Progress Report (2014-2015) of the Forest Health Research and Education Center (through March 31, 2016)

14-JV-11330126-056

Summary

The last year has been dedicated to staffing, forming partnerships, and developing the critical mass to successfully acquire extramural research funding. We developed a prospectus and implemented functional and administrative structures placing key expertise/personnel in various positions. We also developed a business plan, including a financial plan, and implemented key portions of that plan. We are particularly excited that the FHC now has two full-time USDA Forest Service (USFS) scientists on UK's campus, Dr. Dana Nelson, Research Geneticist and FHC Co-Director, and Dr. Tyler Dreaden, Research Pathologist. The FHC has had a successful year in terms of grantsmanship to advance our research and educational objectives. Since the original $560,000 grant ($350,000 USFS, $210,000 UK) in 2014 to establish the FHC, we have attracted over $1.5 million in extramural funding. This report details some of the specific projects each team (i.e., Biological Sciences, Social Sciences, and Education/Outreach) has identified as priority for their disciplines and areas of responsibility. The loss of our faculty lead for the Social Sciences Team (Dr. Andrew Stainback moved to a new position with the Everglades Foundation) necessitated reaching out to another USFS Southern Research Station (USFS-SRS) unit to find expertise to advance those objectives; we are pleased to report that Dr. Tom Holmes has taken up the lead of the Social Sciences Team and brings another helpful dimension to our work in this area. We are excited about the developments occurring within the Education/Outreach Team as they identify priority areas for educational programming and have begun conducting workshops, producing publications, and advancing the citizen science objectives for that team. The FHC now has three graduate students and five post-doctoral scholars working on various aspects of forest health, creating significant force-multipliers. We look forward to the coming year when we hope to plan an international conference, continue to seek funding for additional positions, and continue our grantsmanship to advance our research objectives.

Funding

Funding received (10 grants totaling over $1,545,690):

- Received grant funding for "Abiotic stress response and adaptive phenology in fruit trees" ~$425,000 (12/03/2015 - 12/02/2018) from USDA-AFRI. PI: Abbott and co-PIs: Liu, Dardick, Zhebentyayeva, Staton, Nelson, and Conrad.
- Received grant funding for "Rapid Tree Breed: a revolutionary tree breeding concept", ~$100,000. 1 year exploratory grant from USDA-NIFA. PI: Abbott, co-PIs Dardick, Liu, German-Retana, Bordat, Decroocq, and Nelson.

- Received grant funding for "Evaluating Chemical Fingerprinting as a Tool to Rapidly Screen Hybrid Chestnut for Disease Resistance" $3000 (10/24/2015 - 10/24/2016) from The American Chestnut Foundation. PIs: Conrad, Abbott, Nelson, and other collaborators.
- Received funding for “Standards and Cyber-Infrastructure That Enable "Big-Data" Driven Discovery for Tree Crop Research” from a NSF-PGRP (~$300K to UK-FHC). Proposal with Washington State University as a subcontractor.
- Received funding for KY WRRI proposal “Toward rapid detection of *Phytophthora cinnamomi* and *P. ramorum* in Appalachian streams” Chris Barton and Kenton Sena ($5,000) (unofficially awarded)
- Developed and executed a USFS-SRS Joint Venture Agreement: $560,000 total funds to support FHREC for 2 years ($350,000 USFS-SRS, $210,000 UK)
- Received funding ($70K; $50K USFS-SRS and $20K in UK matching) from the SRS Director’s Award competition for work on economy-wide modeling of various threats to oak trees and forests (“Economics of Host Resistance in Forest Trees” to be used for oak expert opinion survey and economy-wide modeling)
- Received funding ($128,800; $92K USFS-SRS and $36.8K in UK matching) from SRS to begin exploring and developing RNAi technology for the control of emerald ash borer (“Development of RNAi in Woody Plants for Broad-scale Management of Tree Pests”)
- Received support (~$300,000) from Foundation for the Carolinas for *Phytophthora* root rot resistance research in chestnut.
- Awarded Tracy Farmer Institute for Sustainability and the Environment (TFISE) Casner Award, $2,890, “Towards Rapid Detection of *Phytophthora spp*. in Appalachian Streams,” Barton, Christopher, and Kenton Sena. 2015. July 2015 to July 2016.

Funding being sought or pending:

- Seeking additional private funds for Endowed Chair position (a Forestry Development priority as discussed with Ms. Marci Hicks January 23, 2014)
- Seeking a new Natural Resources building for UK, number 1 priority for UK College of Agriculture, Food and Environment (CAFE). Partnering with USFS SRS to develop plans for dedicated space for FHC in this facility
- Submitted grant (pending) for "Oak Genetic Improvement Program” funding request from Kentucky Division of Forestry ($350,000). Collaboration between UK, FHC and KDF to fund a new tree breeding specialist position (November 13, 2015).
- Submitted grant (pending) for “Using forest health assessment as a tool for citizen engagement and education” to Lexington Fayette County Urban

Government Sustainability Grant ($3520) PIs: Ellen Crocker and Megan Seifert. (March 2016)

- Submitted grant pre-proposal (pending) "Distribution and genetic diversity of *Phytophthora cinnamomi* in eastern Kentucky" to NSF Environmental Biology Program (January 2016)
- Submitted grants for 3 USDA-AFRI proposals submitted: Two (each ~ $500K) were not funded, though one was ranked high priority. The third proposal is pending (~$100K).
- Submitted grant (not funded) "Promoting the Use of Local and Sustainable Wood and Paper Products on Campus," from UK Sustainability Challenge Grant Program (October 2015)
- Submitted grant (not funded) to KSEF proposal selected for full submission (Chris Barton and Kenton Sena)

New personnel hires and collaborators

- Hired postdoctoral scholar in Forestry Extension on Outreach/Education Team serving as Forest Health Specialist (2 years, starting April 2015) (Dr. Ellen Crocker)
- Hired postdoctoral scholar on Biological Sciences Team in Molecular Biology/Genetics (2 years, starting July 2015) (Dr. Anna Conrad)
- Hired postdoctoral Scholar in Bioinformatics and Molecular Biology (Dr. Shenghua Fan)
- Co-hosted with the Southern Institute of Forest Genetics Fulbright Scholar visiting scientist (September 1-November 30, 2015) (Dr. Rita Costa, INIAV, Portugal)
- Dr. Wendell Haag, freshwater stream ecologist with USFS-SRS relocated to UK (currently on 1-yr sabbatical with KDFWR in Frankfort) and is interested in collaborations with FHC
- Dr. Tyler Dreaden, USFS-SRS plant pathologist, hired and relocated to UK, working with the FHC
- Hired postdoctoral scholar to work in entomology with Dr. Lynne Rieske-Kinney on development of RNAi inhibition of Emerald Ash Borer (Dr. Thais Barros Rodrigues)

Student research updates

- Rachel Lanham, undergraduate and MS student in UK Department of Forestry, research project on white oak genetics and bioinformatics in collaboration with University of Tennessee working with FHC
- Kenton Sena, PhD student in UK Department of Forestry, research project on *P. cinnamomi* distribution and mining land reforestation working with FHC

- Carmen Santos, PhD student from INIAV in Portugal, co-hosted with the Southern Institute of Forest Genetics for FHC bioinformatics workshop and chestnut genetic mapping research

Biological Sciences Team Summary

The goals of the Biological Sciences Team are to understand, improve and utilize tree resistance to invasive pests and environmental stress. This team has greatly expanded their scope in this time period, making important strides in research capacity, funding, and progress. This year has seen the addition of several new team members (including three postdoctoral scholars, one visiting scholar, two graduate students, one new USFS-SRS scientist and one relocated USFS-SRS scientist) and the cohesion of a research team in forest health at the University of Kentucky. The team has made great progress in applying for research funding and was awarded several grants from a diverse group of national and regional funding organizations. This progress has resulted in the initiation of a wide range of cutting-edge research projects including research into:

- Rapid cycle breeding techniques for forest trees
- Abiotic stress response in forest trees
- Chemical fingerprinting of American chestnut to identify resistance
- Developing RNAi techniques to inhibit Emerald Ash Borer
- Identifying genetic resistance to *Phytophthora* root rot in American chestnut
- Understanding the distribution of the soil pathogen *Phytophthora cinnamomi* in Eastern KY
- Building a better database infrastructure to study tree genomics

Biological Sciences Team Research Publications:

- Conrad, A. O. and P. Bonello. 2016. Application of infrared and Raman spectroscopy for the identification of disease resistant trees. *Front. Plant Sci.* 6:1152. doi: 10.3389/fpls.2015.01152
- Santos, C., Zhebentyayeva, T., Serrazina, S., Nelson, C. D., and R. Costa. 2015. Development and characterization of EST-SSR markers for mapping reaction to *Phytophthora cinnamomi* in Castanea spp. Scientia Horticulturae 194:181–187.
- Amerson, H.V., Nelson, C.D., Kubisiak, T.L., Kuhlman, E.G., and S. A. Garcia. 2015. Identification of Nine Pathotype-Specific Genes Conferring Resistance to Fusiform Rust in Loblolly Pine (*Pinus taeda* L.). *Forests 6*, 2739-2761.
- Georgi, L. L., Zhebentyayeva, T., Islam-Faridi, N., Vining, E., Abbott, A. G., Nelson, C. D., and F. V. Hebard. 2015. The search for genes for resistance to chestnut blight. Chestnut 29(1):16-22.

- Nelson, C. D., Boyd, G., Rousseau, R. J., Crane, B. S., Echt, C. S., and K. H. Johnsen. 2015. Participatory genetic improvement: longleaf pine. In Proceedings of the 17th biennial southern silvicultural research conference. e–Gen. Tech. Rep. SRS–203. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 4 p.
- Staton, M., Zhebentyayeva, T., Olukolu, B., Fang, G. C., Nelson, C. D., Carlson, J. E., Abbott, A. G. 2015. Substantial genome synteny preservation among woody angiosperm species: comparative genomics of Chinese chestnut (*Castanea mollissima*) and plant reference genomes. BMC Genomics In press: GICS-D-15-00088R1
- Nelson, C.D., Powell, W.A., Merkle, S.A., Carlson, J.E., Hebard, F.V., Islam-Faridi, N., Staton, M.E., and L. Georgi. 2014. Chestnut. In: K. Ramawat, editor, *Tree Biotechnology, Chapter 1*, CRC Press, pp. 3-35.

Biological Sciences Team Meeting Sponsored:

- Genetics and Genomics of Phytophthora root rot resistance in Chestnut, 10-11 April 2015, Ashville, NC.

Biological Sciences Team Research Presentations:

- Nelson, C. D., Conrad, A. O., Crocker, E. V., and A. G. Abbott. Towards a forest health paradigm based on host genetics and participatory breeding. Southern Forest Tree Improvement Committee Annual Conference, June 2015, Hot Springs, AR.
- Conrad, A.O., Rodriguez-Saona, L., McPherson, B., Wood, D., and P. Bonello. Alternative approaches for phenotyping trees for disease resistance. Talk given at the Northern Forest Genetics Association Meeting, Martinsville, IN, July 14-16, 2015.
- Sena, K. and C. Barton. 2015. Toward Rapid Detection of *Phytophthora cinnamomi* in Appalachian Streams. UK Integrated Plant and Soil Sciences (IPSS) Graduate Research Symposium, Lexington, KY, August 18, 2015.
- Dreaden, T. J. Influence of soil community on American chestnut (*Castanea dentate*) field survival – proposed research. USDA FS SRS All Researches Meeting. Asheville, NC. November 17-19, 2015
- Hughes, M. A., Dreaden, T. J., Cognato, A., Riggins, J., Koch, F. and J. Smith. Unprecedented cascading effects of a clonal symbiosis. Interagency. Research Forum on Invasive Species. Annapolis, MD. January 12-15, 2016.
- Abbott, A. G. Tree Genetics. UK Plant and soil sciences departmental seminar series in Cameron Williams Auditorium, February 2016, Lexington, KY.
- Dreaden, T. J. and J. A. Smith. 2016. Response of swamp bay, *Persea palustris*, and redbay, *P. borbonia*, to *Raffaelea* spp. isolated from Xyleborus glabratus. Southern Appalachian Forest Entomologist/Pathologist Seminar, Newland, NC, March 3-4, 2016.

- Sena, K., Crocker, E., and T. Dreaden. Tracking a tree-killer Modeling species

distribution of *Phytophthora cinnamomi* in Appalachian streams. Southern Appalachian Forest Entomologist/Pathologist Seminar, Newland, NC, March 3-4, 2016.

- Smith, J., Hughes, M., Dreaden, T., Cognato, A., Riggins, J., Koch, F., and R. Ploetz. Holy Guacamole: Insights into the laurel wilt disease pandemic. Southern Appalachian Forest Entomologist/Pathologist Seminar, Newland, NC, March 3-4, 2016.
- Smith J., Black, A. W, Mullerin, S., and T. J. Dreaden. Evaluating the risk to oaks from *Diplodia corticola* and *D. quercivora*, two emergent fungal pathogens. Southern Appalachian Forest Entomologist/Pathologist Seminar, Newland, NC, March 3-4, 2016.
- Sena, K. and C. Barton. 2016. "Stewarding Appalachia's Forests: Challenges and threats, both former and future." Oral presentation at Graduate Appalachian Research Community Appalachian Research Symposium and Arts Showcase, Lexington, KY, March 5-6.
- Sena, K., Crocker, E. V., Dreaden, T., and C. Barton. 2016. "Towards Rapid Detection of *Phytophthora cinnamomi* in Appalachian streams." Kentucky Water Resources Research Institute Annual Symposium, Lexington, KY, March 28, 2016.
- Dreaden, T. J., Black, A. W., Mullerin, S., and J. A. Smith. Development of a detection method for the survey of the oak pathogens *Diplodia corticola* and *D. quercivora* in Florida. Central Hardwood Forest Conference, Columbia, MO March 28- April 1, 2016.
- Nelson, C. D. and A. G. Abbott. 2014. Alternative approaches to tree breeding for no-analog physical and fiscal environments. Presentation to IUFRO Forest Tree Breeding Conference, Prague, Czech Republic, August 2014. (invited)
- B.D. Bartlett, J.H. Roberds, K.C. Showmaker, D.G. Peterson, C.D. Nelson. 2015. Draft Genome Sequence of *Mycosphaerella dearnessii* from Two Isolates Infecting Longleaf Pine. SFTIC presentation, June 8-11, Hot Springs, AR.
- Piculell, B. J., Nelson C. N., Roberds, J. H., and J. D. Hoeksema. 2015. Effects of interaction with mycorrhizal fungi on correlations between traits in loblolly pine. SFTIC presentation, June 8-11, Hot Springs, AR. (Best presentation award)
- Burdine, C.S., Smith, K. E., Bartlett, B. D., Davis J. M., and C.D. Nelson. 2015. Single Genotype Isolates of the Fusiform Rust Fungus: Process and Progress. SFTIC presentation, June 8-11, Hot Springs, AR.
- Zhebentyayeva, T., Perkins, M.T., Jeffers, S., James, J., Sisco, P., Hebard F., Georgi, L., Staton M., Nelson, C. D., and A. G. Abbott. 2015. Mapping of resistance to *Phytophthora* root rot (caused by *P. cinnamomi*) in interspecific American/Chinese and American/Japanese chestnut hybrid families. SFTIC presentation, June 8-11, Hot Springs, AR.
- Piculell, B. J., Nelson, C. D., Roberds, J. H., Eckhardt, L. G., and J. D. Hoeksema. 2015. Examining the evolutionary interactions of loblolly pine

with both beneficial and pathogenic fungi. Presentation, Ecological Society of America Annual Meeting, August 9-14, 2015, Baltimore, MD.

- Abbott, A.G., Zhebentyayeva, T., Jeffers, S., James, J., Georgi, L., Hebard, F.V., Sisco, P., Santos, C., Costa, R. and C.D. Nelson. 2015. Forest Health Research and Education Center: Leveraging forest tree genomics and genetics resources to mark and identify genes for resistance to important forest tree pathogens and pests. August 2015, Orleans, France.

Social Sciences Team Summary

The goals of the Social Sciences Team are to understand the economic and cultural impacts of forest health challenges and forest management responses. This has been a year of exciting changes for the Social Sciences Team. Dr. Tom Holmes with the USFS-SRS has taken on a leadership role for this team while the previous team leader, Dr. Andrew Stainback, is in collaboration with the FHC in his new position with the Everglades Foundation. While previous Social Sciences Team research on the economic impact of forest health threats continues, the social sciences team has also initiated several new projects with new team members and collaborators. For example, currents projects now include:

- Delphi expert opinion survey of oak threats and their potential impacts—part 1 of Economics of Host Resistance project
- Economy-wide modeling of potential economic impacts of oak threats—part 2 of Economics of Host Resistance project
- Assessing public opinion concerning genetically modified (GM) forest trees
- Economic evaluation of reforestation on reclaimed mining lands
- Emerald ash borer's (EAB) impact on urban housing markets
- Hemlock wooly adelgid's (HWA) impact on housing markets

<u>Social Sciences Team Research Publications and Presentations:</u>

- Li, X., Stainback, A., and C. Barton. Paper presented at International Society of Forest Resource Economics Meeting to May 31-June 2, 2015, Vancouver, BC.
- Li, X., Stainback, A., and C. Barton. Valuing the Environmental Benefits from Reforestation on Reclaimed Mining Land in Kentucky. Poster presented at Society of American Foresters annual conference, August 2015, Baton Rouge, LA.
- Boyle, K., Kaul, S., Hashemi, A., and X. Li. Applicability of Benefit Transfers for Evaluation of Homeland Security Counterterrorism Measures." In Benefit-Cost Analyses for Security Policies, C. Mansfield and V.K. Smith (eds.). Cheltenham, UK: Edward Elgar Publishing. 2015.

Outreach and Education Team Summary

The goals of the Outreach and Education Team are to increase awareness of forest health challenges, improve understanding of the new genetic technologies available for improving and restoring forest health, and promoting the research work of the FHC. The Outreach and Education team has made great progress this year, working with concerned citizens, forest owners, and forest industries to 1) understand and prioritize forest health concerns, 2) develop education strategies to address these concerns and 3) engage with forest researchers to help define meaningful research avenues and utilize research results to develop solutions to forest health issues. To do this, team members have offered a wide variety of talks, workshops and publications, building connections for future work within the region as well as nationally. In addition, this team has interfaced regularly with both the biological sciences team and the social sciences team to increase education and outreach related to forest health threats and the genetics-based approaches to forest protection and restoration. Current focuses of the Education and Outreach Team include:

- Increasing public and professional understanding of forest health
- Increasing understanding of biotechnology's potential in forest restoration
- Developing a citizen science network for forest tree research and education collaboration
- Collaborating in regional multi-institutional citizen science research
- Enhancing Forest Health Curriculum and Student Training
- Sharing and applying the research of the Forest Health Research and Education Center

<u>Outreach and Education Team Meeting Sponsored:</u>

- Sponsored white oak sustainability meeting for wood industry and bourbon distillers, Lexington, KY, March 25, 2015.
- Hosted a biweekly forest health-themed journal club meeting at the University of Kentucky, fall 2015-spring 2016. 15 sessions, featuring 10 different presenters.

<u>Outreach and Education Team Publications:</u>

- Crocker, E. V. 2015. Decline of our forests and trees-- Can modern genetics provide a solution? Kentucky Woodlands Magazine 10(1): 6-10.
- Crocker, E. V. 2015. Plant Health: Anthracnose. UK Urban Forest Initiative online Tree Talk Series.
- Crocker, E. V. 2015. There's a Fungus among Us. UK Urban Forest Initiative online Tree Talk Series.
- Fountain, W.F. and E.V. Crocker. 2016. What's Your Tree Worth? UK Urban Forest Initiative online Tree Talk Series, Spring 2015.

- Crocker, E.V. and N.W. Gauthier. 2016. Don't Eat Those Mushrooms… Unless You Know What You Are Doing. Forestry Extension Publication, FORFS-16-01.

Outreach and Education Team Posters:

- Conrad, A.O., Crocker, E.V., Li X., Abbott, A.G., Stainback G.A., Stringer J.W., Nelson C.D., and T.T. Baker. 2015. An Interdisciplinary Approach to Address Current and Emerging Threats to Forest Health. Society of American Forester Meeting. November 3-5, 2015, Baton Rouge, LA.

Outreach and Education Team Invited Presentations:

- Stringer, J. W. White Oak Sustainability. White Oak Sustainability Meeting. Lexington, KY. March 2015.
- Crocker, E. V. White Oak Threats. White Oak Sustainability Meeting. Lexington, KY. March 2015.
- Stringer, J. W. White Oak Sustainability. Annual Meeting Associated Cooperage Industries of America, October 12, 2015.
- Crocker, E. V. White Oak Threats. Annual Meeting Associated Cooperage Industries of America, October 12, 2015.
- Crocker, E. V. Threats on Our Doorstep: Emerging pathogens and pests. Ohio Valley Lumber Drying Association Annual Meeting. April 2015.
- Backer, T. Presentation to the Executive Committee of LFUCG Tree Board, February 4, 2015
- Crocker, E. Invited speaker for firewood safety segment, local TV news morning show, WTVQ channel 36, June, 2015.
- Crocker, E. Invited speaker for emerald ash borer segment, local TV news noon show, WKYT channel 27, July 2015.

Outreach and Education Team Educational Programs and Presentations:

- Crocker, E. An Introduction to Invasive Plants and Pests in Central Kentucky. Woodland Owners Short Course Central Kentucky, August 15, 2015.
- Crocker, E. Managing Woodlands to Deal with Key Invasive Plants in Central Kentucky. Woodland Owners Short Course Central Kentucky, August 15, 2015.
- Crocker, E. An Introduction to Invasive Plants and Pests in Eastern Kentucky. Woodland Owners Short Course Eastern Kentucky, September 26, 2015.
- Crocker, E. Managing Woodlands to Deal with Key Invasive Plants in Eastern Kentucky. Woodland Owners Short Course Eastern Kentucky, September 26, 2015.

- Crocker, E. Signs of Woodland Health Issues. KY Woodland Expo, One Acre at a Time Program, September 19, 2015.
- Crocker, E. Welcome to Kentucky's Forests. Video presentation at KY Woodland Expo, September 19, 2015.
- Crocker, E. An Introduction to Invasive Plants and Pests. Keep Frankfort Forested educational series, November 7, 2015.
- Stringer, J., and E. Crocker. Are Your Woodlands Healthy? Forestry Extension Fall Webinar Series, November 12, 2015.
- Crocker, E. V and A. Conrad. Instructors in Forest Health component of UK Forestry junior undergraduate field course. 2016.