2015 CLIMATE CHANGE COMMITTEE REPORT

Committee Co-Chairs:
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For WIFDWC 2015, the Climate Change Committee organized, “Drought and other factors as contributors to tree mortality”. A few key points from the presentations are provided below.

Functional trade-offs along a continuum of tree drought resistance
Rick Meinzer, USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR.
Decisive answers regarding mechanisms that cause mortality due to drought are elusive, there are multiple stressors and there are trade-offs between survival mechanisms. Intense drought stress causes two types of physiological failure: hydraulic connectivity failure (embolisms), and carbon starvation due to stomata closure. Biological agents can exacerbate both mechanisms.

Different plant species have different drought coping mechanisms. Isohydric species maintain internal water potential at a steady state regardless of how much drought stress occurs. Anisohydric species alter their internal water potential in response to drought conditions. Juniper is an anisohydric species, pinyon pine is isohydric. The wide-scale pinyon pine die-off in the Southwest US, from 2002 to 2003, was the result of a severe drought. The pinyon pines died while the junipers survived so the area is now dominated by juniper. Pinyon pines lost their ability to open their stomata because of a loss of turgor pressure, eventually the trees starved to death. The hydraulic risk for a given tree is influenced by xylem efficiency, xylem vulnerability to embolisms, hydraulic capacity, stomatal control of xylem tension, and xylem recovery from embolisms.

Structural mechanisms used by woody plants to deal with water stress
Barbara Lachenbruch, Oregon State University, Corvallis, OR.
Water is vital to many essential plant processes: cooling, mechanical support, nutrient and waste transport, and photosynthesis. Lack of water can cause plants to overheat, starve for carbon, wilt, and cease growth. Water moves through plants in a continuous column from roots to leaves driven by strong internal cohesion along a tension gradient. The gradient can be impeded by embolisms (air bubbles), or blocked by tyloses or gums (substances produced by parenchyma cells).

Plants can cope with drought at the cellular level by altering the shape or features of single cells, at the tissue level by partitioning or altering proportions of certain tissue functions, and at the organ or plant level by altering proportions of tissues within an organ (i.e. root to shoot ratios).
Depending on water supply and structural differences, top dieback can occur in a tree but a similar neighbor may suffer no apparent damage. Trees with higher leaf area such as those in fertilized or thinned stands can have larger leaf areas and thereby lose more water.

**Tree drought stress and insect and pathogen incidence in western yellow pine**  
Nancy Grulke, USDA Forest Service Western Wildland Environmental Threat Assessment Center, Prineville, OR.

Grulke investigated tree response to a severe 1999-2002 drought in Southern CA that caused some areas to lose 40-80% of its ponderosa pine (Pinus ponderosa). The trees died from a combination of drought stress and bark beetle attack and there was a need to translate environmental drought to the physiological consequences inside trees. The study used a series of Jeffery pine (Pinus jefferyi) trials rather than ponderosa pines as Jeffery pines were subject to less confounding biotic damage agents. Needle elongation was used as a simple proxy for physiological tree drought stress. Trees that had lower cambial total water potential and cambial turgor potential also had reduced resin exudate production. The analysis is on-going.

**Annual trends of Armillaria root disease in Southern BC**  
Michael Murray, British Columbia Ministry of Forests, Lands, and Natural Resource Operations, Nelson, BC.

*Armillaria* is the top mortality agent in Southeast BC where stand volumes can be reduced by as much as 50 percent. Measurements of 3,000 permanently marked trees found that 2/3 of all dead trees were killed by *Armillaria*. The study involved looking at years of infection as identified by ring widths less than 50 percent of the previous year’s growth. Murray used local weather data from within 15 km of trial sites and found pulses of *Armillaria* mortality coincided with drought years, particularly 2003 and 2007.

**Global climate change and wide-scale mortality**  
Richard Cobb, US Davis, Plant Pathology Department, Davis, CA.

Cobb is part of an interdisciplinary research team developing an ecological, mechanistic model of tree mortality. All forested continents have experienced large scale tree die-off events but predictions of where these events will occur are very coarse. The causes of tree mortality are complex and there are multiple interactions but in general the role of biological agents is poorly studied. Landscape level mortality events change ecological function in a variety of ways. In some cases there is a single ecological transition from a single agent; the ecosystem transitions and stabilizes at a new state. In other cases there is an ecological cascade with multiple steps and in other cases there is a multi-pathway response and a variety of new states. Land-use is a major driver of mortality patterns, areas with even-aged silviculture can suffer significant costs from these dieback events (i.e. BC and mountain pine beetle). All examples of mass forest die-offs used in model development have included the influence of climate change, as well as other drivers.

**Climate Change Committee meeting**  
Wednesday, September 23rd, evening meeting
The Climate Change Committee meeting, held September 23, featured Michael Murray, BC Ministry of Forests, Lands, and Natural Resource Operations, Nelson on Birch decline in Southeastern BC. Birch decline has progressed in southern BC over the last ten years. Michael has been working with two graduate student projects looking into the phenomenon (Carlo Sarmiento, Univ. of BC and David Jordan, Trinity Western University). Sarmiento has found a number of pathogens associated with the dead-topped trees including *Fomes fomentarius*, *Armillaria*, *Cerrena unicolor* and a vascular wilt caused by *Cryptosporella tomentella*. Tree ring analysis conducted by Trinity Western University indicates that a variety of mature age classes have died. Alex Woods related observations in the Shuswap region of southern BC where paper birch (*Betula papyrifera*) has largely been removed from its position in mixed-species stands. North Idaho and Southern BC are pretty much the southern range extension of birch so it is possible that the decline is the result of increasing summer droughts. The conditions in the Shuswap area were apparently triggered by the 1998 drought.

**Round robin contributions**

Dave Shaw: Recent high profile scientific papers from the ecology community (i.e. Allen, CD; Breshears, DD; and McDowell, N G. 2015. On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. Ecosphere, 6(8), art129) have covered large-scale forest declines but fail to discuss the role of pathogens in those decline events. Dave Shaw contacted the ecologists, and they have asked forest pathologists to propose how to add pathogens into the literature. D. Shaw posed a challenge back to the forest pathology community to consider “How will forest diseases and insect pests interact with increasingly hotter drought conditions to influence tree mortality patterns?”

Kristen Chadwick, Holly Kearns and Amy Ramsey: Experience with bigleaf maple (*Acer macrophyllum*) decline in WA seems similar to the situation with paper birch in BC. In both cases the species involved is one that is not actively managed so few resources have gone into understanding the decline. A suggestion was made that a panel for a future WIFDWC cover “Signals of climate change from underappreciated species”. Mike McWilliams suggested both the bigleaf maple and birch declines could be associated with Phytophthoras.

Nari Williams: Most of the forest disease problems observed in New Zealand are the result of introduced pathogens rather than climate change impacts on the resident diseases.

Ned Klopfenstein: The incidence and severity of *Dothistroma* needle blight has been increasing in ponderosa pine in natural stands near Moscow, Idaho.

The remainder of the discussion centered on how best to capture changing disease conditions. Richard Cobb noted that it is important to make sure disease data is collected in a standardized fashion so that it could be used for meta-analyses. Forest Inventory and Analysis (FIA) plots in the US were recommended since they are standardized and although they are not very detailed they can be supplemented with additional info. Records of pathogen presence and damage are limited in FIA plots.