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Presentation title: Genomic and genetic approaches to improve Christmas tree health

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Fir (i.e. *Abies* spp.) species are the premiere conifer used for Christmas tree production around the world. However, firs are extremely sensitive to the global impacts of climate change. Increasing evidence suggests overall global temperatures are rising at an accelerated rate which is resulting in increased maladaptation of local conifer populations. Firs are generally adapted to cool, moist environments and geographically constrained to high elevation montane ecosystems. When grown as Christmas trees, firs are planted well below their natural elevational range and associated climatic niche. This stresses trees, decreases productivity, and increases sensitivity to pests and pathogens. Traditional genetic improvement methods cannot keep pace with climate change and the associated challenges of increased damage from pests. Instead, improved tree breeding strategies that accelerate the domestication process are needed. To mitigate the future impacts of climate change, the NC State Christmas Tree Genetics (CTG) program is implementing a multi-pronged approach that includes both functional and quantitative genomics strategies. Specifically, the Whitehill lab is focusing on identifying key genomic associations in Fraser fir (*A. fraseri*). Fraser fir is the premier Christmas tree in the U.S. and represents ~38% of all species sold throughout the country. Fraser fir is known as the 'Perfect Christmas Tree' due to its elite combination of traits including superior post-harvest needle retention, soft needles, long lasting festive aroma, and strong branches to hold ornaments. Nationally, the value of real Christmas trees in the U.S. exceeds \$2.5 billion annually. Fraser fir Christmas trees fetch a higher price than other species and therefore represent ~50% of total annual sales. The largest production region of Fraser fir Christmas trees in the U.S. is focused within small rural communities located in the Southern Appalachian Mountains of North Carolina. However, Fraser fir production faces multiple challenges from pests and pathogens that include: (1) *Phytophthora* root rot and the causal agent *P. cinnamomi*; (2) piercing/sucking insects such as elongate hemlock scale (EHS; *Fiorinia externa*); and (3) grazing ungulates like the white-tailed deer (*Odocoileus virginianus*). Christmas trees with natural resilience to these threats are being cultivated through identification of elite germplasm using genomic selection approaches from existing breeding programs and biotechnology application that utilize clonal propagation through somatic embryogenesis (SE) techniques. Genomic approaches have the potential to generate genetically elite Christmas trees in a matter of years instead of several decades. Ultimately, genetic resistance/resilience is the only viable long-term pest management solution that will ensure the continued success of conifers around the world as climate change continues to accelerate.