at annual business meeting and treasurer and historian, elected every five years.

In Memory of Frederick Gordon Peet (1942-2014)

By Rich Hunt and Alex Woods

Fred was more unique than the average scientist. On one hand he was very private and on the other he was an agitator. On the private side we do not know his age, but a calculated guess is a 1943 birth. He was not keen on people finding out what disease caused his death. He obtained an MSc in physics from Columbia, where he developed a strong interest in particle physics and judging by his office, he was keenly interested in the “god particle”.

He obtained his PhD from UBC. An example on the agitator side, as shop steward, once he understood your problem he was like a dog with a bone. That bone would flap in the face of management while he growled out chapter and verse of collective agreements. Consequently, he did not get promotions; he was stuck as a RS II. Financially he was not too concerned as he had a side business. But when he was shunted to the side and management used his job description, to hire a person at RS IV, well you can imagine what happened! The ruling of the highest court in the land eventually led to his RS IV status. Some believe the stress of this contributed to his cancer and disrupted his research.

Fred watched little television – he knew nothing of Star Trek – nothing about a tachyon beam. To him a tachyon was a theoretical particle that made some old prof’s model work. Can you image what happened when he saw a car pulling out of a rest stop on Highway 1 with a bumper sticker saying “Tachyon Powered”? Fred thought that the tachyon was long dead and now it was obviously powering a vehicle up the highway. He sprinted to his car and chased the tachyon car for a couple of hours towards Prince George, but abandon the chase when it seemed clear that he would run out of gas before the tachyon car lost power. He lamented if he could only have talked to them, as obviously they had new information about the particle.

Fred loved meeting new people and seeing new places, which led to studies in Latin, Russian, German, and French. Fred spoke both French and Russian.

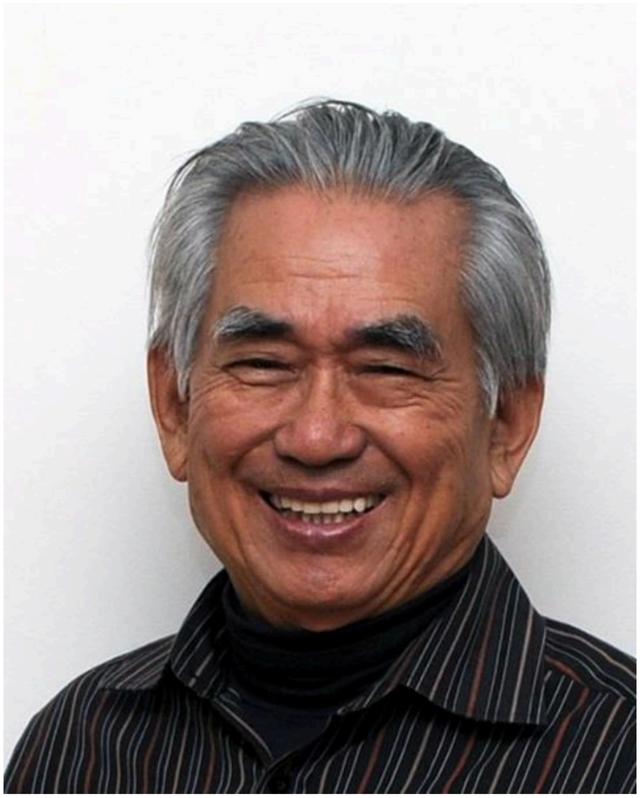
Fred visualized number patterns and readily integrated equations in his head. He was on the team that initiated GIS. His root disease model was a mathematical approach that tried to explain biology as opposed to a biological approach that used mathematics to make it work. His pictorial spread of root disease readily lets the observer see what happens by varying inoculum density, planting density, and potentially other factors.

One of Fred's later hobbies was documenting that the family farm at Prince Albert had been in the family for 100 years. Then it received special recognition by the Province, which made him very proud.

Although Fred and Josephine never had any children, he was great with kids and he would interact with them in a way that would hold him in their memories. He left a great impression. His enthusiasm for projects he was involved with and for life in general was like that of an excited young child, but he brought a level of intelligence and personal integrity that is rare.

In Memory of Yasuyuki "Yasu" Hiratsuka (1933-2013)

By Roger Peterson



Yasu Hiratsuka was a Northern Forest Research Centre (Edmonton) and WIFDWC stalwart for five decades. And besides invigorating our party, he was a major world figure in taxonomy of rust fungi: Morphology of the spermogonia of the rust fungi (with George Cummins, 1963, his doctoral work), Pine Stem Rusts of Canada (with J.M. Powell, 1976), Morphology and taxonomy of rust fungi (with S.Sato, 1982), The Genera of Rust Fungi (1983 with George Cummins, 2003, and a third in progress). And dozens more. And beyond taxonomy, A Field Guide to Forest Insects and Diseases of the Prairie Provinces (1987) and works on life cycles, cytology, damage, and hyperparasites.

Yasu was the world expert on *Cronartium*. He created *Endocronartium* for the taxonomically troublesome pine-to-pine rusts. Unfortunately his 1995 "frame work" for a monograph has not been followed by the real thing.

Yasu's grandfather Naohyaru Hiratsuka published on flax rust, but left pathology to run a linen company. Yasu's father Naohide Hiratsuka (1903-2000) was perhaps the greatest rust taxonomist ever (well, Arthur? Cummins? Yasu?). Yasuyuki collaborated with his father during visits to Japan and helped with Naohide's impressive The Rust Fungi of Japan (1992).

Yasu and I met at Purdue in 1961, when he was starting his doctoral project. Occasional meetings and correspondence to 2013 ensued--always valuable to me for his insights and well-argued disagreements.

As to Yasu the man, the Edmonton Journal's obituary says it well: "Yasu was an incredibly kind and compassionate man who had a profound impact on everyone he met. A globally recognized expert in Mycology, Yasu was a passionate scientist who, at almost 80 years of age, still made significant contributions to his field and maintained collaborations around the world. Yasu was very active in the Japanese community, as well as with his church and was generous with his time helping those in need."

--Roger Peterson
Santa Fe

Memories of James Dale "Jim" Stewart (1947-2015)

By Kenelm Russell - Fellow Forest Pathologist

It might have been earlier than 1962 that I first met Jim. He was a beginning graduate student in Forest Pathology at the University of Michigan in Lansing. I was a working Forester at Kimberly-Clark Corporation in Norway, Michigan's Upper Peninsula. I had not yet entered graduate school but was working in advance on my planned thesis project. We became friends because of our common interest in Forest Pathology.

Every fall most of the Forest Entomologists and Pathologists from the central region of Canada and the U. S. would come together for the Central International Forest Insect and Disease Work Conference (CIFIDWC). University professors would bring their graduate students, and research stations would send their insect and disease scientists. We students learned much from the older experienced researchers, and we formed life-long friendships with them. Jim was a regular at many of these meetings.

Jim and I finished up our Master's degrees in Forest Pathology and took on official titles as Forest Pathologists. We eventually became routine participants and presenters of forest disease information at conferences all over the United States and in Canada, too.

Jim got a job as a Forest pathologist with the Forest Service, and I ended employment with Kimberly-Clark in Upper Michigan In 1965 and moved to the far West to become the first Forest Pathologist for the State of Washington. Around that same time, Jim transferred to Portland with the Forest Service as a regional Forest Pathologist. I was most pleased to work closely with my friend Jim and another Portland Forest Pathologist, Jack Thompson. Together, we took numerous forest disease field trips and planned programs for dozens of forestry conferences. Our primary goal was to teach principles of forest disease management to foresters and forest landowners.

Our travels took us everywhere around the West as we investigated and learned how to deal with insect and disease pests. One of our mentors was Dr. Tobey Childs, Senior Forest Pathologist at the Pacific Northwest Forest and Range Experiment Station. Tobey taught us the rudiments of the "gascutis," his made up word for laminated root rot of Douglas-fir in the Pacific Northwest. We poked into stumps and roots with Tobey until we knew the disease well.

Another special mentor to us was Dr. Frank Hawksworth, world famous pathologist and researcher of the dwarfmistletoes. Frank worked at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, CO. In the 1970's, Frank, Jim, and I traveled to the San Juan Islands in Washington

State to verify the rare presence of hemlock dwarfmistletoe in lodgepole pine growing on Mt Constitution. The hemlock mistletoe confirmation we found on a rare host would go into the dwarfmistletoe book that Frank was co-authoring.

Frank flew in from Fort Collins, CO, and Jim and I picked him up at Seattle. We had chosen one of the coldest early Decembers on record for our trip. Our ferry ride from Anacortes to Orcas Island occurred during winds so strong that the near freezing sheets of spray swept the full length of our ferry. The wind at one point nearly blew us onto rocks while docking at Shaw Island. The trip still ranks as my most exciting ferry ride ever! We made it without further incident to Orcas Island and drove north to the East Sound Inn where we were given the premier Eisenhower Room due to lack of other guests. The cold north wind whistled and moaned through the room that night as if the walls were made of blankets. We piled on extra bedding and managed to avoid frostbite. Fortunately, next morning, the dining room downstairs was toasty warm and our breakfast table had a superb view of East Sound. I watched in awe as near hurricane force williwaws swooped down off 2,500 foot high Mt. Constitution and whipped spray off the Sound 1,000 feet into the air. Despite the freezing weather, both Jim and Frank were still game to go out and search for mistletoe plants on the pines. The sunshine, roaring winds, and extreme cold were invigorating.

The clear sky and below zero wind chill intensified as we drove to the summit of Mt. Constitution. Ice and about two inches of snow covered the road. My trusty station wagon made it to the top without chains. We were just about the only persons outside that day. We climbed the stone tower at the summit and looked to the north up the Strait of Georgia. The winds were howling at over 60 miles per hour, and the water far below us was completely white with spray and whitecaps. We clambered down from the tower and moved off into the woods where we gained some respite from the wind. After a bit of searching, we found a few dwarfmistletoe plants on the pines. Jim and I managed to get some infected branches down, and Frank carefully packaged the frozen plants for the trip back to Fort Collins.

Our warm car was a welcome shelter from the biting cold. The ferry ride and car trip to the airport and home were much quieter in the wintery, sunshine after the storm. We talked about that trip every time we got together in later years.

In Jim's time at Portland, we were all concerned about white pine blister rust. A good many of our meetings were about how we could treat this rapidly invading disease from Europe. Many thought that the white pines were doomed and would be exterminated. We tested two new antibiotic fungicides on blister rust. Phytoactin (made by the Pabst Brewing Company) and Actidione were applied to trees to systemically kill the blister rust fungus inside the tree. Jim and all of the regional pathologists eventually abandoned the idea that these chemicals would be practical and effective for treatment of the rust disease.

I do not remember just when Jim transferred to Denver as a Pathologist for the Rocky Mountain Region, but we were sorry to see him leave Portland. I would still see him regularly at the various meetings we attended. Eventually, he moved to Washington DC and again I had frequent contact as he now had charge of the Federal dollars that were distributed to the states for their insect and disease programs. I secured extra federal dollars for special dwarfmistletoe control projects on state DNR land through Jim. The Washington DNR thinned several hundred acres of mistletoe infected ponderosa pine stands to reduce the disease in the 1970's. I have seen these stands recently, and they are healthy and not as susceptible to wildfire as they would be if left in their diseased condition. Those healthy stands south of Mt Adams are a real credit to Jim.

Jim was always very professional and thorough about his pathology contributions as he progressed through his career. I remember Jim as a most compassionate man in his concern for co-workers who became ill. I watched him tenderly help at meetings to care for fellow pathologist Hart Bynum who became ill with terminal cancer. Jim was a true gentleman who made an indelible mark on his path through life. I will think of him often. (August 6, 2015)

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Don Buckland
Hubert "Hart" Bynum
Elmer Canfield
Fields Cobb
Ross Davidson
Oscar Dooling
Charles Driver
Norm Engelhart
Ray Foster
Dave French
Alvin Funk
Robert Lee Gilbertson
Lake S. Gill
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John Gynn
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Dwight Hester
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GROUP PHOTOS

Back Row (L-R): Peter Angwin, Don Goheen, Angel Saavedra, Bill Woodruff, Walt Thies, Gail Thies.
Front Row (L-R): Brennan Ferguson, Will Little, Terry Shaw, Jim Blodgett.

Back Row (L-R): Ellen Goheen, Holly Kearns, Alan Kanaskie, James Jacobs, Gregory Filip, Dave Shaw, Angel Saavedra.
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Front Row (L-R): Danny Norlander, Anne Lynch, Robin Mulvey, Danielle Martin, Kelly Burns.

Back Row (L-R): John Browning, Dan Omdal, Megan Dudley, Paul Zambino, Josh Bronson, Harry Kope.
Front Row (L-R): Cedar Welsh, Amy Ramsey, Suzanne Marchetti, Gabriela Ritokova.

Back Row (L-R): Stefan Zeglen, Marcus Jackson, Sara Ashiglar, Jim Worral, John Guyon.
Front Row (L-R): Helen Maffei, Elisa Becker, Anna Leon, Kathleen McKeever, Betsy Goodrich.

(L-R): John Guyon, MaryLou Fairweather, Mike McWilliams, Blakey Lockman.