agencies to determine the cause of mortality of Florida torreya (*Torreya taxifolia*) – a rare endangered conifer on the brink of extinction (http://article.wn.com/view/2013/01/08/Expert_helps_solve_80year_mystery_as_team_identifies_fungus_/). The cause of mass mortality of this species has long been subject to debate, but our research shows that a novel species of *Fusarium* (named *Fusarium torreyae*) is causing a destructive canker disease that threatens species outside of the range of Florida torreya due to the efforts of citizen scientists interested in assisted migration of Florida torreya to the southern Appalachians. We are continuing to unravel the biology of this disease and develop ways to mitigate its affects on the remaining population *in situ* as well as efforts to maintain the species *ex situ* and to determine how climate may be exacerbating disease severity. I am also continuing to work with colleagues to determine the causes of mortality of rare Araucariaceae in New Caledonia including Mt. Panie Kauri (*Agathis montana*) a CITES Red listed species with significant cultural importance. Also I have been working at identifying rare species that are hosts of laurel wilt, including the federally endangered pondspice (*Litsea aestivalis*).

The impact of my research program is illustrated by several measures. According to current researchgate (www.researchgate.com) statistics, my RG score is 30.70 and I have *h*-index of 15 (over 630 citations). Publication output includes **53 peer reviewed journal publications since 2002**, with an average of 6 publications per year over the past 5 years.

Research funding since 2007 has totaled **$8,853,897 (average of $885,389 per year)** with me as a PI or Co-PI, with my personal share totaling $2,887,331 (average of $288,733 per year for ten years).

Several components of my work exemplify a synthesis of research and dedication to the discipline. These include invited speaking at numerous international meetings, serving on committees (including PhD committees in South Africa and Sweden) and providing service to the profession and regulatory agencies (our laurel wilt diagnostic method has been adopted as standard protocol by the National Plant Diagnostic Network). Numerous media outlets have covered my research – I've done interviews for many international news agencies (NPR, Al Jazeera etc.) and have represented US forest research at the World Forestry Congress at the request of the USDA Forest Service.

CREATIVE WORKS OR ACTIVITIES (Total 11)

Identification Guides

1. In 2011, I developed (along with collaborators at FL Division of Forestry) a "Forest Tree Disease and Insect Guide" currently being used by extension agents, arborists, graduate students and teachers. A final version is being printed in summer 2011.

2. In 2011, I co-authored a pamphlet entitled "Understanding decay in Florida trees: An explanation and pictorial guide to some of the more common decay fungi observed on Florida Trees." This is a collaborative effort with the Florida Division of Forestry and results from and ISA grant (see section 18a) and requests from extension agents and professional arborists for a guide on decay fungi in urban trees in Florida.

Instructional Multi-Media Presentations

1. Twenty of my presentations from 2009-2017 on laurel wilt have been recorded and are available online for extension agents or other clientele groups to access.

2. In 2010 I produced a DVD for educators that includes two Division of Forestry videos on forest health and invasive exotic species.

3. In 2010, I made 4 Powerpoint presentations available as part of a cd entitled "Florida's Forest Health Educational Materials" that is being used by educators throughout Florida (see Extension section).

Websites

1. My Twitter account: @forestpathology, initiated in 2015, already has 900 followers including research, science and media leaders.

2. In 2014 we launched a website for the forest pathology laboratory that includes a "field to lab blog" as well as a link to our forest health forum.

3. Website – in 2011, I developed a new forest health extension website (http://www.sfrc.ufl.edu/extension/forest_health/index.shtml) that provides up to date information on forest health research and extension activities in Florida.

4. As part of my Dendropathology course (FOR 6934) my students developed Wikipedia articles on several important tree pathogens and these were uploaded in 2011.

Other

1. In 2006 my research on white pine blister rust resistance in eastern white pine (*Pinus strobus*) led to commercialization of a resistant cultivar ('Silver Splendor'). This is a trademarked cultivar.

2. Scanning electron microscopy images from my research on white pine blister rust resistance were used for the front cover of the January, 2006 issue of the journal *Phytopathology*.

PUBLICATIONS[1]

[1] Underline denotes a senior or one of the principal authors, an asterisk (*) denotes a graduate student, and † denotes a technician or postdoctoral associate under my supervision.

a. Book(s), Contributor of chapter(s): (2)

1. .....Florida Climate Institute.

2. Smith, J.A. 2017. Fusiform rust and Diseases of Southern pines (2 chapters). *In:* Compendium of Conifer Diseases. APS Press. St. Paul, MN. In press

b. Refereed Publications: (Total: 53)

1. Mullerin, S.*, Black, A., Dreaden, T.J.* and. J.A. Smith. 2017. *Diplodia corticola* and *D. quercivora* implicated as serious potential threats to North American oaks. *Plant Disease.* In press.

2. Hughes, M. A.*, J. J. Riggins, F. H. Koch, A. I. Cognato, C. Anderson*, J. P. Formby, T. J. Dreaden*, R. C. Ploetz, J. A. 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

3. Hughes, M.A.*, Martini, X., Kuhns, E., Colee, J., Mafra-Neto, A., Stelinski, L.L. and Smith, J.A. 2017. Evaluation of repellents for the redbay ambrosia beetle, *Xyleborus glabratus*, the vector of the laurel wilt pathogen. *The Journal of Applied Entomology*. DOI: 10.1111/jen.12387

4. Dreaden, T. J.*, A. S. Campbell*, C. A. Gonzalez-Benecke, R. C. Ploetz and J. A. Smith. 2017. Response of swamp bay, *Persea palustris*, and redbay, *P. borbonia*, to *Raffaelea* spp. isolated from *Xyleborus glabratus*. *Forest Pathology*. 47: n/a, e12288. doi:10.1111/efp.12288.

5. Martini, X., M. A. Hughes*, N. Killiny, J. George, S. L.Lapointe, J. A. Smith, L. L. Stelinski. 2017.The fungus *Raffaelea lauricola* modifies behavior of its symbiont and vector, the redbay ambrosia beetle (*Xyleborus glabratus*), by altering host plant volatile production. *Journal of Chemical Ecology*. DOI: 10.1007/s10886-017-0843-y

6. Zhou, X., O'Donnell, K., Aoki, T., Smith, J.A., Kasson, M.T., Z. M. Cao. 2016. Two novel *Fusarium* species that cause canker disease of prickly ash (*Zanthoxylum bungeanum*) in northern China form a novel clade with *Fusarium torreyae*. *Mycologia.* In press.

7. Ploetz , R. C., Y. Y. Thant, M. A. Hughes*, T. J. Dreaden*, J. Konkol, J. A. Smith, and C. L. Harmon. 2016. Laurel wilt, caused by *Raffaelea lauricola*, is detected for the first time outside the southeastern USA. *Plant Disease*. 100: 2166.

8. Ostry, M. E., Moore, M., Jacobs, J., Smith, J.A. and N. Anderson. 2016. Bronze leaf disease: a threat to cultivated aspens, white poplars and their hybrids. *Forest Pathology.* In press.

9. Brar, G.S.*, Capinera, J.L, Kendra, P.E., Smith, J.A. and J. E. Peña. 2015.Temperature-Dependent Development of *Xyleborus glabratus* (Coleoptera: Curculionidae: Scolytinae). *Florida Entomologist* 98(3):856-864.

10. Hughes, M.A. †, Smith, J.A., Ploetz, R.C., Kendra, P.E., Mayfield, A.E. III, Hanula, J.L., Hulcr, J., Stelinski, L., Cameron, S., Riggins, J.J., Carrillo, D., Rabaglia, R.J., Eickwort, J. and T. Pernas. 2015.. National Plant Disease Recovery System - Recovery plan for laurel wilt on redbay and other forest species caused by *Raffaelea lauricola* and disseminated by *Xyleborus glabratus*. *Plant Health Progress*. DOI: 10.1094/PHP-RP-15-0017.

11. Martini, X., Hughes†, M. A., Smith, J. A. and L. L. Stelinski. 2015. Attraction of redbay ambrosia beetle, *Xyleborus glabratus*, to leaf volatiles of its host plants in North America. *Journal of Chemical Ecology*. 41:613-621.

12. Hughes, M.A. †, Inch, S. A., Ploetz, R.C., Er, H.L.*, VanBruggen, A. and J.A. Smith. 2015. Responses of swamp bay, *Persea palustris*, and avocado, *Persea americana*, to various concentrations of the laurel wilt pathogen, *Raffaelea lauricola*. *Forest Pathology* 45: 111-119.

13. Hughes, M.A. †, Black, A.W†. and J.A. Smith. 2014. First report of laurel wilt, caused by *Raffaelea lauricola*, on bay laurel (*Laurus nobilis*) in Florida. *Plant Disease* 98(8): 1159.

14. Dreaden, T. J.*, Davis, J. M., de Beer, W., Ploetz, R. C., Soltis, P. S., Wingfield, M. J., and J.A. Smith. 2014. Phylogeny of ambrosia beetle symbionts in the genus *Raffaelea*. *Fungal Biology* 118: 970-978.

15. Sniezko, R., Smith, J.A., Liu, J.J. and R. Hamelin. 2014. Genetic Resistance to Fusiform Rust in Southern Pines and White Pine Blister Rust in White Pines - A Contrasting Tale of Two Rust Pathosystems. *Forests* 5: 2050-2083.

16. Dreaden, T.J.*, Davis, J.M., Harmon, C.L., Ploetz, R.C., Palmateer, A.J. and J.A. Smith. 2014. Development of multilocus PCR assays for *Raffaelea lauricola*, causal agent of laurel wilt disease. *Plant Disease* 98(3): 379-383.

17. Dreaden, T.J.*, Black, A.W. †, Mullerin, S.* and J.A. Smith. 2014. First report of *Diplodia quercivora* causing shoot dieback and branch cankers on live oak (*Quercus virginiana*) in the USA. *Plant Disease* 98:282.

18. Dreaden, T.J.*, Wingfield M. J., and Smith, J. A. 2014. Development of a PCR-RFLP Based Detection Method for the Oak Pathogens *Diplodia corticola* and *D. quercivora*. *Plant Health Progress* 15: 9-12.

19. White, T.L., Davis, J.M., Gezan, S., Hulcr, J., Jokela, E., Kirst, M., Martin, T.A., Peter, G., Powell, G. and Smith, J.A. 2014. Breeding For Value in a Changing World: Past Achievements and Future Prospects. *New Forests* 45: 301-309

20. Hughes, M* and J.A. Smith. 2014. Vegetative propagation of putatively laurel wilt-resistant redbay (*Persea borbonia*). *Native Plants Journal* 15:42-50.

21. Kasson, M.T., K O'Donnell, A. P. Rooney, S. Sink, R. C. Ploetz. J. N. Ploetz; J. Konkol, D. Carrillo, S. Freeman, Z. Mendel, J. A. Smith, A. W. Black†, J. Hulcr, C. Bateman*, K. Stefkova, P. R. Campbell, A. D. Geering, E. K. Dann, A. Eskalen, K. Mohotti, D. P. Short, T. Aoki, K. A. Fenstermacher, D. D. Davis, D. M. Geiser. 2013. An inordinate fondness for *Fusarium*: Phylogenetic diversity of fusaria cultivated by ambrosia beetles in the genus *Euwallacea* on avocado and other plant hosts. *Fungal Genetics and Biology.* 56: 147-157.

22. Machado-Caballero, J.E., Lockhart, B.E., Mason, S.L., Mollov, D. and J. A. Smith. 2013. Identification, transmission, and partial characterization of a previously undescribed flexivirus causing a mosaic disease of ash (*Fraxinus* spp.) in the USA. Online. *Plant Health Progress.* doi:10.1094/PHP-2013-0509-01-RS.

23. Hughes, M. A.*, Brar, G.*, Ploetz, R. C., and Smith, J. A. 2013. Field and growth chamber inoculations demonstrate *Persea indica* as a newly recognized host for the laurel wilt pathogen, *Raffaelea laurciola*. Online. *Plant Health Progress* doi:10.1094/PHP-2013-08XX-01-BR.

24. Spence, D.*, J.A. Smith, J. Hulcr, A.E. Mayfield, R.C. Ploetz and L. Stelinski. 2013. Effect of chipping on emergence of the redbay ambrosia beetle (Coleoptera: Curculionidae: Scolytinae) and recovery of the laurel wilt pathogen from infested in wood chips. *Journal of Economic Entomology* 106: 2093-2100.

25. Spence, D.*, M. Hughes*, and J.A. Smith. 2013. Laurel wilt: An exceptionally damaging exotic symbiosis that threatens Florida's forests. *Journal of Florida Studies*. Refereed Online Journal Only.

26. Takayuki, A., Smith, J. A., Mount, L. L.*, Geiser, D. M., and O'Donnell, K. 2013. *Fusarium torreyae* sp. nov., a pathogen causing canker disease of Florida torreya (*Torreya taxifolia*), a critically endangered conifer restricted to northern Florida and southwestern Georgia. *Mycologia* 105, 312-319

27. Peña, P.E., D. Carrillo R. E. Duncan, J. L. Capinera, G. Brar*, S. McLean,M. L. Arpaia, E. Focht, J. A. Smith, M. Hughes and P. E. Kendra. 2012. Susceptibility of *Persea* spp. and other Lauraceae to attack by redbay ambrosia beetle, *Xyleborus glabratus* (Coleoptera: Curculionidae: Scolytinae). *Florida Entomologist* 95(3): 783-787.

28. Ploetz, R.C., J. M. Perez-Martınez, J. A. Smith, M. Hughes*, T. J. Dreaden*, S. A. Inch and Y. Fu. 2012. Responses of avocado to laurel wilt, caused by *Raffaelea lauricola*. *Plant Pathology* 61 (4): 801-808.

29. Dreaden, T.J.*, J. A. Smith, G.M. Blakeslee and E.L. Barnard. 2012. Development and evaluation of a real-time PCR seed lot screening method for *Fusarium circinatum*, causal agent of pitch canker disease. *Forest Pathology* 42(5): 405-411.

30. Hughes, M. A.*, Shin, K.,* Eickwort, J. and Smith, J. A. 2012. First Report of Laurel Wilt Disease Caused by *Raffaelea lauricola* on Silk Bay in Florida. *Plant Disease* 96 (6): 910.

31. Hughes, M.*, J. A. Smith, A. E. Mayfield, III, M. C. Minno, and K. Shin*. 2011. First report of laurel wilt disease caused by *Raffaelea lauricola* on pondspice in Florida. *Plant Disease* 95: 1588.

32. Ploetz, R. C., J. E. Peña, J. A. Smith, T. J. Dreaden*, J. H. Crane, T. Schubert, and W. Dixon. 2011. Laurel Wilt, Caused by *Raffaelea lauricola*, is Confirmed in Miami-Dade County, Center of Florida's Commercial Avocado Production. *Plant Disease* 95: 1589.

33. Dreaden, T.J.*, J.A. Smith and K. Shin*. 2011. First report of *Diplodia corticola* causing branch cankers on live oak (*Quercus virginiana*) in Florida. *Plant Disease* 95: 1027.

34. Smith, J.A., K. O'Donnell, L.L. Mount*, K. Shin*, K. Peacock†, A. Trulock*, T. Spector, J. Cruse-Sanders and R. Determann. 2011. A novel *Fusarium* causes a canker disease of the critically endangered conifer, *Torreya taxifolia. Plant Disease* 95: 633-639.

35. Croxton, M.*, M. Andreu, D. Williams, W. Overholt and J.A. Smith. 2011. Source and diversity of air-potato (*Dioscorea bulbifera*) in Florida. *Invasive Plant Science and Management* 4: 22-30.

36. Damadi, M., M.H. Pei, J.A. Smith and M. Abbasi. 2010. A new species of *Melampsora* rust on *Salix elbursensis* from Iran. *Forest Pathology*. Article first published online 7 Dec., 2010; DOI: 10.1111/j.1439-0329.2010.00699.x

37. Kubisiak, T.L., C.L. Anderson†, H.V. Amerson, J.A. Smith, J.M. Davis and C.D. Nelson. 2010. A genomic map enriched for markers linked to *Avr1* in *Cronartium quercuum* f.sp. *fusiforme*. *Fungal Genetics and Biology* 48: 266-274.

38. Anderson, C.L. †, T.L. Kubisiak, J.A. Smith, J.M. Davis and C.D. Nelson. 2010. Genome size variation in the pine fusiform rust pathogen *Cronartium quercuum* f.sp. *fusiforme* as determined by flow cytometry. *Mycologia* 102: 1295-1302.

39. Riggins, J.J., M. Hughes*, A. E. Mayfield III, B. Layton, C. Balbalian, R. Campbell and J. A. Smith. 2010. First occurrence of laurel wilt disease on redbay trees in Mississippi. *Plant Disease* 94: 634.

40. King, J.N., A.J. David and J.A. Smith. 2010. A review of genetic approaches to the management of blister rust in white pines. *Forest Pathology* 40: 292-313.

41. Smith, J.A., T.J. Dreaden*, M. Hughes*, A.E. Mayfield III, A. Boone, S.W. Fraedrich and C. Bates. 2009. First report of laurel wilt disease caused by *Raffaelea lauricola* on sassafras in Florida and South Carolina. *Plant Disease* 93: 1079.

42. Smith, J. A., L.L. Mount*, A.E. Mayfield III, C.A. Bates, W.A. Lamborn and S.W. Fraedrich. 2009. First report of laurel wilt disease caused by *Raffaelea lauricola* on camphor in Florida and Georgia. *Plant Disease* 93: 198.

43. Mayfield, A.E., J.E. Pena, J.H. Crane, Smith, J.A., C.L. Branch, E.D. Ottoson, and M. Hughes*. 2008. Ability of the redbay ambrosia beetle (Coleoptera: Curculionidae: Scolytinae) to bore into young avocado (Lauraceae) plants and transmit the laurel wilt pathogen (*Raffaelea* sp.). *Florida Entomologist* 91: 485-487.

44. Mayfield, A.E., J.A. Smith, M. Hughes*, and T.J. Dreaden*. 2008. First report of laurel wilt disease caused by a *Raffaelea* sp. on avocado in Florida. *Plant Disease* 92: 976.

45. Burnes, T.A., J.A. Smith, R.A. Blanchette, and J.J. Luby. 2008. Black currant clonal identity and white pine blister rust resistance. *HortScience* 43: 200-202.

46. Mayfield, A.E., E.L. Barnard, J.A. Smith, S.C. Bernick, J.M. Eickwort, and T.J. Dreaden*. 2008. Effect of propiconazole on laurel wilt disease development in redbay trees and on the pathogen *in vitro*. *Arboriculture & Urban Forestry* 34: 312-324.

47. Schwingle, B. W., J.A. Smith, and R. A. Blanchette. 2007. *Phytophthora* species associated with diseased woody ornamentals in Minnesota nurseries. *Plant Disease* 91: 97-102.

48. Schwingle, B. W., J. A. Smith, R. A. Blanchette, S. Gould, and B. Blanchette, J. L. Pokorny, and S. D. Cohen. 2006. First report of dieback and leaf lesions on *Rhododendron* spp. caused by *Phytophthora hedraiandra* in the United States. *Plant Disease* 90: 109.

49. Smith, J.A., R.A. Blanchette, J.J. Jacobs, L. Higgins, B. A. Witthun, J. H. Gillman and A. J. David. 2006. Proteomic comparison of needles from blister rust-resistant and susceptible *Pinus strobus* seedlings reveals up-regulation of putative disease resistance proteins. *Molecular Plant-Microbe Interactions* 19: 150-160.

50. Smith, J.A., R.A. Blanchette, T.A. Burnes, J.H. Gillman and A. J. David. 2006. Epicuticular wax and white pine blister rust resistance in selections of *Pinus strobus* L. *Phytopathology* 96: 171-177.

51. Smith, J.A., R.A. Blanchette, and G. Newcombe. 2004. Molecular and morphological characterization of the willow rust fungus, *Melampsora epitea*, from arctic and temperate hosts in North America. *Mycologia* 96: 1330-1338.

52. Gillman, J.H., D. Zlesak, and J.A. Smith. 2003. Application of potassium-silicate reduces black spot infection of *Rosa* 'Meipelta' (Fuschia Meidilin®). *HortScience* 38: 1144-1147.

53. Smith, J.A., R.A. Blanchette, M.E. Ostry and N.A. Anderson. 2002. Etiology of bronzeleaf disease of *Populus*. *Plant Disease* 86: 462-469.

c. Non-refereed Publications[1] (Total 32)

[1]The Extension Digital Information System (EDIS) is the electronic repository for all peer reviewed extension related publications within IFAS. This system is available to all persons with internet access and the documents are readily retrieved with simple web searches. EDIS statistics show that my extension documents were accessed and/or downloaded more than 10,000 times in 2010 through the EDIS portal.

1. Peer Reviewed Extension Publications (21)

1. C. A. Paez*. And J.A. Smith. Biscogniauxia (Hypoxylon) Canker or Dieback in Trees. 2017. FOR XXX. UF/IFAS EDIS. In press.

2. A. L. Loyd*, J. A. Smith, B. S. Richter, R. A. Blanchette, and M. E. Smith. 2017. The Laccate *Ganoderma* of the Southeastern United States: A Cosmopolitan and Important Genus of Wood Decay Fungi. PP 333. UF/IFAS EDIS. http://edis.ifas.ufl.edu/pdffiles/PP/PP33300.pdf.

3. Marble, C., Smith, J.A., Broschat, T.K., Black, A.*, Gilman, E. and C. White. 2016. Metsulfuron-Methyl Containing Herbicides Potentially Damaging Ornamentals when Applied to Turfgrass. HOR XXX. UF/IFAS EDIS. In press.

4. Hughes, M.A.*, Smith, J.A. and Coyle, D. 2016. Biology, ecology and management of laurel wilt and the redbay ambrosia beetle (SREF-FH-006). *Southern Regional Extension Forestry* (Online).

5. Dreaden, T.J.*, J.A. Smith, M.M. Cram, and D.R. Coyle. 2016. Biology, diagnosis and management of Heterobasidion root disease of southern pines. Southern Regional Extension Forestry Fact Sheet SREF-FH-004. 5 p.

6. Mullerin, S.* and J. A. Smith. 2015. Bot canker of oak in Florida, caused by *Diplodia corticola* and *D. quercivora*. FOR 318. UF/IFAS EDIS. https://edis.ifas.ufl.edu/pdffiles/FR/FR38600.pdf

7. Proctor, N.* and J.A. Smith. 2014. Cat's-Claw Vine, *Dolichandra unguis-cati*: A Showy but Invasive Plant in Florida. FOR 323. UF/IFAS EDIS. http://edis.ifas.ufl.edu/fr391

8. Sanagorski, L., Trulock, A.* and J.A. Smith. 2013. Armillaria root rot. ENH 1217. UF/IFAS EDIS. http://edis.ifas.ufl.edu/ep478

9. Spence, D.* and J.A. Smith. 2012. Thousand cankers disease: a threat to black walnut in Florida. FOR 308. UF/IFAS EDIS. http://edis.ifas.ufl.edu/fr376

10. Hicks, S.L.*, M.C. Monroe, G. S. Iyer* and J.A. Smith. 2011. What is a healthy forest?: A supplement to the Project Learning Tree. FOR 286. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr354

11. Iyer, G. S.*, M.C. Monroe and J.A. Smith. 2011. Beyond the trees: A systems approach to understanding forest health in the southeastern United States, A High School Module. FOR 287. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr376

12. Spence, D.* J. A. Smith, A. E. Mayfield III, J. Hulcr, R.C. Ploetz and L. Stelinski. 2011. Assessing the survival of the redbay ambrosia beetle and laurel wilt pathogen in wood chips. FOR 351. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr351

13. Spence, D.* and J. A. Smith. 2011. Emerald Ash Borer: a potential future threat to ash trees in Florida. FOR 284. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr346.

14. Smith, J. A. and K. Peacock*. 2010. Oak Wilt: A potential future threat to oaks in Florida. FOR 274. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr336.

15. Smith, J.A. 2010. Seridium canker of Leyland cypress. FOR 279. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr341.

16. Smith, J. A. and A. Trulock*. 2010. The decline of Florida torreya: An endemic conifer on the edge of extinction. FOR 276. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr338.

17. Crane, J. C. and J. A. Smith. 2010. Homeowner detection of and recommendations for mitigating redbay ambrosia beetle – laurel wilt disease on redbay and avocado trees in the home landscape. HS 1179. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/hs1179.

18. Dreaden, T.J.* and J.A. Smith. 2010. Annosum root rot of southern pines. FOR 269. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr331.

19. Dreaden, T.J.* and J.A. Smith. 2010. Pitch canker disease of pines. FOR 236. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr298.

20. Hughes, M.* and J.A. Smith. 2009. Red root and butt rot of sand pine. FOR 238. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/fr300.

21. Mayfield, A.E., J.H. Crane and J.A. Smith. 2008. Laurel wilt: A threat to redbay, avocado and related trees in urban and rural landscapes. HS-1137. UF/IFAS EDIS Database. http://edis.ifas.ufl.edu/HS391.

2. Curricula (2)

1. Iyer, G.*, M.C. Monroe and J.A. Smith. 2010. Healthy Forests: A high school handbook. UF/IFAS Extension. 108 pp.

2. Hicks, S.L.*, M.C. Monroe, J.A. Smith, J. Tomasello and E. L. Barnard. 2010. A guide to forest health: A Project Learning Tree Supplement for grades 5-7. UF/IFAS Extension. 79 pp.

3. Identification guides (2)

1. Barnard, E.L. and J.A. Smith. 2011. Understanding decay in Florida trees: An explanation and pictorial guide to some of the more common decay fungi observed on Florida Trees. Florida Division of Forestry. 8 pp.

2. Smith, J.A., Barnard, A.E. Mayfield, III., J. Eickwort, D. Treadway and M.C. Monroe. 2011. Tree disease and insect identification guide. UF/IFAS Extension. 41 pp.

4. Trade journals (6)

1. Hulcr, J., D.C. Adams, C. Bateman*, P. Carton de Grammont, M.A. Hughes† and J.A. Smith. 2015. Preventing invasion of destructive forest pests using pre-invasion assessments. *The Forestry Source*. February 2015, Vol. 20, No. 2.

2. Black, A.W.*, Hughes, M.A*. and Smith, J.A. 2013. Laurel wilt-resistant redbays: Hope for the future of a disappearing species. *Florida Land Steward.* Summer/Fall, Vol. 2, No. 3.

3. Spence, D.* and J.A. Smith. 2013. The status of Laurel wilt. *Palmetto.* In press.

4. Smith, J.A. and D. Spence*. 2010. Laurel wilt disease summary for Florida. *Florida Arborist* 13(3): 1,5-7.

5. Smith, J.A. 2008. Worried over wilt. *Ornamental Outlook*. September, 2008 Issue. pp 12-14.

6. Smith, J.A., A.E. Mayfield, III, H. Mayer and F. Escobedo. 2007. Marchitez del laurel en arboles de laurel rojo en bosques urbanos de la Florida. (Laurel wilt of redbay and urban trees in Florida) Florida International Society of Arboriculture Newsletter. Deciembre, 2007.

CONTRACTS AND GRANTS SINCE THE LAST PROMOTION (NOT TO EXCEED TEN YEARS) OR FROM UF EMPLOYMENT FOR TENURE NOMINEES, whichever is more recent.

a. Funded Externally

Effective Date	Amount	Funding Agency	Project Title	Role (my share of grant)
1/1/17-9/30/18	$50,000	USDA-Forest Service	Developing laurel wilt resistant redbay (*Persea borbonia*) and swamp bay (*Persea palustris*)	100%
9/1/16-8/31/19	$105,000	ISA-Florida Chapter	Improving hazard tree diagnosis by comparing saprophytic and pathogenic capability of Ganoderma species in the Southeastern US	100%
2015-2020	$3,456,195	NIFA	Laurel wilt of avocado: Management of an unusual and lethal disease.	Co-PI (~10%)
2016-2017	$135,396	USDA/APHIS-Farm Bill	Mitigating ecological and cultural losses from laurel wilt – Year 2	PI (100%)
2015-2016	$80,000	USDA-Forest Service, Forest Health Protection	Laurel wilt tolerance in native *Persea* species	PI (100%)
2015-2016	$52,465	USDA-Forest Service, Forest Health Protection	Evaluation of incidence and severity of *Diplodia* dieback of slash pine in peninsular Florida:	PI (100%)

			Year 2	
2015-2016	$25,000	USDA-Forest Service, Region 8	Evaluating the use of coppice-regeneration to maintain redbay as a Native American cultural resource in the face of laurel wilt	PI (100%)
2014-2015	$135,900	USDA/APHIS – Farm Bill	Mitigating ecological and cultural losses from laurel wilt	PI (100%)
2014-2015	$22,515	USDA-ARS	Recovery plan for redbay (*Persea borbonia*) and related Lauraceae affected by Laurel wilt: An update on research and recommendations	PI (100%)
2014-2015	$50,000	USDA-Forest Service, Forest Health Protection	Developing laurel-wilt resistant redbay (*Persea borbonia*) and swamp bay (*Persea palustris*)– *FY 2014*	PI (100%)
2014-2015	$52,465	USDA-Forest Service, Forest Health Protection	Evaluation of incidence and severity of *Diplodia* dieback of slash pine in peninsular Florida	PI (100%)
2014-2015	$1,500	Florida Native Plant Society	Propagation and testing of putatively canker-resistant Florida torreya (*Torreya taxifolia*), a critically endangered conifer of the Apalachicola River region	PI (100%)

2013-2014	$22,090	Orange County – Orlando Expressway Authority	Investigation of the cause and management of pine dieback and mortality along OOCEA expressways	PI (100%)
2013-2014	$209,925.00 (my share = $19,812)	USDA-Forest Service	Confirmation and development of a rapid PCR screening test for the presence of *Fusarium circinatum*, the causal agent of pitch canker on pine planting material	Co-PI (~9%)
2012-2013	$50,000	USDA-Forest Service	Evaluation of natural resistance in redbay (*Persea borbonia*) to laurel wilt disease	PI (100%)
2012-2013	$70,000	USDA-Forest Service	Assessing the distribution and threat from *Diplodia corticola*, a new exotic pathogen of live oak in Florida: Year 2	PI (100%)
2012-2013	$35,000	Horticultural Research Institute	Biology and management of live oak rapid decline in Florida nurseries	PI (100%)
2012-2013	$5,000	Atlanta Botanical Garden	SSR analysis of Florida torreya (*Torreya taxifolia*)	PI (100%)
2011-2012	$5,000	Florida Nursery Growers and Landscape Industry	Detection and prevention of *Diplodia corticola*, an exotic pathogen of oaks in Florida nurseries	PI (100%)
2011-2013	$64,590	USDA-Forest Service	Assessing the distribution and threat from *Diplodia corticola*, a new exotic pathogen of live oak in Florida	PI (100%)

2010-2012	$44,413	USDA-Forest Service, Southern Region	Biology and management of Fusarium canker disease of Florida torreya (*Torreya taxifolia*) – a critically endangered conifer	PI (100%)
2010-2011	$116,988	Florida Division of Forestry	Healthy forests education: Why and how? – Part 3	Co-PI (50%)
2010-2013	$1,000,000	USDA-NIFA Agriculture and Food Research Initiative	Improvement and deployment of rapid standardized PCR diagnostic tools to increase detection capacity for high-impact plant pathogens	Co-PI (~ 20%)
2009-2014	$1,967,863	USDA-Small Crops Research Initiative	Laurel wilt of avocado: Mitigation and management of an exotic, insect-vectored disease	Co-PI (~12%)
2009-2011	$89,900	USDA	Laurel wilt critical needs research: Disease management for avocado.	PI (100%)
2009-2010	$120,000	USDA-Tropical-Subtropical Agricultural Research Program	Management, epidemiology and detection of laurel wilt on avocado and avocado relatives in Florida.	Co-PI (~50%)
2008-2010	$65,000	USDA-Forest Service	Map based cloning of *AvrFr1* and genome sequencing of *Cronartium quercuum* fsp. *fusiforme*.	PI (100%)
2008-2010	$147,349	Florida Division of Forestry	Healthy forests education: Why and how? – Parts 1 and 2	PI (50%)
2007-2011	$140,000	USDA-Forest Service	Selecting red bay (*Persea borbonia*) for resistance to laurel	PI (100%)

			wilt disease.	
2007-2009	$7,500	International Society of Arboriculture: TREE FUND	Improving hazard tree diagnostic tools for arborists: how well do visual observations of fungal fruiting bodies predict extent of wood decay in urban trees?	PI (100%)
2007-2009	$33,500	Florida Division of Forestry	Vascular pathogen diagnosis in oaks in Florida.	PI (100%)

Summary of External Grant Funding, Nominee's Share, 2006-Present

Role	**Total**	Direct Costs	Indirect Costs
Principal Investigator	$1,633,582	$1,559,293	$74,289
Co-Principal Investigator	$701,416	$591,999	$109,417
Total	$ 2,234,998	$2,151,292	$183,706

b. Funded Internally

Effective Date	Amount	Source	Project Title	Role
2016	$38,038	UF/IFAS Office of Research	Restoring redbay lost to laurel wilt in OSBS: A silvicultural approach with tolerant germplasm	PI
2016	$9,450	UF Mid-Career International Grant	Protecting and conserving endangered conifers: An international collaborative effort in New Caledonia	PI
2016	$105,315	Climate Change Seed Grant	Pine Forest Health in the Future: Discovering Biological Drivers of Disease Ecology in a Changing Climate	PI
2014	$44,126	McIntire-Stennis Mini Grant	Host-pathogen interactions and understanding tolerance in the laurel wilt pathosystem	PI

2014	$52,095	UF/IFAS Infrastructure Grant	Modernization and upgrades to forest entomology and pathology labs	Co-PI
2014	$74,300	UF/IFAS Infrastructure Grant	Improving the Foundation for Natural Resources Research in IFAS – A Proposal to Modernize Facilities	PI
2013-2014	$11,697	UF Faculty Enhancement Opportunity	Collaboration on forest health in New Caledonia	PI
2012	$35,233	UF/IFAS Infrastructure Grant	Improving forest health diagnostic capacity in SFRC	PI
2012-2013	$3,000	IFAS-Dean for Extension	Diagnosis of pine blight in central Florida	PI
2011-2012	$12,000	IFAS Extension Enhancement Grant	Protecting the trees we love: Florida Urban Tree Health Program	PI
2011-2012	$29,188	SFRC Mini-grant Program	Unraveling the fusiform rust pathosystem in *Quercus*: The key to future durable disease management	PI
2011-2012	$15,000	UF-IFAS Dean For Research/SFRC	Assessment of potential biological control of the laurel wilt pathogen, *Raffaelea lauricola*	PI
2010-2011	$30,000	UF-IFAS Dean For Research	Evaluation of wood chips as a pathway for spread of the redbay ambrosia beetle and the laurel wilt disease pathogen	PI
2007-2008	$34,000	IFAS Innovation Fund	Map-based cloning of *AvrFr1* from *Cronartium quercuum* fsp. *fusiforme*.	Co-PI

Summary of Internal Grant Funding, 2006-Present

Role	**Total**	Direct Costs	Indirect Costs
Principal Investigator	$493,442	$493,442	0

d. **Submitted - Pending Decision**

Effective Date	Amount	Funding Agency	Project Title	Role(my share of grant)
6/1/2017-5/31/2019	$97,842	USDA-Forest Service	Restoring redbay lost to laurel wilt: A silvicultural approach with tolerant germplasm – Cooperative Proposal Between UF & USDA FS/ R8 FHP	PI
8/15/2017-8/14/2020	$1,197,298	USDA-NIFA	Genome-editing of elite *Populus deltoides* (eastern cottonwood) cultivars for disease resistance	Co-PI

d. In-kind contributions.

I was a Co-PI on a proposal to the U.S. Department of Energy's Joint Genome Initiative Community Sequencing Program to sequence the genome of *Cronartium quercuum* fsp. *fusiforme.* After submitting a letter of intent, our project was chosen for full submission and awarded in 2009. The total value of the resources generated (DNA sequences data and expression libraries) from this project exceeds $3 million.

e. Monetary (SHARE) contributions. In 2015, Bartlett Tree Experts donated $150,000 to my program for forest pathology research.

UNIVERSITY GOVERNANCE AND SERVICE

a. University of Florida

2017-present	Plant Science Research and Education Unit (PSREU) Advisory Council
2008-present	UF/IFAS EDIS publications, reviewer
2007-present	Emerging Pathogens Institute, affiliate faculty member,
2010-present	Doctor of Plant Medicine Program Coordinating Committee, member

2011-present	Natural Areas Teaching Laboratory Committee
2012	Sponsored Programs, New PI Reporting System Consultant
2011-2014	UF Faculty Senate: Lakes, Vegetation and Landscape Committee, member
2012-2014	UF Faculty Senate: Lakes, Vegetation and Landscape Committee, Chair
2012-2104	UF Infrastructure Council, Member
2013-2014	UF Asset and Property Management Committee, member
2011-2014	UF Faculty Senate: Land Use and Facilities Committee, member
2013-present	Tree Campus USA Project Advisor

b. College of Agricultural and Life Sciences

2007-2013	Marshal, CALS Graduate and Undergraduate Commencement

c. School of Forest Resources and Conservation

2015-present	Graduate Student, Stakeholder and Alumni Awards Committee
2016	Arboriculture position search and screen committee, member
2016	Genetic Resources of Insect and Disease resistance search and screen committee, member
2015	Resistance and Resilience Silviculture Search and Screen Committee, member
2014-15	Teaching Peer Evaluation Committee Chair for Jiri Hulcr
2013	Teaching Peer-Evaluation Committee for Wendell Cropper
2012	Operations Manager Position, Search and Screen Committee, member
2011	Forest Entomology Faculty Position, Search and Screen Committee, member
2010	Marine Ecology and Diseases Faculty Position, Search and Screen Committee, member

2010	IFAS/Research Innovation Fund Review Panel
2010	Teaching Peer-Evaluation Committee for Leda Kobziar
2007-present	John Gray/Spring Symposium Committee, member
2007-2010	SFRC Seminar Organizing Committee, member (*ad hoc*)

CONSULTATIONS OUTSIDE THE UNIVERSITY[1]

Date	Location	Work performed	Organization/ Employer
2017	Gainesville,FL	Updating invasive species factsheets	CABI
2017	Columbus, MS	Pine defoliation diagnosis and consulting	Weyerhauser Inc.
2016	Columbus, GA	Pine decline diagnosis and consulting	Rayonier Inc.
2013-15	New Caledonia	Conservation and disease of endangered conifers	Conservation International
2015	Athens, GA	Reviewer for B. Mayfield	USDA-Forest Service, Region 8, FHP
2014	Gainesville, FL	Laurel wilt recovery plan for redbay and related forest species	USDA-ARS, Plant Recovery System
2014	Gainesville, FL	Scot's pine blister rust recovery plan	USDA-ARS, Plant Recovery System
2013	Gainesville, FL	Peer reviewer for USDA-Forest Service research scientist promotion	USDA-Forest Service
2010	Panama City, FL	Peer reviewer for 5-year species recovery plan for Florida torreya (*Torreya taxifolia*)	U.S. Fish and Wildlife Service
2010	Gainesville, FL	Consultation for pathogen detection in seeds	USDA Seed Laboratory

2009	Gainesville, FL	Contributor, reviewer and author for recovery plan for redbay (*Persea borbonia*) for National Plant Disease Recovery System (NPDRS) called for in Homeland Security Presidential Directive Number 9 (HSPD-9)	USDA
2009	Gainesville, FL	Experiment Station program peer reviewer for Dr. Andrew David, University of Minnesota	University of Minnesota
2009	Gainesville, FL	Focus Group on Laurel Wilt of the National Plant Disease Recovery System (NPDRS), USDA, January, 2009. Gainesville, FL (by conference call). Research and regulatory priorities for laurel wilt disease in the United States	USDA
2009	Mangilao, Guam	Diagnosing and managing ironwood decline in Guam and neighboring islands	University of Guam
2008	Starke, FL	Diagnosing and managing diseased slash pine forest stands	RMK Timberland Group

[1]These consultations were unpaid, voluntary activities.

EDITOR OF SCHOLARLY JOURNAL, SERVICE ON EDITORIAL ADVISORY BOARDS, REVIEWER FOR SCHOLARLY JOURNALS

a. Editor

2010-present Associate Editor, international journal *Forest Pathology* (Wiley-Blackwell Publishing); 6-10 manuscripts reviewed per year

INTERNATIONAL ACTIVITIES

Australia – My research on laurel wilt has led to collaborations with scientists within CSIRO in Australia to use the molecular diagnostic protocols developed by my laboratory. Collaborators from CSIRO will visit my laboratory in March, 2011 to get training in laurel wilt diagnostics.

Brazil – I have been working with USDA-APHIS and agencies in Brazil to develop phytosanitary regulatory guidelines for the importation of *Populus deltoides* seeds from the United States. I am also collaborating with Dr. Jack Putz, Botany Department, UF on understanding the dynamics of tree decay in forest stands in Brazil.

Canada – I have an ongoing relationship with Dr. Philip Northover, plant pathologist with the Manitoba Department of Agriculture and Philip Ronald, owner of a major nursery in Canada to deal with Bronze Leaf Disease of *Populus*. We have been working together to improve our understanding of the disease, develop clones with resistance and educate the public about this destructive pathogen.

In addition, I am working with Dr. Robert Blanchette, University of Minnesota and personnel from Parks Canada to investigate the biology and impact of rust diseases on *Salix* species in the Canadian high arctic.

Collaborations are underway with Dr. Richard Hamelin, Canadian Forestry Service on molecular barcoding of *Melampsora* species affecting Salicaceae hosts.

France – My research on detecting *Fusarium* spp. in seeds has led to a collaboration between the USDA and the REINFORCE project in France to use our methodology to test seedlots of North American conifers to be exported to France.

Iran – I am working with Dr. Mohsen Damadi at Tabriz University on biology and diversity of rust diseases of trees in Iran. I have been providing Dr. Damadi with technical expertise and training on DNA analysis for phylogenetic studies. This work has led to identification of a new species of rust fungus causing stem cankers on willows (see publication in Section 16I)

Japan – In spring of 2012, I hosted Dr. Kazu Futai as a visiting scholar in my laboratory. Dr. Futai is an international expert on wilt diseases from Japan and this visit ended in mutual adoption of a memorandum of understanding that will encourage collaboration and exchange of information between the two institutions.

New Caledonia – I am collaborating with researchers at the Atlanta Botanical Garden, Montgomery Botanical Center and the government of New Caledonia to diagnose and manage decline of endangered conifers including *Araucaria humboldtensis* on Mount Humboldt, New Caledonia. We evaluated samples and a field trip took place in 2014. Work continues on this collaboration in 2016-17.

Peru – I hosted a group of forest pathologists and entomologists from Peru that visited Florida to learn more about forest health research.

South Africa – I am collaborating with scientists at FABI, University of Pretoria, South Africa on laurel wilt and eucalyptus diseases. I have served on two PhD committees of students at FABI and visited the institute in May, 2011. In 2012, my PhD student (Tyler Dreaden) spent 3 months at FABI working on a collaborative project. I have also served on the committee of a student at the University of Stellenbosch.

Sweden – I am serving as the external reviewer of a PhD student at SLU in Uppsala, Sweden and collaborating with Dr. Jan Stenlid there. qI visited the university twice in 2015, giving two invited talks and serving as the PhD opponent.

Turkey – In fall of 2012, I hosted Dr. Yusuf Yanar (a visiting scholar from Turkey) in my laboratory.

Yale Environment 360

A rare mature torreya on a street in Madison, Florida, which appears to be unaffected by a fungal blight that has wiped out nearly the entire species. JASON SMITH

CONSERVATION

For Endangered Florida Tree, How Far to Go to Save a Species?

The Florida torreya is North America's most endangered conifer, with less than one percent of its population remaining. Now, scientists are mounting a last-ditch effort to save the torreya and are considering using new gene-editing technologies to protect it.

BY JANET MARINELLI

MARCH 27, 2018

Edward O. Wilson clambered partway down a slope in the Florida Panhandle, aided by a park ranger and trailed by a few dozen scientists, conservationists, and local landowners. The group had gathered in Torreya State Park, a landscape of dazzling botanical diversity along the upper Apalachicola River, as part of a whirlwind two-day meeting early this month to ponder the fate of its most storied tree. As the wind gusted through leafless branches, the lanky, white-haired Wilson, at 88 years of age still one of the most brilliant biologists of his generation, planted a seedling of the Florida torreya, North America's most endangered conifer.

Wilson first visited the Apalachicola bluffs in 1957, as a self-described "young guy" with a new position at Harvard University, on an ant-collecting trip in Florida. "I came here," he recounted, "the way you would go to Paris to visit a cathedral. I just had to see the torreya." The trees had already begun their steep decline.

More than 60 years later Wilson was back. This time he declared the site "is not only a cathedral, but also a battleground at which one of the greatest events in American history will take place" – a turning point, as he sees it, in the planetary struggle to slow biodiversity loss.

Last spring, another "young guy" was at Torreya State Park on a camping trip with his lab. University of Florida forest pathologist Jason Smith "couldn't believe how much worse the torreyas were" than when he had seen them the year before. "The population was crashing." Smith, who has reddish brown hair and a bundle of energy, decided to assemble a team to reflect on the meaning of the species' imminent demise, to catalog the "torreya tree of life" – all living things with which it associates in the wild – and to plan a last-ditch effort to save it.

"This is a now or never moment for the species," he says.

Does it make sense to save a tree like the torreya

that has a tiny historical range and no commercial value?

While the massive wildfires and tree die-offs out West have gotten most of the press in recent years, the Eastern forests are also in crisis. An increasing number of the region's iconic native trees are plagued by pests and pathogens introduced from abroad. This has researchers scrambling to find genes that can help impart resistance, and to breed them into the ailing trees. Because classical crossbreeding takes decades – perhaps too long for a critically endangered species like the torreya – options once unimaginable as conservation measures are now being considered, including the new group of gene-editing technologies called CRISPR that has taken the biotech world by storm.

The growing forest health crisis is forcing scientists, conservationists, and the public to answer some of conservation biology's thorniest questions. Will we be able to use biotechnologies on the frontier of plant science to rescue imperiled species? Should we? And when so many species are at risk, does it make sense to go to extraordinary lengths to save a tree like the Florida torreya that has a tiny historical range and no commercial value?

Not long ago, *Torreya taxifolia*, as the tree is technically known, cast an evergreen veil over its historical habitat, a short stretch of sharp-sloped ravines called steepheads, some of which plunge at inclines close to 45 degrees – enough to induce wooziness in Floridians accustomed to pancake-flat terrain. In a vast biotic convergence, the tree mingled with massive southern magnolias, fan-leafed palmettos and other subtropical plants as well as northern denizens such as beech, hickory, and maple driven to the Panhandle over the eons by glaciers. As many as 650,000 torreyas once lived here.

Conservationists and scientists, including biologist E.O. Wilson (center, with microphone), gathered in Torreya State Park this month to discuss strategies to save the beleaguered Florida torreya tree. CAMILA GUILLEN, UF/IFAS

In the 1800s, local inhabitants used the conifer to make fence posts and shingles and to fuel the steamboats that plied the Apalachicola. Sometime around World War II, the remaining trees were attacked by a fungal blight and began their catastrophic dieback. The Florida torreya has been trapped in a purgatory-like adolescence ever since. Saplings sprout from old roots, only to succumb to the disease before they are mature enough to reproduce.

At the meeting earlier this month, Rob Nicholson, collections manager at Wellesley College Botanic Garden, told the assembled group about the torreya's tangled

history with humans. In the words of Nicholson, who journeyed to the Apalachicola bluffs from Harvard's Arnold Arboretum in 1989 to help survey the trees and collect cuttings, the torreya was once "a beautiful, shaggy pyramid, some fifty feet high and cloaked with glossy evergreen needles." The species, he wrote at the time in *Natural History* magazine, "was going extinct before our eyes."

Today, said Emily Coffey, vice president of conservation and research at the Atlanta Botanical Garden, "only 0.22 percent of the population is left." Since 1990, her organization has led the effort to create a life support system for the species by safeguarding it in cultivation. They have been so successful that the largest population of Florida torreyas, more than 800 specimens, now resides not in the steepheads, but rather a modern-day ark of pots, propagation beds, and experimental plantings at a handful of sites in northern Georgia. The Atlanta Botanical Garden and partner organizations have managed to preserve much of the species' genetic diversity, protecting some 441 genetically distinct individuals in cultivation. The idea is to use the plants to restore the species in the wild.

Safeguarding the torreya has been staggeringly complex. Unlike most plants, the tree has so-called recalcitrant seeds, which cannot be preserved in conventional seed banks because they can't survive drying. This necessitated the development of a tissue-culture system for the species called somatic embryogenesis. Embryos are surgically removed from fully developed seeds, then cultured in vitro to encourage the formation of multiple embryos. These can be safely preserved in a new cryogenic storage unit obtained by Atlanta Botanical Garden, in which the resulting plantlets are coaxed into a state of suspended animation at -321° Fahrenheit in liquid nitrogen.

Saving the torreya in its Florida Panhandle home will require outsmarting the pathogen that is killing it.

Ultimately, however, saving the torreya in its steephead home will require outsmarting the pathogen that is killing it. Although a number of fungal diseases were found to be afflicting the trees to some extent, the lethal pathogen remained elusive. But in 2010, Jason Smith discovered the culprit, *Fusarium torreyae*, a fungal pathogen new to science. Evidence suggests that it was introduced from China. If no action is taken, the tree will go extinct along the Apalachicola, "probably in 50 years," Smith says.

For the past two decades, the Florida torreya has been not only a symbol of fungal pathogens run amok, but also a poster child for assisted migration, the deliberate movement of a species suffering from climate change to more favorable habitat

outside its historical range. The tree is widely believed to be an Ice Age relict that once grew farther north but became trapped in the steepheads when the last glacier retreated. In fact, torreyas planted as far north as Ohio are producing seed. However, a study by one of Smith's graduate students suggests that *Fusarium torreyae* may also be deadly to a number of trees that are native to the southern Appalachians. "It could be that climate change is stressing the torreyas," says Smith, "making them even more susceptible to the disease." But in order to prevent the spread of the pathogen, he says, "we have to deal with the disease first."

ALSO ON YALE E360

As the world warms, how do we decide when a plant is native? Read more.

At the meeting early this month, Dana Nelson, a forest geneticist at the U.S. Forest Service Southern Research Station in Kentucky, reeled off a long list of Eastern trees suffering from exotic bugs and blights. One of them, the emerald ash borer, an iridescent green beetle from northeastern Asia, has killed hundreds of millions of ash trees, including virtually all the ashes in Michigan, where it was discovered in 2002. In the Appalachians, vast tracts of Eastern and Carolina hemlock have been decimated by the hemlock woolly adelgid, a tiny, fuzzy white insect native to East Asia.

Florida torreyas are dioecious, meaning female cones and male cones (seen here) are produced on separate plants in the spring. ATLANTA BOTANICAL GARDEN

One of the first trees to succumb to an introduced blight was the American chestnut, which once painted forests from Maine to Mississippi snowy white when it bloomed in spring. Around the turn of the 20th century, the species was struck by a fungal pathogen imported from Asia. Within 50 years, billions of trees were killed. A forest dominant that once grew up to ten feet wide and soared 100 feet to the top of the forest canopy, American chestnut now clings to life, like the Florida torreya, by sending up spindly stump sprouts.

Smith hopes to use the quest to save the American chestnut as a model for the imperiled torreya. When it was his turn to address the meeting, Jared Westbrook, a forest geneticist who became director of science at the American Chestnut Foundation in 2015, chronicled the group's 90-year struggle to breed resistance into the species.

Efforts began with traditional crossbreeding of American chestnut with its close relative, the Chinese chestnut, which evolved with the pathogen and finds it a minor nuisance. The painfully slow process of back-crossing the resulting hybrids with pure American chestnut over six generations to remove as many foreign genes as possible has yielded trees that are 94 percent American chestnut. "Right now,"

said Westbrook, "the trees have intermediate levels of resistance."

To ramp up the resistance, the foundation hopes to breed these trees with a transgenic chestnut developed at the State University of New York's College of Environmental Science and Forestry. To create the transgenic variety, one wheat gene was inserted into the species' gene pool to disarm the fungus. In the words of lead researcher William Powell, the result is "a plant that is 99.9997 percent American chestnut." Breeding must wait until the transgenic chestnut completes its lengthy federal regulatory review.

A torreya seedling (left) planted by E.O. Wilson. Researchers (right) collect samples from a dead torreya tree in Florida to study the *Fusarium torreyae* fungus. CAMILA GUILLEN, UF/IFAS

Although few scientists fear that the transgenic chestnut would result in a "super tree" capable of overrunning Eastern forests, the public is still jittery about genetic engineering. An impartial committee has been convened by the National Academy of Sciences to study "the potential of biotechnology to address forest health." Its report is expected at the end of this year.

ALSO ON YALE E360

Should genetic engineering be used as a tool for conservation? Read more.

In part to sidestep the controversy, Smith is hoping to use CRISPR to, in his words, "toggle up" disease resistance in the Florida torreya's own genes. Given the tree's imminent extinction along the Apalachicola, he says, "regular breeding is too slow." CRISPR exploits a natural ability of bacterial immune systems to identify and disable invading viruses. Scientists create short RNA sequences that attach to corresponding sequences in the receiving species' DNA. This molecular guidance system is paired with an enzyme that originally was designed to snip the DNA, "knocking out" a targeted gene. Using modified versions of the enzyme, it is now possible to activate or increase gene expression.

Just a few years ago, when CRISPR appeared on the biotech scene, it was a messy business. Scientists whacked DNA with all the finesse of a molecular machete, often triggering not just the desired snips, but a hodgepodge of unintended genetic changes, dubbed "off-target effects." Yet as researchers around the world have continued to fine-tune the technology, fears of CRISPR gone out of control have begun to fade. The technology is already being used to confer crops with everything from drought resistance to longer shelf life.

CRISPR gene-editing technology has never before been used to restore a tree species' fitness for life in the forest.

Still, an easy techno-fix for Florida torreya is unlikely anytime soon. John Davis, associate dean for research at the University of Florida and a member of the steering committee of the Forest Health Initiative, points out that if by chance there is natural resistance in the Florida torreya, plant production for breeding via seed, cuttings, or tissue culture would need to vastly increase. What's more, CRISPR has never before been used to restore a tree species' fitness for life in the forest. "This would require more research," he says.

As the meeting disbanded, Smith and other researchers resolved to begin the hunt for resistance genes. The horticulturists and scientists responsible for safeguarding the species in cultivation said their highest priority is continuing the search for additional genetic diversity in as-yet-unidentified torreyas on private property. Local community members declared they would work with their neighbors to facilitate the search for these remaining trees. Because unique species of fungi, which, in Smith's words, "rule forest trees, both in life and in death," are often associated with a particular tree, University of Minnesota forest pathologists left with vials of soil and dead and living wood. They will analyze the contents to determine whether "an extinction vortex" is underway within the torreya's ecological community.

As Nicholson pointed out, the genus *Torreya* is one of the most ancient groups of plants still in existence, dating back 175 million years to the mid-Jurassic period. But four of the six remaining *Torreya* species, including the Florida native's closest relative, California nutmeg, are on the IUCN's Red List of threatened species and may not survive modernity.

"Every scrap of biological diversity is priceless, to be learned and cherished, and never to be surrendered without a struggle," Wilson wrote in his 1992 book *The Diversity of Life*. At the meeting, he pledged to dedicate his remaining years to raising the global extinction crisis "to the same level of urgency as slowing climate change."

"As biodiversity continues to hemorrhage all around us," Wilson said, "we face a momentous moral decision that can be put in the form of a question: What kind of a species are we to treat the rest of life so cheaply?" This, he added, "is not only a moral issue but an issue of survival." He then posed another question: "What will

future generations think about how we have acted so carelessly?"

Janet Marinelli is an award-winning independent journalist who was director of scientific and popular publications at Brooklyn Botanic Garden for 16 years. She has written and edited several books on imperiled species and the efforts to save them. She also covers ecological approaches to creating resilient landscapes and communities. Her articles have appeared in a variety of publications, from *The New York Times* and *Audubon* to *Landscape Architecture* and *Kew* magazine. **MORE →**

wbur Here & Now

'Bert The Tree' Headed For The Chipper

03:48

August 14, 2015

In Gainesville, Florida, a 200-year-old tree that students have named "Bert" appears to be slated for destruction.

The tree, which is one of the largest heritage bluff oaks in Florida, has become the focus of a debate between students and the University of Florida's administration over plans to build a $50 million engineering building.

Here & Now's Robin Young talks to **Jason Smith**, a professor of forest pathology who has been an active participant in the fight to save Bert.

Guest

INSECTS · July 13th, 2017

Beetle threatens Florida avocado industry

By **Willie James Inman, Fox News**

Beetle threatens Florida avocado industry

Experts say the redbay ambrosia beetle has helped eradicate over 300 million redbay trees since it was discovered in Georgia in 2002

A beetle smaller than a grain of rice could have a huge impact on the agriculture industry in the southeast. The female redbay ambrosia could be deadly for avocado trees and other laurel species plants if left unchecked.

According to researchers, the insect has killed nearly 300 million redbay trees and could devastate the Florida avocado industry. The insect is not native to North America and was first discovered in Georgia in 2002. It has now spread across the region impacting Arkansas, Florida, Louisiana, Mississippi, and Texas.

"It's a species from Asia that was likely introduced through the port of Savannah, Georgia," John Riggins, an associate professor of forest entomology at Mississippi State University told Fox News. He believes the bug was probably brought to the United States inside imported wood.

WHY ALLIGATOR ATTACKS ARE SPIKING IN FLORIDA

Riggins warns the insect could also threaten other tree species used for cooking. "It brought along with it a species of fungus that causes a disease called laurel wilt. This disease impacts trees like avocados, sassafras, redbay and some other native species that we have."

Once a tree or bush becomes a host for the insect the female burrows deep into its victim spreading the fungus, which is deadly to the trees and bushes. The host will then begin to wilt and die after a few weeks to a month. Offspring and clones of the redbay beetle use the fungus as a food source.

The insect can reproduce rapidly both asexually and by mating with males including its own male

offspring, according to Riggins. A majority of the bugs detected at different locations were identical to other beetles found elsewhere.

BEWARE FIRE ANT COLONIES FLOATING ON FLOODWATERS, ALABAMA RESIDENTS WARNED

Riggins says controlling the beetle hasn't gone well but trees could be injected with fungicide before the infection occurs.

Jason Smith, a forest pathologist from the University of Florida School of Forest Resources and Conservation is an expert on the deadly fungus.

"We know that this enormous number of trees has been killed from a single-strain organism. That is unprecedented in biology," Smith said in a statement. "It was a pretty significant surprise for us to discover there was no genetic variation and a single-strain pathogen vector system has caused such diverse and severe damage across the landscape."

The spread of the redbay ambrosia beetle could have a major economic impact on the avocado industry. California accounts for the overwhelming majority of U.S. production of avocados with over $295 million in value with Florida at just over $19 million in production of the popular fruit. The beetle invaders could also jump the border into Mexico, which grows the majority of the world's avocados.

SCIENTISTS DISCOVER 'ALIEN' INSECT IN AMBER FROM 100 MILLION YEARS AGO

Avocados are not the only food ingredients that could be wiped out by the beetle invaders. Bay leaf and sassafras trees and plants are also on the bug's nesting list. Sassafras is used to make a powder used in file gumbo.

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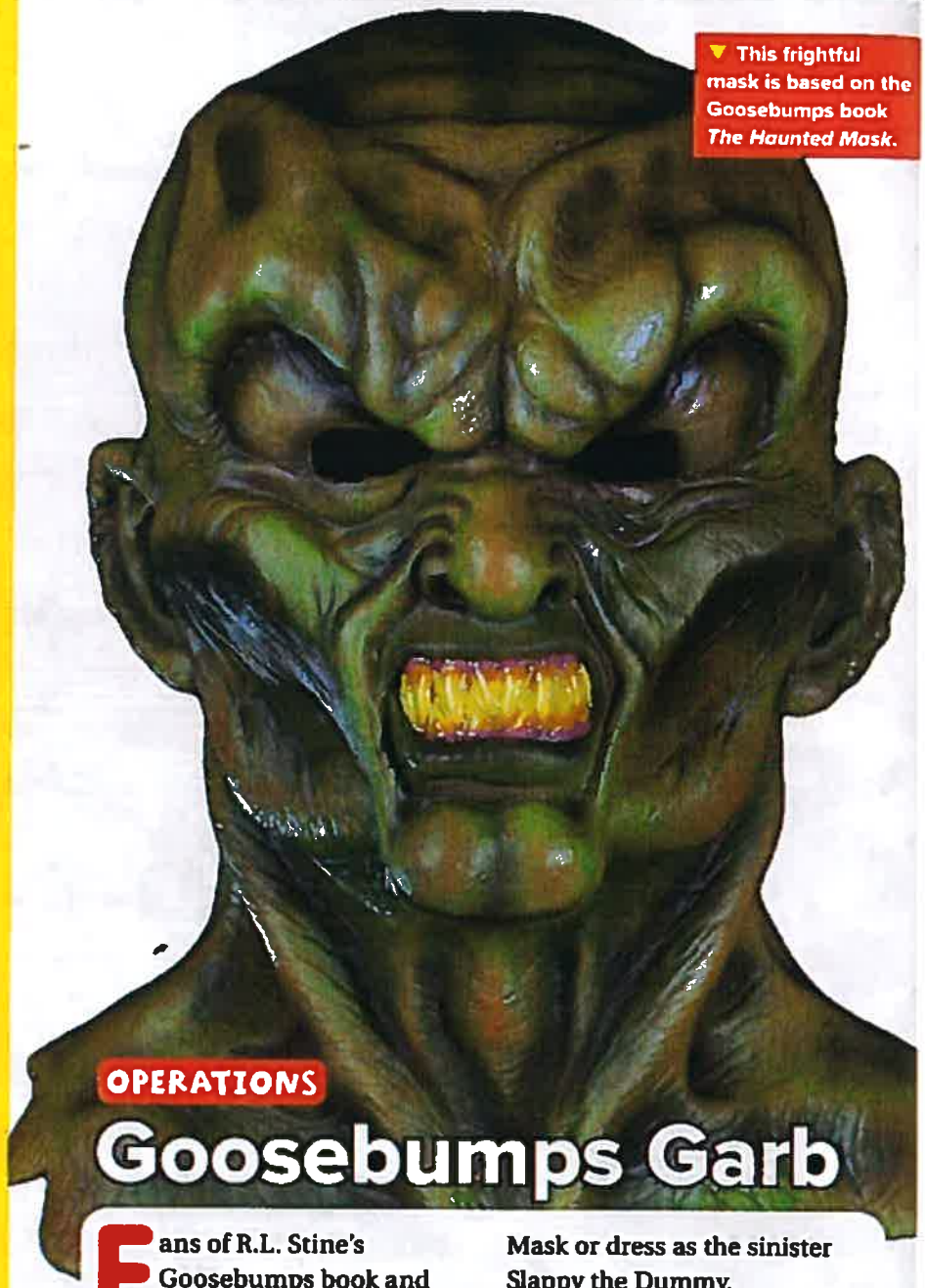

▼ This frightful mask is based on the Goosebumps book *The Haunted Mask.*

OPERATIONS

Goosebumps Garb

Fans of R.L. Stine's Goosebumps book and TV series can now dress up like their favorite creepy character with a new line of masks inspired by the stories. A Halloween mask company and Scholastic (the publisher of *DynaMath*) created the masks.

This Halloween, trick-or-treaters can wear a Haunted Mask or dress as the sinister Slappy the Dummy.

? A Slappy the Dummy full-head mask costs $50. The Haunted Mask costs $60. If you and a friend have a total of $100, could you afford both? If not, how much more money would you need?