Progress Report of the Forest Health Research and Education Center

(April 1 2016 to March 31, 2017)

14-JV-11330126-056

Summary

During this period the Forest Health Research and Education Center (FHC) has continued to evolve with several shifting team leads. Dr. Jeff Stringer, previously head of the FHC Education and Outreach Team, joined Dr. Dana Nelson as a co-director of the FHC. Dr. Red Baker stepped down from this role due to his relocation to the University of Florida. The FHC gained a new Social Sciences Team Leader with the arrival of Dr. Thomas Ochuodho, the new Assistant Professor of Forest Economics at the University of Kentucky's Department of Forestry. The FHC continues to have 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. In addition, three graduate students, three post-doctoral scholars, and one research associate are working with the FHC on various aspects of forest health. The FHC has continued to successfully pursue a wide variety of competitive grants to advance our research and educational objectives. During this period the FHC has attracted over $695,031 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 priorities for their disciplines and areas of responsibility. The Biological Sciences Team has made exciting progress, particularly towards the development of a potential RNAi approach to managing the emerald ash borer. In addition, collaborations between the Education & Outreach Team and the Biological Sciences Team are underway which will advance forest health-related citizen science and support the development of a white oak initiative and tree-breeding program. We look forward to the coming year when we plan to continue our grantsmanship to advance our research objectives, push forward on various projects, and continue to engage a broad network of forest health collaborators.

Funding

Funding received (6 grants totaling $695,031):

- **Conrad AO**, **Abbott AG, Nelson CD**, Bonello P, and E Rodriguez-Saona. "Evaluating chemical fingerprinting as a tool to rapidly screen hybrid chestnut for disease resistance." **$4,511** additional funding from the American Chestnut Foundation
- Main D, Staton M, Jung S, Wegrzn J, Ficklin S, **Nelson CD,** and **AG Abbott**. "Standards and CyberInfrastructure That Enable "Big-Data" Driven Discovery For Tree Crop Research." NSF PGRP. FHC share is **$267,000**, total is approximately $3,000,000.

- **Crocker EV,** Condon BJ, and S Odom. "Expanding Your Horizons- a STEM Conference for Middle School Girls" **$10,000** from NSF EPSCoR, Sept 2016.
- **Crocker EV** and M Seifert. "Using forest health assessment as a tool for citizen engagement and education." **$3,520** from Lexington Fayette County Urban Government Sustainability Grant, March 2016
- **Crocker EV, Abbott AG, Nelson CD, and JW Stringer**. "Oak Genetic Improvement Program" **$350,000** from State and Private Forestry Landscape Scale Restoration-Competitive Resource Allocation Process from USDA Forest Service via Kentucky Division of Forestry.
- **Stringer JW, Abbott AG, and T Ochoudho**. Year 3 modification ($120,000) proposed for the FHREC. USDA Forest Service SRS. **$60,000** awarded.

Funding being sought or pending (3 grants totaling $3,009,039):

- **Nelson CD, Abbott AG, Crocker EV, Stinger JW**. UK VPR's Centers and Institutes Development Grant. **$450,000** requested over 3 years, April 1 2017.
- Martin P, Yang J, **Dreaden TJ**, Randolph K, **Crocker EV**, and C Clark. "Spatio-Temporal Analysis of Laurel Wilt Disease in the Eastern U.S". USDA FS STDP. Proposal. **$59,039** requested over 2 years.
- Barton C, Agouridis C, Jacobsen K, Lhotka J, **Ochuodho T, Abbott AG, Nelson CD, Sena K**, and J Yang. NSF-NIFA Innovations at the Nexus of Food, Energy, and Water Systems. "Integrated Agroenergy Production Systems for Economic and Ecological Transition on Rural Marginal Land." **$2,500,000** requested, over 5 years March 2017.

New personnel hires and collaborators

- New Social Sciences team lead, Dr. Thomas Ochuodho, hired by UK Forestry Department as Faculty in Forest Economics

Student research updates

- Rachel Landham, 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
- Billy Thomas, PhD student in UK Department of Sociology, research project on woodland owner attitudes to woodland management

Biological Sciences Team Summary

The goals of the Biological Sciences Team are to understand, improve, and utilize tree resistance to threats, both biotic and abiotic. In addition, researchers in this team seek to better understand the biological nature of these threats. The Biological Sciences Team has had a very productive year and has advanced the objectives of our externally supported research programs in the following areas:

- Developing RNAi techniques to inhibit the emerald ash borer
- Developing rapid cycle breeding techniques for forest trees using viral vectors to induce early flowering
- Increasing understanding of abiotic stress response in trees through a targeted metabolomics study of the components of the phenylpropanoid pathway through the winter dormancy period in peach and apricot flower buds from high and low chill sibs and cultivars respectively
- Completed a preliminary chemical fingerprinting study of American and Chinese chestnut breeding stock to identify rapid resistance-screening tools
- Worked towards identifying the quantitative trait loci for genetic resistance to *Phytophthora* root rot in chestnut by completing three genotyping by sequencing (GBS) based maps of Chinese/American chestnut hybrid families
- Increasing understanding of the distribution of the soil pathogen *Phytophthora cinnamomi* in Eastern KY
- Work towards identifying the genetic intervals controlling resistance to Plum Pox Virus and flowering time using genome wide association studies (GWAS) of apricot varieties
- Building a better database infrastructure to study tree genomics and store citizen science data
- Better understanding *R. lauricola* population genetics by using microsatellites and a mating type assay to describe the genetic structure of the pathogen in the US and Asian populations
- Leading a proposal for the development of the Institute of Forest Tree Breeding
- Co-leading scoping work on the development of a second project under the Forest Health Initiative

Biological Sciences Team Research Publications:

- Hughes MA, Riggins JJ, Koch FH, Cognato AI, Anderson C, Formby JP, **Dreaden TJ**, Ploetz RC, and JA Smith. 2017. No rest for the laurels: Symbiotic invaders causes unprecedented damage to southern USA forests. Biological Invasions. doi:10.1007/s10530-017-1427-z .
- Ploetz RC, Kendra PE, Choudhury RA, Rollins JA, Campbell A, Garrett K, Hughes M, and **TJ Dreaden**. 2017. Laurel Wilt in Natural and Agricultural Ecosystems: Understanding the Drivers and Scales of Complex Pathosystems. Forests. 8:48; doi:10.3390/f8020048.

- **Dreaden TJ**, Campbell AS, Gonzalez-Benecke CA, Ploetz RC and JA Smith. 2017. Response of swamp bay, *Persea palustris*, and redbay, *P. borbonia*, to *Raffaelea* spp. isolated from *Xyleborus glabratus*. Forest Pathology. 47: e12288. doi:10.1111/efp.12288
- Lu M, Krutovsky KV, **Nelson CD**, West JB, Reilly NA, Loopstra CA. 2017 Association genetics of growth and adaptive traits in loblolly pine (*Pinus taeda L.*) using whole exome-discovered polymorphisms. Tree Genetics & Genomes. (Accepted)
- **Rodrigues TB**, Rieske LK, Duan J, Mogilicherla K and SR Palli. Submitted Jan 2017, revision currently under review. Development of RNAi method for screening candidate genes to control emerald ash borer, *Agrilus planipennis.*
- Simmons DR, de Beer ZW, Huang Y, Bateman CC, Campbell AS, **Dreaden TJ**, Li Y, Ploetz RC, Li H, Chen C, Wingfield, and J Hulcr. 2016. New *Raffaelea* species (Ophiostomatales) from the United States and Taiwan associated with ambrosia beetles and plant hosts. IMA Fungus. 7:265-273.
- **Dreaden TJ**, Smith JA, Cram MM, and Coyle DR. 2016. Biology, diagnosis and management of Heterobasidion root disease of southern pines. Southern Regional Extension Forestry Fact Sheet SREF-FH-004. 5 p.
- Campbell AS, Ploetz RC, **Dreaden TJ**, Kendra P, and W Montgomery. 2016 Geographic variation in mycangial communities of *Xyleborus glabratus*. Mycologia. 108:657-667.
- Ploetz RC, Thant YY, Hughes MA, **Dreaden TJ,** Konkol J, Smith JA, and CL Harmon. 2016. Laurel wilt, caused by *Raffaelea lauricola*, is detected for the first time outside the southeastern USA. Plant Disease. 100:2166.
- McCluskey KA, Alvarez, Bennett R, Bokati D, Boundy-Mills K, Brown D, Bull T, Coffey M, **Dreaden TJ**, Duke C, Dye G, Ehmke E, Eversole K, Fenstermacher K, Geiser D, Glaeser A, Greene S, Gribble L, Griffith P, Hanser K, Humber R, Johnson W, Kermode A, Krichevsky M, Laudon M, Leach J, Leslie J, May M, Melcher U, Nobles D, Fonseca R, Robinson S, Ryan M, Scott J, Silflow C, Vidaver A, Webb M, Wertz E, Yentsch S, and S Zehr. 2016. The U.S. Culture Collection Network lays the foundation for progress in preservation of valuable microbial resources. Phytopathology 106: 532-540.
- Bradley JC, Will RE, Stewart JF, **Nelson CD**, and JM Guldin. 2016. Post-fire resprouting of shortleaf pine is facilitated by a morphological trait but fire eliminates shortleaf x loblolly pine hybrid seedlings. Forest Ecology and Management 379:146–152.
- Dalgleish HJ, **Nelson CD**, Scrivani JA, and DF Jacobs. 2016. Consequences of shifts in abundance and distribution of American chestnut for restoration of a foundation forest tree. Forests 7(1), 4. (9 pages)

- Stewart JF, Will RE, Crane BS, and **CD Nelson**. 2016. Occurrence of shortleaf X loblolly pine hybrids in shortleaf pine seed orchards: Implications for ecosystem restoration. Forest Science DOI: 10.5849/forci.15-167.

- Stewart JF, Will RE, Crane BS, and **CD Nelson**. 2016. The genetics of shortleaf pine (*Pinus echinata* mill.) with implications for restoration and management. Tree Genetics & Genomes (in press).
- Lu M, Krutovsky KV, **Nelson CD**, Koralewski TE, Byram TD, and CA Loopstra. 2016. Exome genotyping, linkage disequilibrium and population structure in loblolly pine (*Pinus taeda* L.). BMC Genomics. doi:10.1186/s12864-016-3081-8

Biological Sciences Team Research Presentations:

- **Dreaden TJ**, Hughes MA, and JA Smith. Population Genetics of *Raffaelea lauricola,* the Laurel Wilt Pathogen. Southern Appalachian Forest Entomologist/Pathologist Seminar, Newland, NC, March 2-3, 2017.
- **Conrad AO.** The role of phytochemicals in tree responses to abiotic and biotic stress. Forestry Department Seminar, University of Kentucky. Lexington, KY, March 1, 2017.
- **Sena K** and C Barton. Green Forests Work in Appalachia: Restoring new and old surface-mined lands to native forests. Oral presentation to Asbury University Introduction to Research Class, February 28 2017.
- **Nelson CD** and **TJ Dreaden**. SRS forest health research in Kentucky. Daniel Boone National Forest roundtable with UK Forestry. Lexington, KY. Feb. 1, 2017.
- **Sena K**, **Crocker EV**, **Dreaden TJ**, Clark C, Yang J, and C Barton. Tracking a Tree-killer: Improving detection and characterizing species distribution of *Phytophthora cinnamomi* in Appalachian forests. Poster presentation at Graduate Appalachian Research Community (GARC) Appalachian Research Symposium and Arts Showcase, Lexington, KY, February 19 2017.
- **Sena K**, **Crocker EV**, **Dreaden TJ**, Clark C, Yang J, and C Barton. Tracking a Tree-killer: Improving detection and characterizing species distribution of *Phytophthora cinnamomi* in Appalachian forests. Oral presentation at Sharing Work Across Appalachia, University of Kentucky Appalachian Center, Lexington, KY, February 15, 2017.
- **Sena K**. Research Update: Improving detection and characterizing distribution of *P. cinnamomi* in Appalachian forests. Oral presentation to *Phytophthora cinnamomi* working group, US Forest Service, Asheville, NC, 3 February 2017.
- Abbott AG, Zhebentyayeva T, Sisco P, Kubisiak T, Olukolu B, Jeffers SN, James J, Hebard F, Georgi L, Staton M, and **CD Nelson**. Genetic mapping of resistance to *Phytophthora cinnamomi* for American chestnut restoration in the southeastern United States. Plant and Animal Genome, Jan. 2017, San Diego, CA.
- **Dreaden TJ**. Molecular disease diagnosis. FOR 310. Lexington, KY, January 31, 2017.
- **Conrad AO.** Early screening of chestnut hybrid seedlings for resistance to chestnut blight and Phytophthora root rot. Invited talk at a meeting of the Virginia Chapter of the American Chestnut Foundation, Genomics and American Chestnut Restoration:

New Tools to Identity and Increase Disease Resistance. Blacksburg, VA, October 28, 2016.

- **Dreaden TJ**, Kappler RH, Knight KS, and JL Koch. Endophytic fungal diversity of green ash. 2016 Emerald Ash Borer Research and Technology Development Meeting. Wooster, OH, October 19-20, 2016.
- **Nelson CD**, **Crocker EV, Conrad AO, Dreaden TJ, Abbott AG, and JW Stringer**. Update on the Forest Health Research and Education Center. KY-TN state-line meeting, Oct. 12, 2016, Frankfort, KY. (invited)
- **Conrad AO**, Abbott A, Nelson CD, Westbrook J, Zhebentyayeva T, Jeffers S, Bonello P, Rodriguez-Saona L, Sisco P, and J James. Chemical fingerprinting: An alternative approach for screening hybrid chestnut for disease resistance. Oral presentation at NE-1333 Annual Meeting, Syracuse, NY, September 30-October 1, 2016.
- **Nelson CD**. Forest genetics in forest health. Auburn Univ seminar series, Auburn, AL, Sep. 21, 2016 (invited)
- Simmons DR, de Beer ZW, Huang Y, Bateman CC, Campbell AS, **Dreaden TJ**, Li Y, Ploetz RC, Li H, Chen C, Wingfield MJ, and J Hulcr. New *Raffaelea* species (*O phiostomatales*) from the United States and Taiwan associated with ambrosia beetles and plant hosts. Mycological Society of America, Berkeley, CA, August 7-11, 2016.
- Smith JA, Hughes MA, Held B, Blanchette R, **Dreaden TJ,** and RC Ploetz. Shovel-ready trees: novel strategies for development of disease resistant woody plants. American Phytopathological Society Annual Meeting, Tampa, FL, July 30- August 3, 2016.
- Hughes MA, Riggins JJ, Koch F, Cognato A, Anderson C, **Dreaden TJ**, Formby JP, Ploetz RC and JA Smith. The Laurel Wilt Story: Introduction and impact of an exotic vector (*Xyleborus glabratus*) and pathogen (*Raffaelea lauricola*). American Phytopathological Society Annual Meeting, Tampa, FL, July 30- August 3, 2016.
- **Dreaden TJ**, Hughes MA, and JA Smith. Development of a multiplex PCR microsatellite marker set for *Raffaelea lauricola*, and its potential applications. American Phytopathological Society Annual Meeting, Tampa, FL, July 30- August 3, 2016.
- Ploetz RC, Thant YY, Hughes MA, **Dreaden TJ**, Konkol JL, Kyaw AT, Smith JA, and CL Harmon. Laurel wilt, caused by *Raffaelea lauricola*, is detected for the first time outside the southeastern USA. American Phytopathological Society Annual Meeting, Tampa, FL, July 30- August 3, 2016.
- **Conrad AO**, Westbrook J, Zhebentyayeva T, Rodriguez-Saona L, Bonello P, **Nelson CD**, and **AG Abbott.** Evaluating chemical fingerprinting as a tool to rapidly screen hybrid chestnut for resistance to pathogens. Poster presentation at American Phytopathological Society Annual Meeting, Tampa, FL, July 30-August 3, 2016.
- **Nelson CD**, et al. Shovel ready trees for forest restoration. American Phytopathological Society Annual Meeting, Tampa, FL, Aug. 1, 2016 (invited)

- **Conrad AO**, **Nelson CD, Abbott AG**, and P Bonello. Chemical fingerprinting: An alternative approach for identifying disease resistant trees. Poster presentation at Society of Postdoctoral Scholars Research Symposium, University of Kentucky, Lexington, KY, June 3, 2016. *Received 3rd place poster presentation for postdoctoral scholars.
- Carlson JE, N Cannon, ME Staton, C Addo-Quaye, N Henry, LP Tomsho, S Ficklin, N Islam-Faridi, T Zhebentyayev, C Saski, R Burhans, D Drautz, TK. Wagner, N Zembower, SC Schuster, **CD Nelson**, **AG Abbott**, L Georgi, FV Hebard. The Chinese Chestnut Genome Project. IUFRO Genomics & Forest Tree Genetics, May 30-June 3, 2016, Arcachon, France.
- **CD Nelson**, et al. Cyberinfrastructure project workshop. Gene Conservation of Tree Species, Chicago, May 2016 (invited).
- Smith, KE, **CD Nelson**, et al. Red bay genetics and conservation. Gene Conservation of Tree Species, Chicago, May 2016.
- Echt, CS, BS Crane, **CD Nelson**. Restoration Seed Reserves in forest tree conservation. Gene Conservation of Tree Species, Chicago, May 2016.
- **Dreaden TJ.** How should tree improvement respond to invasive pests? Western Gulf Forest Tree Improvement Contact Meeting. Broken Bow, OK, May 17-18, 2016.
- **Dreaden TJ**, Black AW, Mullerin S, and JA 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.

2015-16 publications not included in previous report:

- Belyamani I, Otaigbe JU, **Nelson CD**, Strom B, and J Roberds. 2015. Rheological properties of southern pine oleoresins. Applied Rheology 25:5 (2015) 53708
- Islam-Faridi N, Majid MA, Zhebentyayeva T, Georgi LL, Cannon N, Staton ME, Hebard FV, Sisco PH, Carlson, JE, and **CD Nelson.** 2015. Genome organization and cyto-molecular map of chestnut. In: Proceedings of the 33rd Southern Forest Tree Improvement Conference, June 8-11, 2015, Hot Springs, AR. pp. 66-70.
- Guldin JM, Rosson JF, and **CD Nelson**. 2015. Restoration of longleaf pine—The status of our knowledge. In: Proceedings of the 18th Biennial Southern Silvicultural Research Conference. March 2-5, 2015, Knoxville, Tennessee, pp. 323-331.
- Butnor JR**,** Johnsen KH, and **CD Nelson**. 2015. Changes in soil chemistry six months after prescribed fire in a longleaf pine plantation in Mississippi. Proceedings of the 18th Biennial Southern Silvicultural Research Conference. March 2-5, 2015, Knoxville, Tennessee, pp. 563-564.

2015-16 presentations not included in previous report:

- **Dreaden TJ.** Disease Diagnosis using Molecular Techniques, University of Kentucky FOR356, Lexington, KY. February 4, 2016.

- Islam-Faridi N, MA Majid, T Zhebentyayeva, S Fan, LL Georgi, FV Hebard, PH Sisco, AG Abbott, JE Carlson, **CD Nelson**. Reciprocal Translocation in Chestnut (Castanea spp). Plant & Animal Genome Conference XXIV, January 9-13, 2016, San Diego, CA. https://pag.confex.com/pag/xxiv/webprogram/Paper21437.html
- **Nelson, CD**. QTL mapping in chestnut. Schatz Symposium/TACF Annual Meeting, State College, PA, October 2015.
- Abbott, AG, **CD Nelson**. Comparative genomics in chestnut. Schatz Symposium/TACF Annual Meeting, State College, PA, October 2015.
- Islam-Faridi N, **CD Nelson**, et al. Chestnut Molecular Cytogenetics – an update. Schatz Symposium/TACF Annual Meeting, State College, PA, October 2015.
- Will, RE, JF Stewart, KM Robertson, J Bradley, BS Crane, J Guldin, **CD Nelson**. Fire Exclusion is causing an Increase in Hybrids between Shortleaf and Loblolly Pine. Presentation/abstract, Third Shortleaf Pine Conference, Knoxville, TN, Sep 22-24, 2015.
- Stewart, JF, BS Crane, RE Will, JM Guldin, **CD Nelson**. 2015. Some shortleaf pine seed orchard clones are hybrids with loblolly pine. Presentation/abstract, Third Shortleaf Pine Conference, Knoxville, TN, Sep 22-24, 2015.
- **Nelson, CD**, C Burdine, S Fan. SIFG Report to NE-1333. NE1333 meeting presentation, Marion, VA, Sep 11-12, 2015.

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. Dr. Tom Holmes of USFS-SRS steered the Social Sciences Team through the year in the absence of his counterpart from the UK side. Fortunately, Dr. Thomas Ochuodho, who had been engaged with the Social Sciences Team from Auburn University, formally joined the UK forestry department in November 2016 as a new faculty to replace Dr. Andrew Stainback who left December 2015. Dr. Ochuodho will now co-lead the Social Sciences Team (from UK side) alongside Dr. Tom Holmes (USFS-SRS side). We look forward to new initiatives from this team in the coming year.

The Social Sciences Team research agenda remained focused on the economic impact of forest health threats and continued on in the following specific projects:

- Delphi expert opinion surveys 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

Social Sciences Team Research Presentations:

- **Li X,** Boyle KJ, Pressier E, **Holmes TP**, Orwig DA and Liebhold AM. "The Effect of Adjustment on Spatial Interpolation Errors on the Hedonic Model" at International Society of Forest Resource Economics, April 2016, in Raleigh, NC.

Social Sciences Team Research Publications:

- Wang J, Zhao F, Yang J, **Li X**. Mining Site Reclamation Planning Based on Land Suitability Analysis and Ecosystem Services Evaluation: A Case Study in Liaoning Province, China. Sustainability. *In review.*
- **Li X,** Boyle KJ, Pressier E, **Holmes TP**, Orwig DA and Liebhold AM. 2016. The Effect of Spatial Interpolation on the Hedonic Model: a Case of Forest Damages. International Society of Forest Resource Economics. Page 54: *In* Frey, Gregory E.; Nepal, Prakash, eds. Proceedings of the 2016 Meeting of the International Society of Forest Resource Economics. e-Gen. Tech. Rep. SRS-218. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

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 continued to make great progress working with concerned citizens, forest owners, and forest industries to 1) understand and prioritize forest health concerns, 2) develop educational 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. The Outreach and Education Team has taken the lead in organizing a regional white oak initiative to support the sustainability of white oak through research and education. This year the Outreach and Education Team has also increased its engagement with a more general audience of adults and youth regarding the importance of healthy trees and forests (including those in urban areas). 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. The Outreach and Education Team is engaging a diverse range of the public and supports inclusive excellence through leadership in efforts to engage underrepresented students in forest health and STEM education in general. 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 program for forest tree research and education collaboration

- Enhancing forest health curriculum, student training, and engagement of underrepresented students
- Increasing awareness of the importance of urban forests
- Sharing and applying the research of the Forest Health Research and Education Center

Outreach and Education Team Publications:

- **Crocker EV**. 2016. Biotechnology: Scientific Advances That Could Save Our Native Forests. Kentucky Woodlands Magazine Kentucky Woodlands Magazine 10(2): 8-10.
- **Crocker EV** and NW Gauthier. 2016. Don't Eat Those Mushrooms… Unless You Know What You Are Doing. Forestry Extension Publication, FORFS-16-01.
- Fountain WM, **Crocker EV**, Townsend L, and NW Gauthier. 2016. After Your Ash Has Died: Making an Informed Decision on What to Replant. Horticulture Extension Publication (ID-241) http://www2.ca.uky.edu/agcomm/pubs/ID/ID241/ID241.pdf
- Fountain WM and **EV Crocker**. 2016. What is Your Tree Worth? Horticulture Extension Publication (ID-240) http://www2.ca.uky.edu/agcomm/pubs/ID/ID240/ID240.pdf

Outreach and Education Team Educational Programs:

- Tree Detectives Youth Outreach Program (Spring and Summer 2016), **Crocker EV**. Designed and led an inquiry-based outreach program about on tree health for middle school students. Sessions included:
    - Governor's Minority Student College Preparation Program, UK, June 27- 28, 2016 (~100 youth)
    - 4H camp in Jabez KY, May 21, 2016 (~100 youth)
    - Tech Savvy Conference at Kentucky State University, May 21, 2016 (~20 youth)
- Urban tree health workshop series (Fall 2016- Spring 2017), **Crocker EV**. Organized monthly workshops about trees and tree health with invited speakers geared at an urban audience and attracted a diverse and large audience. Topics included:
    - Pruning 101 with UK Arborist Senior Stacy Borden (March 11, 2017, 30 people)
    - Winter Tree ID with retired Forestry Extension agent Doug McLaren (Feb 4, 2017, 70 people)
    - Putting Your Trees To Bed: Preparing Your Trees For Winter with City Arborist Heather (Nov 12, 2016, 23 people)
    - From Wet Places to Urban Spaces: A Walking Tree Tour of Bottomland Trees with UK Herbarium Director Rob Parately (Oct 23, 2016, ~20 people)
    - Tree ID 101 with retired Forestry Extension agent Doug McLaren (Sept 14, 2016, ~45 people)

Outreach and Education Team Courses Taught and Meetings Sponsored:

- **Crocker EV**. Hosted a biweekly forest health-themed journal club meeting at the University of Kentucky, fall 2015-spring 2017. 15 sessions, featuring 10 different presenters.
- **Crocker EV, Conrad AO, and TJ Dreaden**. Instructors in FOR 310, UK Forestry Forest Health course. Spring 2017.
- **Crocker EV**. Instructor in UK undergraduate course EXP 396 Engaging Girls in STEM: Leadership and Service Learning for the Expanding Your Horizons Conference, Spring 2017, Experiential Education, University of Kentucky
- **Crocker EV**. Instructor in UK graduate course EXP 650 Engaging Girls in STEM: Leadership and Service Learning for the Expanding Your Horizons Conference, Spring 2017, Experiential Education, University of Kentucky
- **Crocker EV.** Instructor of "Tree Detectives" 4 day mini-course through UK GEAR UP program for underrepresented high school students, July 25-28 (~10 youth)
- **Crocker EV**. Instructor in UK undergraduate course UK300-003 IAmAWomenInSTEM, Spring 2015. Designed and lead semester's discussions for undergraduates about issues facing women in STEM fields.

Outreach and Education Team Educational Presentations:

- **Crocker EV.** "KY Forest Health Update" Presentation at Ohio River Valley Woodlands and Wildlife Workshop, Boone Co. KY, March 25, 2017 (~35 people)
- **Crocker EV.** "An Introduction to Invasive Plants and Pests" talk, Keep Frankfort Forested lecture series, Nov 5, 2016 ~12 people
- **Crocker EV.** "Kentucky Forest Health Update 2016" Webinar through UK Forestry Extension fall series, Nov 1, 2016 https://www.youtube.com/watch?v=99H0BpGynx4
- **Crocker EV.** "Ash Tree Identification" Program at Raven Run Emerald Ash Borer awareness event, Oct 8, 2016, ~25 people
- Coy G, **Crocker EV** and N Williamson**.** Co-designed and facilitated "Neighborhood Tree Health" workshops, outreach sessions to eight Fayette County homeowners associations to increase awareness of urban tree health problems and care reaching ~100 people June-July 2016.
- **Crocker EV.** "Introduction to Fungi" Presentation at Kentucky Forestry Leadership Camp, June 7, 2016
- Laurie Thomas and **Crocker EV.** "Tree Detectives" Program at Youth Mountain Agriculture Day, Robinson Forest, Sept 29, 2016
- **Crocker EV.** Designed and taught "Tree Detectives" Program at Outdoor Adventure Camp, McConnell Springs, Lexington KY, June 27 (~12 youth) and July 18 (~12 youth).
- Laurie Thomas and **Crocker EV.** "Tree Detectives" Program at 4H Teen Conference, June 14-15, 2016
- **Crocker EV.** "Backyard Bark Beetles" Program at Russell Cave Elementary, April 22, 2016 (~200 youth)
- **Crocker EV.** "Fantastic Fungi" Presentation at Ohio River Valley Woodlands and Wildlife Workshop, Madison Indiana, April 2, 2016 (~25 people)