

# THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

*Record of the Year*

2020-2021



# CAES

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The Connecticut Agricultural Experiment Station

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*Putting Science to Work for Society since 1875*

The Connecticut Agricultural Experiment Station, founded in 1875, was the first state agricultural experiment station in the United States. The Station has laboratories, offices, and greenhouses at 123 Huntington Street, New Haven 06511, Lockwood Farm for experiments on Evergreen Avenue in Hamden 06518, the Valley Laboratory and farm on Cook Hill Road, Windsor 06095, and a research center in Griswold and Voluntown. Station Research is conducted by members of the following departments: Analytical Chemistry, Entomology, Environmental Sciences, Forestry and Horticulture, Plant Pathology and Ecology, and the Valley Laboratory. The Station is chartered by the Connecticut General Statutes to experiment with plants and their pests, insects, soil and water and to perform analyses.



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## BOARD OF CONTROL

The management of The Station is vested in a Board of Control as specified in section 22-79 of the General Statutes of Connecticut.

The members of the Board of Control as of June 30, 2021 were:

Governor Ned Lamont, President  
Terry Jones, Vice President  
Dr. Michael P. O'Neill, Secretary  
Dr. Jason C. White, Director  
Commissioner Bryan Hurlburt

Dr. Erol Fikrig  
Ms. Joan Nichols  
Dr. Frederick M. Cohan  
Ms. Patti J. Maroney

The Board of Control met on August 5, 2020; October 14, 2020; January 19, 2021; and April 14, 2021.

## STATION STAFF

The Experiment Station exists to advance scientific knowledge, and that advance depends completely upon the quality and dedication of its staff. The following was the staff of The Connecticut Agricultural Experiment Station as of June 30, 2021.

### ADMINISTRATION

Dr. Jason C. White, Director  
Dr. Wade H. Elmer, Vice Director  
Michael P. Last, Chief Financial Officer  
Dianne F. Albertini  
Vickie M. Bomba-Lewandoski  
Sandra E. Carney  
Michael J. Cavadini  
Lisa L. Kaczinski  
Jennifer L. Stevens

### ANALYTICAL CHEMISTRY

Dr. Christian O. Dimkpa, Department Head  
Dr. Ishaq O. Adisa  
Michael A. Ammirata  
Terri Arsenault  
Dr. Brian D. Eitzer  
Dr. Walter J. Krol  
Dr. MaryJane Incorvia Mattina, Emeritus  
Craig Musante  
Kitty Prapayotin-Riveros  
John F. Ranciato  
Dr. Christina S. Robb  
Dr. Yu Shen  
Dr. Yi Wang  
Dr. Nubia Zuverza-Mena

### ENTOMOLOGY

Dr. Kirby C. Stafford III, Department Head  
Dr. John F. Anderson, Emeritus  
Tia M. Blevins  
Jamie L. Cantoni  
Mark H. Creighton  
Katherine D. Dugas  
Jeffrey M. Fengler  
Dr. Megan A. Linske  
Dr. Eliza A.H. Little  
Morgan Lowry  
Gerda Magana  
Dr. Chris T. Maier, Emeritus  
Dr. Gale E. Ridge  
Dr. Claire E. Rutledge  
Dr. Victoria L. Smith  
Dr. Kimberly A. Stoner

Heidi R. Stuber  
Tracy A. Zarrillo

#### ENVIRONMENTAL SCIENCES

Dr. Joseph J. Pignatello, Department Head  
Dr. Wael Abdelraheem  
Dr. Theodore G. Andreadis, Director Emeritus  
Dr. Philip M. Armstrong  
Dr. Douglas E. Brackney  
Angela B. Bransfield  
Gregory J. Bugbee  
Duncan W. Cozens  
Dr. Zannatul Ferdous  
Dr. Andrea Gloria-Soria  
Dr. Rebecca Johnson  
Noelle Khalil  
Jacquelyn LaReau  
Dr. Joseph R. McMillan  
Michael J. Misencik  
Dr. Goudarz Molaei  
Dr. Sara L. Nason  
Tanya A. Petruff  
Dr. Brij L. Sawhney, Emeritus  
Dr. Rohit Sharma  
John J. Shepard  
Summer Stebbins  
Dr. Blaire T. Steven  
Dr. Charles R. Vossbrinck  
Dr. Chengjin Wang  
Dr. Zhengyang Wang

#### FORESTRY AND HORTICULTURE

Dr. Jeffrey S. Ward, Department Head  
Joseph P. Barsky  
Dr. Martin P.N. Gent, Emeritus  
Dr. Susanna Keriö  
Dr. Abigail A. Maynard  
Michael R. Short  
Dr. Paul E. Waggoner, Emeritus  
Dr. Scott C. Williams

#### GRISWOLD RESEARCH CENTER

Robert J. Durgy, Research Farm Manager

#### LOCKWOOD FARM

Richard Cecarelli, Research Farm Manager  
Rollin J. Hannan

#### MAINTENANCE

Eric M. Wagner, Maintenance Supervisor  
Eric J. Flores

Brian Hart  
Ronald A. LaFrazier  
Miguel Roman  
Michael A. Scott

#### PLANT PATHOLOGY AND ECOLOGY

Dr. Wade H. Elmer, Vice Director, Department Head  
Dr. Sandra L. Anagnostakis, Emeritus  
Dr. Donald E. Aylor, Emeritus  
Dr. Zhouqi Cui  
Dr. Washington L. da Silva  
Dr. Sharon M. Douglas, Emeritus  
Dr. Francis J. Ferrandino, Emeritus  
Dr. Mohamed-Amine Hassani  
Regan B. Huntley  
Dr. Yonghao Li  
Dr. Robert E. Marra  
Dr. Neil A. McHale, Emeritus  
Dr. Ravikumar R. Patel  
Dr. Richard B. Peterson, Emeritus  
Dr. Neil P. Schultes  
Dr. Teja S. Shidore  
Dr. Stephen J. Taerum  
Dr. Lindsay R. Triplett  
Dr. Israel Zelitch, Emeritus  
Dr. Quan Zeng

#### VALLEY LABORATORY

Dr. James A. LaMondia, Department Head  
Dr. Jatinder S. Aulakh  
Dr. Carole A. Cheah  
Dr. Richard S. Cowles  
Jeffrey M. Fengler  
Rose T. Hiskes  
Dr. Srikanth Kodati  
Dr. DeWei Li  
Ethan Paine  
James J. Preste, Research Farm Manager  
Thomas M. Rathier, Emeritus  
Diane C. Riddle  
Michelle R. Salvas

## NEW SCIENTIFIC STAFF

### **Dr. Christian O. Dimkpa**



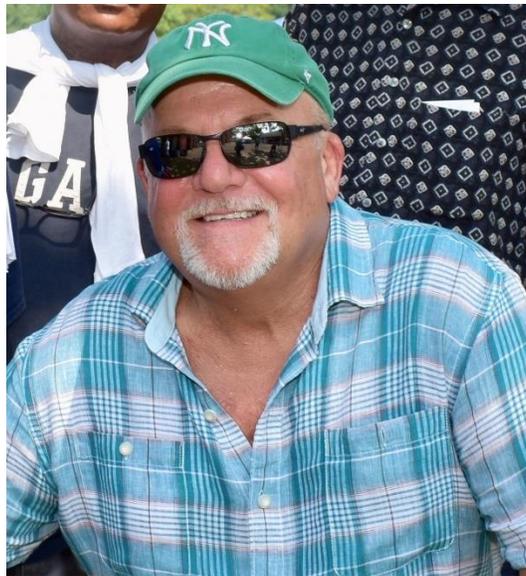
Dr. Christian O. Dimkpa assumed the position of Department Head of Analytical Chemistry on August 3, 2020. He came to the Station from the International Fertilizer Development Center based in Muscle Shoals, Alabama, where he was a Senior Scientist and worked on balanced nutrient fertilizer development and evaluation under a variety of agro-environmental conditions, such as drought. He coordinated research partnerships on USDA- and USAID-funded projects in the broad area of enhancing nutrient (nanoscale and conventional) use efficiency in different crop systems. Christian obtained his PhD in Bioenvironmental Science in 2009 from the University of Jena in Germany, under the auspices of the International Max Planck Research School of the Max Planck Institute for Chemical Ecology Jena.

## RETIREMENTS



### **Jane Canepa-Morrison**

Jane Canepa-Morrison started her CAES career at the Valley Laboratory on April 19, 1989, working for two different scientists, Dr. James LaMondia and Dr. John Ahrens. Little did she know how varied and diverse her career at the Station would be. In the early 1990s, she spent a half year in New Haven trapping mice and collecting ticks for Drs. Anderson, Magnarelli, and Andreadis before returning to Windsor and Dr. LaMondia where she worked in the field and in the laboratory conducting plant pathology, plant breeding, and nematology research. She became one of the few people in the region adept at nematode identification and diagnostics and was equally at home working in a shade tobacco tent, the laboratory, or in the office. In the office, Jane was the business office at the Valley Laboratory and coordinated equipment, supplies, inventory, and the needs of the entire Valley Laboratory with Dr. LaMondia and the New Haven Business Office. Everything that Jane did was done for the good of the Station and the Valley Laboratory. Jane made wherever she was working better, certainly neater, and more organized. She was always responsible and conscientious, courteous, and professional, whether dealing with colleagues or with the public. Jane retired on April 1, 2021, and is greatly missed for both her work and her personality.



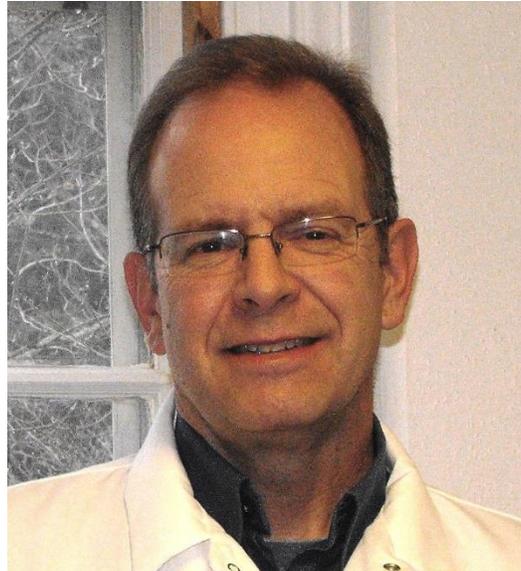
### **Michael McHill**

Mr. Michael McHill joined The Connecticut Agricultural Experiment Station on November 13, 2006. He was a valuable and dedicated member of the Lockwood Farm staff for almost fifteen years.

His commitment to the maintenance of the Lockwood Farm and the Station's grounds will be greatly missed. His dedication to preparing for fourteen Plant Science Days will always be appreciated. He earned

recognition as a Connecticut Accredited Nursery Professional from the Connecticut Nursery and Landscape Association in 2008. During his time at the Experiment Station, he performed many tasks such as fruit tree pruning, snow removal, mowing, leaf cleanup, research plot maintenance, pruning of ornamental trees and shrubs, garden installations, fertilizing, irrigating, and equipment maintenance.

We express our gratitude and appreciation to Michael McHill for all of his contributions to the Experiment Station. We wish him all the best in his retirement. May he continue to enjoy all of his hobbies and interests.



**Peter Thiel**

Mr. Peter Thiel came to The Connecticut Agricultural Experiment Station out of college in 1984. He had a mechanical mind, a green thumb, and a love of motorcycles. He has proudly served the State of Connecticut and the Station for 37 years.

Peter was an extremely conscientious, hard-working, loyal, and dedicated member of the Department of Plant Pathology and Ecology. Serving Dr. Donald Aylor for 23 years, and then Dr. Wade Elmer for another 14 years, Peter always provided outstanding, reliable, and invaluable support to his supervisors, staff, and colleagues. His unwavering commitment to detail and his thoroughness in completing any task at hand, helped to establish his reputation of excellence, which has followed him throughout his days at the Station. Whether it be counting spores, washing roots, or managing Plant Science Day vendors, Peter always gave 100%.

Peter's skill and talent along with his professional, friendly, and disarming personality are qualities that will be missed by everyone who worked with him.

A true public servant and ambassador for the Experiment Station and the State of Connecticut, we honor and express our sincere gratitude and appreciation to Peter Thiel for his extraordinary service on the occasion of his retirement.

# The Connecticut Agricultural Experiment Station

## 110<sup>th</sup> Plant Science Day - Virtual

### Wednesday, August 5, 2020

#### PLANT SCIENCE DAY 2020

Plant Science Day 2020 was a virtual event due to the global pandemic. A total of 231 guests viewed the morning session and 94 guests viewed the afternoon session.

In the morning session, Director Jason C. White gave the morning greeting and opening remarks, and presented the Connecticut Century Farm Award and the Connecticut Outstanding Young Farmer Award. Then there was a presentation by Mr. Skip Hobbs, President of the Experiment Station Associates, followed by the Samuel W. Johnson Memorial Lecture entitled “COVID-19’s Impact on CT’s Agricultural Industry,” which was presented by Mr. Bryan Hurlburt, Commissioner of the Connecticut Department of Agriculture.

Also during the morning session, welcome messages were given by Senator Richard Blumenthal, Senator Chris Murphy, Representative Rosa DeLauro, Lieutenant Governor Susan Bysiewicz, and Indrajeet Chaubey, Dean and Director of the UConn College of Agriculture, Health, and Natural Resources.

In the afternoon session, “Presentations on Research – Q&A,” Station scientists answered questions from viewers.

#### **AWARDS:**

#### CONNECTICUT CENTURY FARM AWARD

#### **Fish and Kent Farm Suffield, CT**

The Connecticut Century Farm Award is given to a farm that has been in family operation for more than 100 years. The recipient is selected by the Connecticut Agricultural Information Council (CAIC).

#### *Proclamation from Governor Ned Lamont:*

The site has been in agricultural use for 150 years and in the same family for more than a century. Andrew J. Fish, great-grandfather of the current owner, was in the Connecticut 12th Volunteers in the Civil War and purchased the farm in 1900. Andrew J. Fish did well with the farm until the Great Depression in 1928, when farming became difficult. They lost one of the tobacco sheds in the Hurricane of 1938. The stalls in the barn housed draft horses used for tobacco cultivation until the 1940s, the last tobacco crop was destroyed by the 1955 hurricane. The sheds were rented to General Cigar and tobacco fields were rented to the Coulter Dairy Farm. Strawberries and vegetables were sold to Winter’s Market in New Haven until the sixties. General Cigar rented the sheds until the 1960s. A second tobacco shed was lost due to arson in 1980. Today, one of the adjacent farms, the Sheldon Mel Farm, uses the last remaining shed for curing of tobacco. The

site had pigs in the 1940s-1950s and goats in the 1970s. The basement of the main barn was used for dairy up until the mid-20th century and the barn stalls were used for riding horses until the late fifties. In 2009, the development rights were sold to the state, ensuring that the land will remain open space. Currently, there are 8 acres of hay, hens, honey bees, and a small orchard, and 20 acres are rented to a local dairy farm for corn. A forest management plan was just completed for the approximately 45 acres of woodland, and trees will be harvested when lumber prices increase.

## CONNECTICUT OUTSTANDING YOUNG FARMER AWARD

**Jimmy Bloom**  
**Copps Island Oysters by Norm and Son, LLC**  
**Norwalk, Connecticut**

The Outstanding Young Farmer Award is given annually by the Connecticut Agricultural Information Council (CAIC), a coalition of state farming groups, as part of the festivities surrounding Connecticut Agriculture Day at the Capitol. Candidates are selected based on their achievements in their agricultural enterprises, involvement in the agriculture industry and their community, and their work on soil and water conservation projects.

*Proclamation from Governor Ned Lamont:*

Jimmy Bloom, along with his father at Copps Island Oysters, farm approximately 14,000 acres along the Connecticut coast from Greenwich to Stonington. Jimmy is part of a third generation oyster farming operation that has a dedicated focus not just on harvesting but also on continually regenerating beds in a sustainable fashion. Jimmy's love of shellfish farming began at the age of 2, when he would accompany his father on the deck of his oyster boat. That began a life-long love of oyster farming that continues to this day. Jimmy has also served on the Board of the Fairfield County Farm Bureau and the Connecticut Aquaculture Advisory Council. This award recognizes Jimmy's commitment to agriculture in Connecticut, both in the present and the future.

### SHORT TALKS:

Dr. Jeffrey S. Ward	Return of Multi-Year Defoliations in Southern New England
Dr. Walter Krol and Ms. Terri Arsenault	Industrial Hemp: An Emerging Crop in Connecticut
Dr. Kirby C. Stafford III	Plant Science Day Celebration: A History

### TECHNICAL DEMONSTRATIONS:

Mr. Gregory J. Bugbee and Ms. Summer Stebbins	Container and Raised Bed Gardening: Big Yields from Small Places
Dr. Scott C. Williams and Mr. Michael R. Short	Deer and Wildlife Control in Your Garden

### VIRTUAL BARN EXHIBITS:

- **Murder and Maggots: Introduction to Forensic Entomology**  
Dr. Kirby C. Stafford III and Dr. Gale E. Ridge, Department of Entomology

- **How Mosquito Feeding Behavior Impacts Disease Transmission**  
Dr. Doug Brackney and Dr. Philip Armstrong, Department of Environmental Sciences
- **Palmer Amaranth: A New Devastating Pigweed to Watch Out For**  
Dr. Jatinder S. Aulakh, Valley Laboratory
- **Soil Protists and Plant Health**  
Dr. Lindsay R. Triplett, Dr. Stephen Taerum, and Dr. Ravi Patel, Department of Plant Pathology and Ecology
- **Food and Feed Safety Investigations and Research at CAES**  
Dr. Brian Eitzer, Department of Analytical Chemistry
- **Healthy Forests, Healthy People**  
Dr. Scott C. Williams and Dr. Megan A. Linske, Department of Forestry and Horticulture

## **FIELD PLOTS:**

### Public Health:

1. **Tracking Ticks and Tick-Associated Diseases in Connecticut**  
Dr. Goudarz Molaei assisted by Ms. Noelle Khalil and Ms. Sarah Bonello
2. **An Integrated Tick Management Project for the Control of the Blacklegged Tick, *Ixodes scapularis***  
Dr. Megan A. Linske, Dr. Kirby C. Stafford III, Dr. Scott C. Williams assisted by Michael Short, Heidi Stuber, Hunter Badey, and Daniel Duque
3. **Statewide Monitoring Program for Mosquito-borne Viral Diseases in Connecticut**  
Dr. Philip Armstrong, Mr. John Shepard, Dr. Andrea Gloria-Soria, Ms. Angela Bransfield, Mr. Michael Misencik, and Ms. Tanya Petruff assisted by Mr. Greg Cooper, Mr. Patrick Daly, Ms. Amanda DeLucia, Mr. Neil Ferland, Mr. Ronald Ferrucci, Mr. Robert Fitch, Mr. Nicholas Grottole, Ms. Bethany Hoshcar, Ms. Alyssa Marini, Mr. Michael Olson, Mr. Anthony Perugini, and Ms. Hannah Sproch.

### Plant Health:

1. **The Cooperative Agricultural Pest Survey (CAPS) Program and Plant Protection Act Surveys**  
Ms. Gerda Magana
2. **Healthy Plants—Healthy Business: Support of The Green Industry by Inspection**  
Dr. Victoria Lynn Smith assisted by Ms. Tia Blevins, Mr. Mark Creighton, and Mr. Jeff Fengler
3. **Use of Engineered Nanomaterials to Improve Agricultural Production**  
Dr. Roberto De la Torre-Roche, Dr. Chuanxin Ma, Dr. Ishaq Adisa, Dr. Carlos Tamez, Dr. Yu Shen, Dr. Chun Song, Mr. Peter Thiel, Dr. Nubia Zuverza-Mena, Dr. Wade Elmer, and Dr. Jason C. White

4. **Use of Nanoparticles of Metal Oxides to Suppress Diseases of Plants**  
Dr. Wade Elmer, Dr. Renata C. M. Pereira, Dr. Chun Song, and Dr. Jason White assisted by Mr. Peter Thiel
5. **Use of Experimental Fungicides for Suppression of Fusarium Wilt of Chrysanthemum**  
Dr. Wade Elmer assisted by Mr. Peter Thiel
6. **Use of Nanoparticles of B, CuO, MnO, MoO<sub>4</sub>, Zn on Fusarium Crown Rot of Asparagus**  
Dr. Wade Elmer assisted by Mr. Peter Thiel
7. ***Phytophthora abietivora*, a New Species Isolated from Diseased Christmas Trees in Connecticut**  
Dr. De-Wei Li, Dr. Neil P. Schultes, Dr. James LaMondia, and Dr. Richard Cowles
8. **Understand Critical Colonization and Entry Points of an Important Apple Pathogen *Erwinia amylovora* During Invasion of Apple Flowers**  
Dr. Quan Zeng and Dr. Zhouqi Cui assisted by Ms. Regan B. Huntley
9. **Boxwood Blight**  
Dr. Srikanth Kodati

Environmental Health:

1. **Per- and Polyfluoroalkyl Substances (PFAS): An Emerging Class of Toxic Environmental Contaminants**  
Dr. Sara L. Nason and Dr. Nubia Zuverza-Mena assisted by Dr. Carlos Tamez
2. **Design of Biochars for Excess Nutrient Removal and Recycling**  
Dr. Joe Pignatello assisted by Dr. Philip Wang
3. **Pollinator Visitation Among Cultivated Varieties of Zinnias**  
Dr. Kimberly A. Stoner assisted by Ms. Morgan F. Lowry, Ms. Tracy Zarrillo, Mr. Benjamin Gluck, and Ms. Annie Bolduc
4. **Baseball Fields as Habitat: The Fauna of Our Overlooked Artificial Sand Plains**  
Dr. Claire Rutledge assisted by Ms. Tracy Zarrillo, Ms. Miaora Scott, and Ms. Ashley Martone
5. **Native Woody Shrubs**  
Dr. Jeffrey S. Ward assisted by Mr. Joseph P. Barsky, Ms. Katherine Overstrum, and Ms. Anna Welch
6. **Composting Leaves Using the Static Pile Method**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
7. **Sheet Composting with Maple and Oak Leaves**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori

New Crops:

1. **Grapevine Demonstration Plots**  
Drs. Francis Ferrandino, Washington da Silva, and Gale E. Ridge
2. **Hemp Demonstration Plot**  
Dr. Walter Krol, Ms. Terri Arsenault, Mr. Richard Cecarelli, Dr. Brian Eitzer, and Dr. Jason C. White
3. **Propagation of Figs**  
Dr. Charles R. Vossbrinck
4. **Hops - Variety Evaluation and Integrated Pest Management**  
Dr. James A. LaMondia and Dr. Srikanth Kodati assisted by Ms. Michelle Salvas

5. **Annual Production of Globe Artichokes**  
Dr. Abigail Maynard Assisted by Mr. Joseph Liquori
6. **Sweet Potato Trials**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
7. **Beach Plum Trials**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
8. **Pawpaw Trials**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
9. **Heirloom Tomato Variety Trials**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
10. **Storage Onion Trials**  
Dr. Abigail Maynard assisted by Mr. Joseph Liquori
11. **Establishing High-Yield Honey Companion Crops in Existing Christmas Tree Plantings**  
Dr. Richard S. Cowles and Dr. Jatinder S. Aulakh

Invasive Species:

1. **Biological Control of Hemlock Woolly Adelgid and Mile-a-Minute Weed**  
Dr. Carole Cheah
2. **Invasive Aquatic Plant Program**  
Mr. Gregory Bugbee assisted by Ms. Summer Stebbins, Mr. Matt Latella, and Ms. Maylani Velazquez

Kid's Corner

Outside Organizations:

Below are a number of non-profit organizations and Connecticut-based specialty vendors that typically have an exhibit at Plant Science Day. We would like to acknowledge them and invite you to explore their websites. They have varied and interesting missions, from local to nationwide.

Agrivolution, LLC: Innovation in Full-Spectrum Lighting

[www.agrivolution.co](http://www.agrivolution.co)

Mr. Richard Fu, President

[richard.fu@agrivolution.us](mailto:richard.fu@agrivolution.us)

140 George Road, South Windsor, CT 06074

(888) 789-6587

American Farmland Trust

[www.farmland.org](http://www.farmland.org)

Ms. Chelsea Gazillo

[cgazillo@farmland.org](mailto:cgazillo@farmland.org)

1 Short Street, Suite 2, Northampton, MA 01060

(413) 586-9330, fax (860) 683-4275

CT Christmas Tree Growers Association

[www.ctchristmastree.org](http://www.ctchristmastree.org)

Ms. Kathy Kogut, Executive Director

[wkogut@cox.net](mailto:wkogut@cox.net)

304 Parker Avenue, Meriden, CT 06450

(203) 641-1632, fax (203) 379-5054

CT College Arboretum

<https://www.conncoll.edu/the-arboretum/>

Ms. Maggie Redfern, Assistant Director

[arbor@conncoll.edu](mailto:arbor@conncoll.edu)

Box 5201, 270 Mohegan Avenue, New London, CT 06320

(860) 439-2144

CT Department of Energy and Environmental Protection (CT DEEP), Division of Forestry's Private & Municipal Lands Program

[www.ct.gov/deep/forestry](http://www.ct.gov/deep/forestry)

Mr. Frank Cervo, Service Forester, Eastern District

[frank.cervo@ct.gov](mailto:frank.cervo@ct.gov)

James L. Goodwin State Forest & Conservation Center

23 Potter Road, Hampton, CT 06247

Office (860) 455-0699, Cell (860) 930-5037, Fax (860) 424-4020

CT Department of Energy and Environmental Protection (CT DEEP), Wildlife Division

[www.ct.gov/deep/wildlife](http://www.ct.gov/deep/wildlife)

Ms. Laura Rogers-Castro, Natural Resource Educator

[laura.rogers-castro@ct.gov](mailto:laura.rogers-castro@ct.gov)

SWMMA, P. O. Box 1550, Burlington, CT 06013

(860) 675-8130

CT Department of Agriculture

[www.ctgrown.gov](http://www.ctgrown.gov)

Mr. Bryan P. Hurlburt, Commissioner

Rebecca Eddy, Marketing and Inspection Representative

[rebecca.eddy@ct.gov](mailto:rebecca.eddy@ct.gov)

450 Columbus Boulevard, Suite 703, Hartford, CT 06106

(860) 713-2503, fax (860) 730-8321

CT Environmental Council

[www.ctenvironmentalfacts.org](http://www.ctenvironmentalfacts.org)

Mr. Paul Sicilian, Executive Administrator

[ctec@ctenvironmentalfacts.org](mailto:ctec@ctenvironmentalfacts.org)

59 Rainbow Road, East Granby, CT 06026

(860) 586-7508, fax (860) 586-7550

CT Farm Bureau Association

[www.cfba.org](http://www.cfba.org)

Ms. Joan Nichols, Executive Director

[joann@cfba.org](mailto:joann@cfba.org)

78 Beaver Road, Suite 2A, Wethersfield, CT 06109

(860) 768-1100, fax (860) 768-1108

CT Farmland Trust

[www.ctfarmland.org](http://www.ctfarmland.org)

Ms. Brianna Dunlap, Development and Communication Manager

[outreach@ctfarmland.org](mailto:outreach@ctfarmland.org)

77 Buckingham Street, Hartford, CT 06106  
(860) 247-0202 x223, fax (860) 247-0236

CT Horticultural Society

[www.cthort.org](http://www.cthort.org)

Ms. Cheryl Marino

[office@cthort.org](mailto:office@cthort.org)

2433 Main Street, Rocky Hill, CT 06067

(860) 989-6149

CT Invasive Plant Working Group

<https://cipwg.uconn.edu/>

Ms. Charlotte Pyle, Co-Chairperson

[cpcpcp@sbcglobal.net](mailto:cpcpcp@sbcglobal.net)

c/o Victoria Wallace, UConn Extension, 562 New London Turnpike, Norwich, CT 06360

(860) 486-6448, fax (860) 486-0682

CT Occupational Safety and Health Act (Conn-OSHA)

[www.connosha.com](http://www.connosha.com)

Ms. Catherine Zinsser, Occupational Safety Training Specialist

[Catherine.zinsser@ct.gov](mailto:Catherine.zinsser@ct.gov)

38 Wolcott Hill Road, Wethersfield, CT 06109

(860) 263-6942, fax (860) 263-6940

CT Pomological Society

Ms. Kathy Spielman, Secretary/Treasurer

[CTPomologicalSociety@gmail.com](mailto:CTPomologicalSociety@gmail.com)

39 Spielman Road, South Windsor, CT 06074

(860) 608-8677

CT Professional Timber Producers Association (TimPro)

[www.timproct.org](http://www.timproct.org)

Mr. Brennan Sheahan, President

[brennan@ctmulch.com](mailto:brennan@ctmulch.com)

P. O. Box 508, Oneco, CT 06373

(860) 948-0432, fax (860) 844-8844

CT Tree Protective Association

[www.ctpa.org](http://www.ctpa.org)

Ms. Cathy Dvorsky, Executive Secretary

[cathy@ctpa.org](mailto:cathy@ctpa.org)

P. O. Box 1946, Wallingford, CT 06492

(203) 484-2512

Federated Garden Clubs of CT, Inc.

[www.ctgardenclubs.org](http://www.ctgardenclubs.org)

Ms. Arlene Field, President

[arfield2@earthlink.net](mailto:arfield2@earthlink.net)

1345 Whirlwind Hill Road, Wallingford, CT 06492

(203) 915-1980

Hamden Land Conservation Trust

[www.hlct.org](http://www.hlct.org)

Ms. Gail Cameron

[hamdenlandtrust@gmail.com](mailto:hamdenlandtrust@gmail.com)

P. O. Box 6185, Hamden, CT 06517

(203) 230-4838, fax (203) 785-5156

New England Society of American Foresters

<https://nesaf.org/about-us/divisions-chapters/connecticut-chapter/>

Mr. Nicholas Zito, CT Chapter Chair

[nicholas.zito@gmail.com](mailto:nicholas.zito@gmail.com)

Sleeping Giant Park Association

[www.sgpa.org](http://www.sgpa.org)

Ms. Julie Hulten

[outreach@sgpa.org](mailto:outreach@sgpa.org)

42 Homewood Avenue, North Haven, CT 06473

(203) 407-1818

The Big Dipper Ice Cream Factory

[www.bigdipper.com](http://www.bigdipper.com)

Mr. Harry Rowe, Owner

[harry@bigdipper.com](mailto:harry@bigdipper.com)

91 Waterbury Road, Prospect, CT 06712

(203) 758-3200

UConn IPM Team

[www.ipm.uconn.edu](http://www.ipm.uconn.edu)

Ms. Mary Concklin, Visiting Extension Educator, Fruit Production and IPM, IPM Program Coordinator

[mary.concklin@uconn.edu](mailto:mary.concklin@uconn.edu)

1376 Storrs Road, Unit 4067, Storrs, CT 06269-4067

(860) 486-6449

UConn Master Gardener Program

<http://mastergardener.uconn.edu/>

Ms. Jude Hsiang

[judith.hsiang@uconn.edu](mailto:judith.hsiang@uconn.edu)

305 Skiff Street, North Haven, CT 06473

(203) 407-3167, fax (203) 407-3176

US Dept. of Labor/Occupational Safety and Health Act (USDOL/OSHA)

[www.osha.gov](http://www.osha.gov)

Ms. Marianne Bonito, Compliance Assistance Specialist

[bonito.marianne@dol.gov](mailto:bonito.marianne@dol.gov)

McMahon Federal Building, 915 Lafayette Boulevard, Room 309, Bridgeport, CT 06604

(203) 579-5645, fax (203) 579-5516

US Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS, PPQ)

[www.aphis.usda.gov/plant\\_health](http://www.aphis.usda.gov/plant_health)

Mr. Eric Chamberlain, Plant Health Safeguarding Specialist  
[eric.a.chamberlain@aphis.usda.gov](mailto:eric.a.chamberlain@aphis.usda.gov)  
97 Barnes Road, Unit 200, Wallingford, CT 06492  
(203) 741-5643, fax (203) 741-5660

US Department of Agriculture (USDA), Farm Service Agency  
[www.usda.gov](http://www.usda.gov)

Ms. Teresa Peavey, County Executive Director  
[teresa.peavey@ct.usda.gov](mailto:teresa.peavey@ct.usda.gov)  
97 Barnes Road, Suite 2, Wallingford, CT 06492-1885  
(203) 269-6665, fax (855) 946-3967

US Department of Agriculture/Natural Resources Conservation Service Tolland/SoilSHOP (USDA/NRCS)  
[www.atsdr.cdc.gov/soilshop/index.html](http://www.atsdr.cdc.gov/soilshop/index.html)

Mr. Jacob Isleib, Resource Soil Scientist  
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344 Merrow Road, Suite A, Tolland, CT 06084  
(860) 871-4037, fax (855) 934-2776

US Dept. of Labor, Wage and Hour Division (USDOL/WHD)  
[www.dol.gov/whd](http://www.dol.gov/whd)

Ms. Heather Callahan  
Community Outreach and Resource Planning Specialist (CORPS)  
[callahan.heather@dol.gov](mailto:callahan.heather@dol.gov)  
William R. Cotter Federal Building, 135 High Street, Room 210, Hartford, CT 06103  
(860) 240-4160

Vernon E. Cleaves Agricultural Science & Technology Center at Lyman Hall High School  
[www.LHAgEd.org](http://www.LHAgEd.org)

Ms. Rebecca Rose  
[rose@wallingfordschools.org](mailto:rose@wallingfordschools.org)  
70 Pond Hill Road, Wallingford, CT 06492  
(203) 927-9193, fax (203) 294-5322

Wild Ones Mountain Laurel (CT) Chapter of Wild Ones: Native Plants, Natural Landscapes  
[www.wildones.org](http://www.wildones.org) (national org.)

Ms. Lydia C. Pan, President & Program Coordinator CT Chapter  
[wild.native.plants@gmail.com](mailto:wild.native.plants@gmail.com)  
c/o CT College Arboretum, 270 Mohegan Avenue, New London, CT 06320  
(860) 383-3580

Working Lands Alliance  
[www.workinglandsalliance.org](http://www.workinglandsalliance.org)

Ms. Chelsea Gazillo, Director  
[cgazillo@farmland.org](mailto:cgazillo@farmland.org)  
78 Beaver Road, Suite 2A, Wethersfield, CT 06109  
(707) 495-8223

## THE STATION IN THE COMMUNITY

### Harvest for the Connecticut Food Bank

Sponsored a harvest at Lockwood Farm on August 27 with the CT Hiking Friend Alliance to harvest fruits and vegetables for the Connecticut Food Bank.

## DONATIONS MADE TO THE COMMUNITY

### Lockwood Farm

A total of 22,893 pounds of fresh produce, including cabbage, eggplant, peppers, pumpkins, squash, tomatoes, and winter squash grown at Lockwood Farm were donated to Benchmark Senior Living, Connecticut Food Bank in Wallingford, Davenport Dunbar Home Pantry in Hamden, Hamden/North Haven YMCA in Hamden, Unitarian Society of New Haven in Hamden, and Waverly House in New Haven. Farm Manager Richard Cecarelli arranged for the distribution of the produce.

### Valley Laboratory

A total of 8,345 pounds of fresh produce including butternut squash, acorn squash, muskmelons, summer squash, sweet corn, tomatoes, peppers, and pumpkins grown at the Valley Laboratory were donated to Foodshare of Hartford. Mr. Preste, Drs. Abigail Maynard, and James LaMondia generated the fresh produce, and Jim Preste and Dr. LaMondia organized the distribution effort.

## AWARDS AND RECOGNITION RECEIVED BY STATION STAFF

On September 21, 2020, Dr. Nubia Zuverza-Mena accepted an invitation to join the journal *Biomolecules* as a Topic Editor.

On November 19, 2020, Mr. Gregory J. Bugbee received the District's 2020 Outstanding Environmental Project Award for invasive aquatic plant survey work and public outreach.

On December 1, 2020, Dr. Megan A. Linske was appointed adjunct faculty member at the University of Memphis.

On December 10, 2020, Drs. Quan Zeng, Sara Nason, and Zhouqi Cui were co-PIs on the winning 2020 Louis A. Magnarelli Postdoctoral Fellowship proposal entitled "Bacteria inter-species communication in soybean rhizosphere and its impact to plant fitness."

On December 30, 2020, Drs. Stephen J. Taerum, Blaire Steven, Daniel J. Gage, and Lindsay Triplett's paper published in *Phytobiomes Journal* entitled "Validation of a PNA clamping method for reducing host DNA amplification and increasing eukaryotic diversity in rhizosphere microbiome studies" was selected as Editor's Pick.

On January 14, 2021, Mr. Gregory J. Bugbee was elected President of the Northeast Aquatic Plant Management Society.

On February 1, 2021, Dr. Jason C. White received an FDA Group Recognition Award for being a member of the FDA Laboratory Flexible Funding Model Workgroup.

On February 4, 2021, Dr. Jason C. White was appointed to the Farmland Preservation Advisory Board.

On February 23, 2021, Dr. Jason C. White was elected to the Connecticut Academy of Science and Engineering (CASE).

On February 26, 2021, Dr. Jason C. White was given the inaugural 2020 *Environmental Science & Technology (ES&T)* Lifetime Reviewer Award.

On March 5, 2021, Dr. Kimberly Stoner was awarded the Bill Duesing Organic Living on the Earth Award, Educator Category, from The Northeast Organic Farming Association of Connecticut (CT NOFA).

On March 5, 2021, Dr. Susanna Keriö received the Experiment Station Associates Early Career Scientist Award.

On March 12, 2021, Dr. Jason C. White was invited to become an Associate Editor of *NanoImpact*.

On March 23, 2021, Dr. Jason C. White was appointed as a Clinical Professor of Epidemiology in the Department of Environmental Health Sciences of the Yale School of Public Health.

On March 24, 2021, Dr. Sara Nason was officially appointed as a webmaster for a one-year term for the Benchmarking and Publications for Non-Targeted Analysis working group.

On March 26, 2021, Dr. Teja Shidore won the Best Poster Award in the Professional Researcher Category for her poster entitled "Nanoparticle aided dsRNA delivery system for tackling plant viruses," which was

presented at the 2021 Ohio State University Plant Sciences Symposium.

On March 30, 2021, Dr. Jason C. White received the 2020 Outstanding Reviewer Award from the journal *Environmental Science: Nano*.

On April 22, 2021, Dr. Megan A. Linske became President of the Northeast Section of the Wildlife Society (NETWS).

## THE PUBLIC SPEAKS

On July 10, 2020, Lauraly Joy wrote the following to Goudarz Molaei. “Thank you very much! Really appreciate the prompt action and response!”

On July 16, 2020, Judy Carter wrote the following to Goudarz Molaei and staff. “Thanks so much for getting back to me with the results so soon – I’m very impressed with your efficiency and it is most appreciated!”

On July 24, 2020, Mark Seth Lender, Producer/Explorer in Residence, Living on Earth, wrote the following to Katherine Dugas. “WOW! Thank you for all of this information, a treasure-trove. Please feel free to use the photos if needed. The next time I run an insect segment on air I’ll ask my show runner to put in a credit for you and the Agricultural Station.”

On July 28, 2020, Daytime Gardeners of North Haven wrote the following to Robert Marra. “Thank you for the very informative presentation on Fungi and Forest Ecology. A very intense explanation, like a Class 101 on fungi. Wonderful photos. The Daytime Gardeners of North Haven appreciate your willingness and ability to give a Zoom presentation. Thank you.”

On July 28, 2020, Syma A. Ebbin, PhD wrote the following to Gale Ridge. “Thank you! You are a rock star!”

On July 29, 2020, Steven W. Beck, Beck’s Home & Garden, wrote the following to Rose Hiskes. “Thank you so much for answering all my questions. You and the Agricultural Station are such a wonderful resource for the people of Connecticut. I appreciate your expert scientific advice.”

On August 17, 2020, Jeff DeBishop, DeBishop’s Pest Control, wrote the following to Gale Ridge. “Simply put...you are the best! And thank you so much for the identification. I am well and hope you are too! Thank you again!”

On August 20, 2020, Jeff DeBishop, DeBishop’s Pest Control, wrote the following to Gale Ridge. “I would agree that you are essential! Thank you so much for all you do for me – it’s very appreciated!”

On September 4, 2020, James Federici wrote the following to Yonghao Li. “Thank you Dr. Li for your quick response and helpful information. ... I can’t say enough about the Ag Station and I am always impressed with the level of service that the Station delivers on a consistent basis! I appreciate all that you do!”

On September 4, 2020, Ed Skudlarek wrote the following to Yonghao Li. “Thank you and your staff for your assistance for this help as well as that in the past.”

On September 23, 2020, Bill Kogut, Kogut’s Hemlock Hill Tree Farm Inc., wrote the following to James LaMondia about Jatinder Aulakh. “I am dropping you a note to tell you how impressed I am with Jatinder while he was doing experiments on our farm. He noticed a field that was cleared of trees but overridden with weeds and grasses and took it upon himself to treat it with 4 different combinations of herbicides hoping to find a solution to eliminate these weeds. Jatinder has been most helpful with recommendations for specific herbicides and rates for various weed problems present in different areas on the farm. He has concentrated on doing experiments to eradicate horse nettle which is a big problem in the Christmas trees. We really appreciate Jatinder’s extra efforts and assistance.”

On October 15, 2020, Paola Bertucci wrote the following to Goudarz Molaei. “Thank you! This is an AMAZING service. I wish more people knew about it.”

On October 15, 2020, Erika Engelhaupt, Science Writer & Editor, wrote the following to Gale Ridge. “This helps greatly ... I certainly hope the people of Connecticut appreciate having such a wonderful resource as yourself!”

On October 27, 2020, Tollie Miller wrote the following to Goudarz Molaei. “THANK YOU! Great service you give.”

On October 30, 2020, Jess Killian wrote the following to Goudarz Molaei. “Thank you again for providing these results so quickly! I truly appreciate it.”

On November 4, 2020, Steven Pape wrote the following to Gale Ridge. “I want to thank you for your help. I appreciate it so very much. You were so patient and understanding while explaining to me exactly what it was that I found. It’s great to know that there is an agency with such wonderful people available to provide answers. I’m very grateful.”

On November 9, 2020, Susan Dorfman wrote the following to Goudarz Molaei. “I want to thank you personally for the kindness and care you extended to me. I am deeply grateful for the help and thoroughness in which you responded to my fear and panic about the recent tick bite. ... You treated me with so much care and it truly made a big difference for me! Thank you for the important work you do, your attention to detail, and your caring grace.”

On November 9, 2020, Diane Ratcliffe wrote the following to Yonghao Li. “Just a thank you for informing me about my azaleas. You’re the first person I go to when I have a question about my plants. You are always so great about responding to my dilemmas and I always know the information will be correct. Thanks again.”

On November 12, 2020, Elizabeth Byron wrote the following to Goudarz Molaei. “Thank you! You are the best hidden service in Connecticut.”

On November 24, 2020, Arlene Perri wrote the following to Goudarz Molaei. “Thank you so much for what you do. I am very grateful for your facility.”

On December 1, 2020, Paola Bertucci wrote the following to Gale Ridge. “Thank you, Gale, as always! So wonderful to be able to count on your expertise.”

On December 1, 2020, Ellen Sonnenfroh, Stonebridge Associates, wrote the following to Yonghao Li. “Thank-you for your prompt response concerning the boxwood. This is a new client so we will be sure to do a thorough investigation of all the boxwood on the property, as you requested. You are a wonderful resource for landscapers, homeowners and plant lovers. Thank-you so much for your help, Rob and I really appreciate it.”

On December 3, 2020, Sam Samuelson wrote the following to Goudarz Molaei. “Thank you very much! You are providing a crucial public health service.”

On December 17, 2020, Kari Dunfield and Chris Yost, Editors-in-Chief, *Canadian Journal of Microbiology*, wrote the following to Blaire Steven. “Thank you for being a valued member of the Editorial team for the *Canadian Journal of Microbiology*. We value your service to the journal, especially now during these difficult and uncertain times when so many of us are facing challenges on personal and professional

levels. In light of this, we are immensely appreciative of all the time you take to review manuscripts and to act as an ambassador for our journal. The hours that you volunteer to the journal help ensure the long-term health and success of not only the journal, but of science in Canada and internationally. Thank you for your dedication and service to the journal and for upholding ethical standards for science as a whole.”

On January 7, 2021, Andrew Anderson, Stratford High School, wrote the following to Gale Ridge. “I can’t thank you enough for what you do for our department, your expertise is invaluable, always appreciated, and always benefits the people I pass your knowledge on to. Thank you!”

On May 13, 2021, Joslyn Pollock, Arbor Services of CT, Inc., wrote the following to Gale Ridge. “This is helpful. And confirms what our PHC Tech told me. I will let the customer know that we checked with the eminent scientist Dr. Gale Ridge and this was her conclusion. Many thanks for your help and all the good work you all do collectively at the AG Station!”

On May 20, 2021, Dave Coyle wrote the following to Yonghao Li. “Thank you Dr. Li for your prompt and thorough response(s). Read through everything and believe I have all the information needed to keep this under control. Can’t tell you how much I appreciate the resources you and the Ag Station have provided me for close to 30 years. Your service and expertise are second to none. Thank you once again.”

SCIENTIFIC OFFICERSHIPS AND MEMBERSHIPS ON STATE,  
NATIONAL, OR REGIONAL COMMITTEES

ADMINISTRATION

JASON C. WHITE

- Immediate Past President, International Phytotechnology Society
- Managing Editor, *International Journal of Phytoremediation*
- Editorial Board, *Environmental Pollution*
- Editorial Board, *NanoImpact*
- Editorial Advisory Board, *Environmental Science & Technology*
- Editorial Advisory Board, *Environmental Science & Technology Letters*
- Science Advisory Board, Annual International Conference on Soils, Sediments, Water, and Energy
- Advisor, Nanotechnology Advisory Group, Society of Environmental Toxicology and Chemistry
- Member (ad-hoc), FDA Food Emergency Response Network (FERN) Method Coordination Committee (MCC)
- Member, FDA Flexible Funding Model (FFM) Workgroup
- Member, European Science Foundation (ESF) College of Experts

DEPARTMENT OF ANALYTICAL CHEMISTRY

CHRISTIAN O. DIMKPA

- Affiliateship, Center for Sustainable Nanotechnology
- Senior Editor, *Journal of Basic Microbiology*

BRIAN D. EITZER

- Member, Organizing Committee for the North American Chemical Residue Workshop (and as of June 2021, on the Board of Directors of Flag Works – which runs the Conference)
- Member, Regional Water Authority Representative Policy Board
- Member, Town of Bethany Conservation Commission

CHRISTINA S. ROBB

- Board Member, Eastern Analytical Symposium
- Member, Executive Committee, Eastern Analytical Symposium
- Associate Editor, *Journal of Liquid Chromatography*

NUBIA ZUVERZA-MENA

- Topics Board Editor, *Biomolecules*

DEPARTMENT OF ENTOMOLOGY

KIRBY C. STAFFORD III

- Member, Board, Connecticut Coalition Against Bed Bugs
- Member, Tick IPM Working Group
- Member, NEVBD Tick Working Group

- Assistant Clinical Professor, Department of Medical Sciences, Frank H. Netter MD School of Medicine, Quinnipiac University

#### TIA BLEVINS

- Member, Horticultural Inspection Society-Eastern Chapter
- Archivist, Horticultural Inspection Society-Eastern Chapter

#### MEGAN A. LINSKE

- President-Elect, The Wildlife Society, Northeast Section
- Executive Secretary, The Wildlife Society, Northeast Section
- Workshop Committee Chairperson, The Wildlife Society, Northeast Section
- Awards Committee Member, The Wildlife Society, Northeast Section
- Leadership Institute Mentor, The Wildlife Society
- Leadership Institute Selection Committee Member, The Wildlife Society
- Network and Engagement Committee Member, The Wildlife Society
- Adjunct Faculty, Unity College Distance Education Program
- Postdoctoral Trainee, The Northeast Regional Center of Excellence in Vector-Borne Diseases

#### GALE E. RIDGE

- Chair, Connecticut Coalition Against Bed Bugs
- Assistant Clinical Professor, Department of Medical Sciences, Frank H. Netter MD School of Medicine, Quinnipiac University
- Member, EPA FIFRA Scientific Advisory Board
- Member, State Health Improvement Plan (SHIP)
- Honorary Member, Connecticut Pest Control Association (CPCA)
- Co-Chair, Sustainable Connecticut

#### CLAIRE E. RUTLEDGE

- Director (Board Member), Connecticut Tree Protective Association
- Vice President, Connecticut Tree Protective Association

#### VICTORIA LYNN SMITH

- Member and Past President, Eastern Plant Board
- Member, National Plant Board Systems Approach to Nursery Certification Committee
- Member, New England Wildflower Society, Connecticut Task Force
- Member, Yale Biosafety and Recombinant DNA Committee
- Member, Northeast Area Association of State Foresters Firewood Working Group
- Member, USDA-APHIS-PPQ Early Detection-Rapid Response Committee
- Member, National Clean Plant Network Fruit Tree committee

#### KIMBERLY A. STONER

- Member, Multi-State Research Project NC-1173 – Sustainable Solutions to Problems Affecting Bee Health
- Member, Multi-State Research Project NE-TEMP2001 – Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities
- Organizer and Member, Connecticut Native Plant, Pollinator, and Wildlife Working Group
- Member, M.S. Committee for James Durrell at the University of Bridgeport
- Member, Connecticut Friends of Right-of-Way Habitat Stakeholder Group

- Member, Bee Nutrition Task Force of COLOSS (Society for the Prevention of Honey Bee Colony Loss)
- Member, US National Native Bee Monitoring Research Coordination Network

#### TRACY ZARRILLO

- Member, IUCN SSC Wild Bee Specialist Group
- Member, US National Native Bee Monitoring Research Coordination Network (RCN)
- Secretary (Board Member), Hamden Land Conservation Trust
- Member, Pollinator Pathway Group of Hamden

### DEPARTMENT OF ENVIRONMENTAL SCIENCES

#### DR. JOSEPH J. PIGNATELLO

- Editorial Board, *Molecules*
- Editorial Board, *Environmental Engineering Science*
- Associate Editor, *Soil Science Society of America Journal*
- Editorial Board, *Environmental Research*
- Secretary, The Connecticut Agricultural Experiment Station Research Foundation, Inc.
- Agriculture, Food & Nutrition Technical Board Chair, Connecticut Academy of Science and Engineering

#### THEODORE G. ANDREADIS

- Adjunct Professor, Department of Pathobiology, University of Connecticut
- Clinical Professor, Epidemiology of Microbial Disease Division, Yale University School of Public Health
- Member, Editorial Board, *Journal of Medical Entomology*
- Subject Editor, *Journal of Medical Entomology*
- Member, Connecticut Academy of Science and Engineering

#### DR. PHILIP ARMSTRONG

- Clinical Associate Professor, Department of Epidemiology of Microbial Diseases, Yale School of Public Health
- Member, Multi-State Research Project NE-1443: Biology, Ecology, and Management of Emerging Disease Vectors
- Member, State of Connecticut Mosquito Management Program

#### DR. DOUGLAS E. BRACKNEY

- Assistant Adjunct Professor, Section of Infectious Diseases, Yale School of Medicine
- Assistant Adjunct Clinical Professor, Microbial Diseases Division, Yale School of Public Health
- Associate Editor, *PLoS Neglected Tropical Diseases*
- Adjunct Assistant Professor, Department of Pathobiology and Veterinary Sciences, University of Connecticut

#### MR. GREGORY J. BUGBEE

- President, Northeast Aquatic Plant Management Society
- Panelist, Northeast Aquatic Nuisance Species Panel
- Director, Clear Lake Improvement Association

DR. ANDREA GLORIA-SORIA

- Laboratory Associate, Department of Ecology and Evolutionary Biology, Yale University

DR. GOUDARZ MOLAEI

- Associate Clinical Professor, Department of Epidemiology of Microbial Diseases, Yale School of Public Health
- Editorial Board Member, *Tropical Medicine and Infectious Diseases*
- Lead, Vector-borne Disease subtopic of the Public Health Section of Connecticut Governor Council on Climate Change
- Member, Multi-State Research Project NE-1443, “Biology, Ecology, and Management of Emerging Disease Vectors”

DR. SARA L. NASON

- Adjunct Assistant Research Scientist, Department of Plant Science and Landscape Architecture, University of Connecticut
- Website Manager, Benchmarking and Publications for Non-Targeted Analysis Working Group

MR. JOHN SHEPARD

- Treasurer, Northeastern Mosquito Control Association

DR. BLAIRE STEVEN

- Adjunct Assistant Research Professor, Department of Natural Resources and the Environment, University of Connecticut
- Editorial Board, *Canadian Journal of Microbiology*

DEPARTMENT OF FORESTRY AND HORTICULTURE

JEFFREY S. WARD

- Past Chair, Yankee Division, Society of American Foresters (SAF)
- Program Chair, New England Society of American Foresters
- Chair, Connecticut Forest Ecosystem Monitoring Cooperative
- Secretary, Connecticut Tree Protection Examining Board
- Secretary, Connecticut Invasive Plant Council
- Member, New England Forestry Foundation’s North Central & Transition Hardwoods Exemplary Forestry Standards Technical Advisory Committee
- Member, Yankee Division, SAF, Forest Management and Carbon Task Force
- Member, Audubon Connecticut Science Committee
- Ex-Officio Member, Goodwin Scholarship Committee

JOSEPH P. BARSKY

- Chair, State Consulting Committee for Agricultural Science and Technology Education
- Editor, *NESAF News Quarterly*, New England Society of American Foresters
- Park Naturalist, Sleeping Giant Park Association
- Member, Consulting Committee, Vernon E. Cleaves Agricultural Science and Technology Program
- Member, Connecticut Environmental Review Team

#### SUSANNA KERIÖ

- Member, Forest Pathology Committee, American Phytopathological Society
- Committee Member, Connecticut Urban Forestry Council

#### ABIGAIL A. MAYNARD

- Member, Editorial Board, *Compost Science & Utilization*
- Ex-Officio Member, Connecticut Council on Soil and Water Conservation
- Member, State Technical Committee
- Member, Soil Health Subcommittee, Connecticut Council on Soil and Water Conservation

#### SCOTT C. WILLIAMS

- Adjunct Professor, Department of Natural Resources and the Environment, University of Connecticut, Storrs
- Certified Wildlife Biologist, The Wildlife Society
- Associate Editor, *Animals*
- Editorial Advisory Board Member, *The Wildlife Professional*
- Commissioner, Town of Guilford Inland Wetlands Commission
- Commissioner, Town of Guilford Conservation Commission
- Vice Chair, Town of Guilford Land Acquisition Commission

### DEPARTMENT OF PLANT PATHOLOGY AND ECOLOGY

#### WASHINGTON DA SILVA

- Professor Collaborator, Universidade Federal Rural do Semi-Árido (UFERSA), Brazil
- Adjunct Assistant Professor, University of Connecticut (UConn)
- Member, Research Thesis Advisor, Southern Connecticut State University
- Member, New England, New York and Canada Tree Fruit Pest Working Group
- Member, Thesis Advisory Committee, Universidade Federal Rural do Semi-Árido (UFERSA), Brazil
- Chair, Working Group, American Phytopathological Society (APS) and the Brazilian Society of Plant Pathology (SBF)
- Scientific Member, Connecticut Farm Wine Development Council
- Member, Science/Education Committee, Connecticut Farm Wine Development Council
- Editor, Portuguese Translations for the Plant Health Instructor/APS Education Center

#### WADE H. ELMER

- Director, The Connecticut Agricultural Experiment Station Research Foundation, Inc.
- Associate Editor, *Crop Protection*
- Member, APS Foundation Committee, American Phytopathological Society
- Member, APS Press, American Phytopathological Society
- Member, Widely Prevalent Fungi List Committee, American Phytopathological Society
- Member, Northeast Research, Extension and Academic Programs Committee for IPM
- Member, Thesis Advisory Committee, University of Texas at El Paso
- Member, Thesis, Advisory Committee, Federal University, Lavras, BRAZIL
- Member, Thesis Advisory Committee, Federal University, Lavras, BRAZIL

#### YONGHAO LI

- Member, Tree Improvement Committee, Connecticut Christmas Tree Growers Association
- Member, Scholarship Committee, Connecticut Nurserymen's Foundation

- Member, Online Communication and Web Portal Committee, National Plant Diagnostic Network
- Member, Honorary Advisory Board, Edgerton Park Conservancy

#### ROBERT E. MARRA

- Member, Phytopathology Committee, Mycological Society of America
- Member, Forest Pathology Committee, American Phytopathological Society
- Co-Chair, Forest Ecosystem Monitoring Cooperative, CT State Partnership Committee
- Member, Connecticut Conference on Natural Resources Steering Committee. Founding Member
- Immediate Past-President, Executive Committee, Northeast Division of the American Phytopathological Society
- Chair, West Haven Tree Commission

#### NEIL P. SCHULTES

- Fellow, The Linnaean Society of London
- Vice President and Executive Board Member, Quinnipiac Chapter of Sigma Xi
- Adjunct Faculty, University of Connecticut (UConn)

#### LINDSAY R. TRIPLETT

- Senior Editor, *Plant Disease*
- Associate Editor, *Phytobiomes*
- Faculty Affiliate, Colorado State University
- Gratis Faculty, University of Connecticut
- Chair, APHIS Widely Prevalent Bacteria Committee
- Member, Dissertation Advisory Committee, University of Connecticut
- Member, Bacteriology Committee, American Phytopathological Society

#### QUAN ZENG

- Associate Editor, *Phytopathology*
- Guest Editor, *Frontiers in Plant Science*
- Member, New England, New York and Canada Tree Fruit Pest Working Group
- Member, Bacteriology Committee, American Phytopathological Society
- Adjunct Scientist, University of Connecticut

### VALLEY LABORATORY

#### JATINDER AULAKH

- Member, Connecticut Invasive Plant Working Group

#### CAROLE CHEAH

- Fellow, Cambridge Philosophical Society, UK
- Member, Nearctic Regional Section of IOBC (International Organization for BioControl of Noxious Animals and Plants)
- Member, Honorary Advisory Board, Edgerton Park Conservancy, New Haven

#### RICHARD COWLES

- Secretary, Connecticut Christmas Tree Growers Association

ROSE HISKES

- Co-Chair, Connecticut Invasive Plant Working Group

SRIKANTH KODATI

- Member, Early Career Professionals Committee, American Phytopathological Society
- Member, Biological Control and Soil Microbiology and Root Diseases Committees, American Phytopathological Society

JAMES A. LAMONDIA

- Northeast Regional Project NE-2140, “Sustainable Management of Nematodes in Horticultural and Field Crop Production Systems”
- Chair, Connecticut Agricultural Information Council
- Member, Century Farm Award Selection Committee
- Ex-Officio Member, Connecticut Tree Protection Examining Board
- Member, CT Vegetable & Small Fruit Growers’ Conference Steering Committee
- Member, GLOBAL Globodera Alliance Advisory Board

DEWEI LI

- Associate Editor, *Aerobiologia*
- Member, Editorial Board, *Fungal Biology and Biotechnology*
- Review Editor, *Frontiers in Allergy - Environmental Determinants*

## LECTURES, SEMINARS, AND INTERVIEWS

During the year, staff members present formal lectures and seminars to organized groups outside The Station. They also describe their research to organized groups visiting The Station. Occasionally they report their research to elected officials. At still other times newspaper, radio, and TV reporters interview our staff. These occasions are listed below.

### ARMSTRONG, PHILIP M.

- Was interviewed about EEE virus and the expansion of the statewide surveillance program by the Associated Press (*July 1, 2020*).
- Spoke at a press event on the threat posed by ticks and mosquitoes and met with Senator Richard Blumenthal (*July 9*).
- Was interviewed about climate change and its impact on mosquito populations by the *CT Mirror* (*July 16*).
- Was interviewed about the risk of EEE virus by Patch Media (*July 23*).
- Was interviewed about the first detection of EEE virus in Connecticut by NBC Connecticut, WTIC, WSHU, Patch Media, and FOX61 (*August 11, 12*).
- Was interviewed about the first human case of West Nile virus in Connecticut by WTIC (*August 17*).
- Was interviewed about the first human case of West Nile virus in Connecticut by FOX61 (*August 17*).
- Was interviewed about the increased detection of West Nile virus in mosquitoes by News Channel 8 (*August 28*).
- Was interviewed about the increased detection of West Nile virus in mosquitoes by WTIC (*August 28*).
- Was interviewed about West Nile virus activity in Connecticut by FOX61 (*September 9*).
- Was interviewed about West Nile virus activity in Connecticut by NBC-CT (*September 9*).
- Gave an online seminar entitled “Jamestown Canyon Virus in Connecticut: Lessons Learned from 24 Years of Surveillance and Research” to the American Mosquito Control Association (*September 23*).
- Was interviewed about EEE virus by *The Day* (*September 25*).
- Was interviewed about EEE virus by the *Yale Daily News* (*September 28*).
- Gave a talk entitled “Update on EEE Virus: An Emerging Mosquito-Borne Virus of Public Health Concern” at the Pennsylvania Mosquito Control Association Virtual Conference (*October 8*).
- Was a guest on Face Connecticut, WTIC radio, to speak about the results of his CAES study documenting an overall increase in mosquito abundance and diversity after two decades of statewide surveillance (*November 12*).
- Spoke about the public health implications of pesticide applications to reduce mosquito populations and West Nile virus risk to students in the Environmental Studies Program at Connecticut College (4 attendees) (*April 21, 2021*).
- Was interviewed about the release of genetically-modified mosquitoes as a strategy to reduce mosquito populations in the wild by WTIC (*April 28*).
- Gave a virtual lecture entitled “Regional Vector-Borne Diseases and Emerging Threats” to participants of the Vector Boot Camp Course (25 attendees) (*May 10*).
- Gave a virtual lecture entitled “Phylogenetic Relationships of EEE Virus Strains Circulating in the Northeastern US During the 2019 Outbreak” at the 12th Annual Northeastern Eastern Equine Encephalitis Conference (50 attendees) (*May 17*).
- Was interviewed about the start of the mosquito surveillance program by News Channel 8 (*June 1*).
- Was interviewed about the start of the mosquito surveillance program by NBC CT (*June 1*).
- Was interviewed about the start of the mosquito surveillance program by Fox 61 (*June 2*).
- Was interviewed about the start of the mosquito surveillance program by WSHU (*June 2*).
- Was interviewed about the start of the mosquito surveillance program by *The Day* (*June 3*).
- Was interviewed about EEE virus and the statewide monitoring program by the *Valley Inquiry* (*June*

- 8).
- Was interviewed about the first West Nile virus positive mosquitoes identified in Connecticut this year by the *Connecticut Post* (June 29).
  - Was interviewed about the first West Nile virus positive mosquitoes identified in Connecticut this year by CT Patch (June 29).
  - Was interviewed about the first West Nile virus positive mosquitoes identified in Connecticut this year by WSHU (June 29).
  - Was interviewed about the first West Nile virus positive mosquitoes identified in Connecticut this year by NBC CT (June 29).
  - Was interviewed about the first West Nile virus positive mosquitoes identified in Connecticut this year by News Channel 8 (June 29).

#### ARSENAULT, TERRI

- Gave a presentation to hemp growers for the CT Department of Agriculture entitled “Industrial Hemp: Crop for the Future?” The talk described our qualifications as a laboratory to analyze hemp for total delta-9 THC, and our experiences in growing hemp at Lockwood Farm. As an accredited laboratory, we have developed a quality system for generating defensible test results and are able to process samples within 1 or 2 business days. Unfortunately, at this time many varieties of hemp are prone to exceeding the limit of 0.3% total delta-9 THC allowed for harvest, which represents a serious concern for hemp growers (December 1 and 3, 2020).

#### AULAKH, JATINDER S.

- Gave a presentation entitled “Palmer Amaranth - A New Devastating Pigweed in Connecticut” during the virtual CAES Plant Science Day (August 5, 2020).

#### BARSKY, JOSEPH P.

- Participated in an NESAF 2020 planning committee conference call (November 24, 2020).
- Participated in an NESAF 2020 planning committee conference call (December 8).
- Participated in a New England Society of American Foresters Executive Committee conference call (December 9).
- Hosted Leeane Marvin (UConn Natural Resources student) for a job shadow event (December 30).
- Participated in an NESAF 2021 planning committee conference calls (January 5, 2021).
- Participated in an NESAF executive committee conference call (January 13).
- Participated in an NESAF 2021 planning committee conference calls (January 19).
- Participated in NESAF 2021 planning committee conference calls (February 2, 16).
- Participated in a New England Society of American Foresters executive committee conference call (March 21).
- Served as a session facilitator/moderator during the New England Society of American Foresters Annual Meeting and Conference (March 22-23).
- Gave a presentation entitled “Native Trees and Shrubs” to members of the Federated Garden Clubs of Connecticut as a component of their Gardening School (40 attendees) (April 28).
- Participated in the 2021 Forest Health Monitoring crown health training (May 27).
- Participated in the quarterly meeting of the State Consulting Committee for Agricultural Science and Technology Education and was re-elected Vice-Chair (June 10).
- Participated in the quarterly meeting of New England Society of American Foresters Executive Committee in East Concord, NH (June 16).

#### BLEVINS, TIA M.

- Participated in a three-day virtual meeting of the Aerial Survey Working Group presented by USDA-USFS Forest Health Protection to continue to improve the reliability and accuracy of the aerial survey program (52 participants) (*January 26-28, 2021*).
- Participated in the Connecticut Nursery and Landscape Association Winter Symposium held virtually (approx. 200 participants) (*January 27-28*).
- Participated in the 95th Annual Eastern Plant Board Meeting held virtually via Zoom. This meeting focused on plant protection during a pandemic, deregulation of emerald ash borer, and emerging pests and safety concerns of forests and the plant industry (approx. 135 participants) (*March 30-April 1*).
- Participated in a virtual Post Entry Quarantine (PEQ) training with the USDA APHIS PPQ Professional Development Center focused on procedures required to process plants arriving in to the United States, which need to be quarantined before they can be sold by our Connecticut nurseries (*April 7*).
- Participated in a Beech Leaf Disease (BLD) Workshop, which discussed history, survey, and monitoring efforts as well as detection, cause, and treatment of BLD (*April 15*).
- Participated in Aerial Survey, Aviation Safety & Management (AS2M), a virtual course organized by USDA USFS Forest Health Protection to review risk management, air space coordination, aircraft instrumentation, flight following, and mishaps of 2020 (*April 20-22*).
- Participated in a Region 9 Preseason Aerial Survey meeting presented by the USDA USFS Durham Field Office to review flight plans for the upcoming forest health aerial survey and to prepare the mapping system for data collection (*April 28*).

#### BRACKNEY, DOUGLAS E.

- Presented a talk entitled “Community Scale Surveillance Efforts for SARS-2 CoV” as part of the virtual CAES Seminar Series (*September 2, 2020*).
- Presented a talk entitled “Community Scale Surveillance Efforts for SARS-2 CoV” at the virtual Experiment Station Associates Annual Meeting (*September 9*).
- Was interviewed about his role in SalivaDirect by the Chesterton Tribune (his parent’s hometown newspaper) (*September 16*).
- Was interviewed about the increase in SARS-CoV-2 levels in New Haven sewage sludge by NBC Connecticut (*October 28*).
- Gave a talk entitled “Optimizing Community Scale Surveillance Efforts for SARS-CoV-2” at the monthly Sigma Xi Quinnipiac Chapter at Quinnipiac University (20 student attendees, 35 attendees total) (*November 11*).
- Presented COVID-19 sewage work to Representatives Dorinda Borer and Joseph Gresko, and Senator Christine Cohen in their visit to CAES (*December 30*).

#### BRANSFIELD, ANGELA B.

- Participated in the Federal Select Agent Program’s webinar eFSAP updates (*July 7, 2020*).
- Participated in the Federal Select Agent Program’s webinar APHIS/CDC Forms 2, 3 and 4 Updates and Issues (*July 15*).
- Participated in the American Biological Safety Association’s Select Agent Webinar Personnel Suitability (*July 22*).
- Participated in the American Biological Safety Association’s Select Agent Webinar Virtual Inspections – The 5 W’s (*August 20*).
- Participated in a Federal Select Agent Program’s Multi-Agency Informational Meeting (*September 23*).
- Participated in a Federal Select Agent Program’s RO webinar series Inactivation Protocols, Overview and Updates (*September 30*).
- Participated in the American Biological Safety Association’s SRA Approved Users-Regulatory Session workshop (*November 18*).

- Participated in BioRAFT’s EHS Community Connection webinar entitled “Fit Testing Do’s & Don’ts” (*February 25, 2021*).
- Participated in a BioRAFT’s EHS Community Connection webinar “Designing Safety Training That Sticks” (*March 25*).
- Participated in the Federal Select Agent Program’s RO webinar series “Plant Pathogen Biocontainment; Changes to the BMBL 6th edition and Impact on Inspections” (*May 26*).

BUGBEE, GREGORY J.

- Gave a virtual talk via Zoom entitled “Lawn Care During Drought” at the New Canaan Public Library (approx. 50 attendees) (*July 10, 2020*).
- Spoke on “Invasive Aquatic Plants Threaten Cedar Lake” at a virtual Town of Chester public meeting (22 participants) (*October 1*).
- Gave a talk entitled “Hydrilla Invades the Connecticut River” at a virtual Connecticut Invasive Plant Group Symposium (approx. 100 participants) (*October 7*).
- Spoke on “Hydrilla in the Connecticut River” at a virtual meeting of the Connecticut River Coastal Conservation District (approx. 12 participants) (*October 19*).
- Spoke on “Dogwood Lake - Aquatic Plant Survey Results and Management Options” at a Zoom meeting of town officials and citizens from Trumbull (approx. 12 attendees) (*November 5*).
- Served as a panelist on the Northeast Aquatic Nuisance Species Panel at the 2020 annual virtual meeting (*November 11*).
- With Ms. Summer Stebbins, spoke on “Hydrilla in the Connecticut River” at a virtual meeting of the Connecticut River Coastal Conservation District, and received the District’s 2020 Outstanding Environmental Project Award for invasive aquatic plant survey work and public outreach (approx. 20 attendees) (*November 19*).
- Gave a virtual presentation to the Connecticut Resource and Conservation District on hydrilla in the Connecticut River (approx. 20 attendees) (*December 2*).
- Served as a panelist on the Northeast Aquatic Nuisance Species Panel at their virtual annual meeting (approx. 15 attendees) (*December 17*).
- Was elected President of the Northeast Aquatic Plant Management Society and gave opening remarks for the virtual 22nd Annual Conference (approx. 200 attendees) (*January 14, 2021*).
- With Ms. Summer Stebbins, gave a virtual workshop on “Invasive Aquatic Plants” as part of the 2021 High School Envirothon (approx. 30 attendees) (*January 14*).
- Conducted a virtual annual Board of Directors meeting of the Northeast Aquatic Plant Management Society (approx. 15 attendees) (*January 19*).
- With Ms. Summer Stebbins, provided expertise at a virtual meeting organized by the Aquarion Water Company on hydrilla and its recent discovery in their reservoir system (approx. 15 attendees) (*January 20*).
- Gave a virtual talk entitled “Improving Soil in the Home Garden” to the Orchard Valley Garden Club (approx. 30 attendees) (*January 26*).
- With Ms. Summer Stebbins, gave a virtual talk entitled “CAES IAPP 2020 Aquatic Plant Survey of Pachaug Pond” to the Pachaug Pond Protective Association (approx. 20 attendees) (*January 27*).
- Was featured in a video entitled “Invading the Connecticut River – The Spread of Hydrilla” produced by the Connecticut Resource Conservation and Development Area <https://youtu.be/OZ2baYSgl8Y> (*February 2*).
- Spoke virtually on “Changes in the Aquatic Vegetation in Lake Quonnipaug from 2000 to Now” to the Lake Quonnipaug Preservation Committee (approx. 12 attendees) (*February 8*).
- With Ms. Summer Stebbins, provided testimony virtually on proposed changes to Lake Beseck’s winter drawdown protocol to the Connecticut Environment Committee (approx. 50 attendees) (*February 10*).
- Participated as a panelist in the winter meeting of the Northeast Aquatic Nuisance Species Panel

- (approx. 15 attendees) (*February 17*).
- Participated in a meeting sponsored by Western Connecticut State University on bringing together data on water quality and invasive species in the Housatonic River Watershed (approx. 15 attendees) (*February 18*).
  - Gave two virtual talks entitled “Improving Soil in the Home Garden: A Soil Scientist’s Perspective” in consecutive breakout sessions as part of the Connecticut Master Gardeners Symposium (approx. 200 attendees) (*March 20*).
  - Gave a virtual talk entitled “Lawn Care” as part of the Avon Free Public Library educational outreach program (approx. 30 attendees) (*March 23*).
  - With Ms. Summer Stebbins, gave a virtual workshop “Connecticut’s Invasive Aquatic Plants” as part of the Three Rivers Community College environmental seminar series (approx. 50 attendees) (*March 24*).
  - Spoke on “Soil Testing and Invasive Aquatic Plants” to an earth science class from Southern Connecticut State University (10 attendees) (*April 27*).
  - Was interviewed about grant funding awarded to CAES by the CT DEEP for aquatic invasive species research through the boat registration fee program by the Connecticut Examiner (*May 6*).
  - With Ms. Summer Stebbins, gave a virtual talk entitled “2020 CAES IAPP Aquatic Plant Survey of Middle Bolton Lake” at a meeting of the Friends of Bolton Lake (approx. 30 attendees) (*May 13*).
  - Served as a panelist for the Northeast Aquatic Nuisance Species Panel (*May 18-19*).
  - Gave a virtual talk entitled “Hydrilla Invades the Connecticut River” at a combined meeting of the Aquatic Plant Management Society and the National Aquatic Species Management Society as part of National Invasive Species Awareness Week (approx. 200 attendees) (*May 20*).
  - Gave a talk entitled “Hydrilla Invades the Connecticut River” at the Chester Town Meeting Hall and concurrently via Zoom (approx. 50 attendees) (*June 24*).

#### CANTONI, JAMIE L.

- With Dr. Scott Williams, Dr. Megan Linske, and Ms. Heidi Stuber, participated in an interview by Yehyun Kim, *CT Mirror*, at Lake Gaillard in Guilford and demonstrated tick sampling, mouse capture, and tissue sampling, and discussed the impact of climate change on new and emerging tick species (*August 7, 2020*).
- Was interviewed by Debra Aleksinas, a contributing writer with the *Lakeville Journal* for the May 20th edition, featuring a section on Land Trusts in the Northwest corner. The interview pertained to the projected 2021 tick season, current tick sampling efforts and how this compares to previous results, and the arrival of novel tick species and their potential impact on CT residents, particularly those residents of the Northwest corner of CT and Dutchess County, NY (*May 12, 2021*).

#### CHEAH, CAROLE A.

- Was interviewed about the importance of weather data and diversity of hemlock sites at Great Mountain Forest to her hemlock research by Mary Neill for an article for the Great Mountain Forest October newsletter (*September 21, 2020*).
- Was interviewed about managing threats of hemlock woolly adelgid to a unique relic eastern hemlock stand by Josh Levesque for an article on the conservation of Alabama hemlocks (*October 14*).
- Was interviewed about her hemlock research and experiences working at Great Mountain Forest in Norfolk by David Leff for an upcoming book (*December 9*).
- Gave a presentation on the HWA biological control program at the Forest Health Monitoring Workshop via Zoom (80 attendees) (*March 4, 2021*).
- Presented a talk entitled “The Plight of the Hemlock Tree” via Google meet for the Land Trust Hot Topics Series, hosted by The Flanders Nature Center and Land Trust, Town of Woodbury, and participated in the round table discussion (10 attendees) (*March 9*).

- Was interviewed about biological control of HWA releases in the Town of Woodbury conservation area of Nonnewaug Falls by Hannah Snyder of the *Republican-American* and implemented the releases together with 15 members of the Woodbury Conservation Commission (*May 12*).

#### COWLES, RICHARD S.

- Presented “Targeted Insect and Mite Management” for the Great Lakes Christmas Tree Association summer meeting, as a webinar; the presentation was recorded and can be viewed online (100 attendees) (*July 30, 2020*).
- Presented virtually “Soil Acidification for Improved Health of Christmas Tree Transplants” for the North Carolina Christmas Tree Workshop (40 attendees) (*January 29, 2021*).
- Presented virtually “The Asian Invasion and Say Nix to Neonics” for the Connecticut Grounds Keepers Association (170 attendees) (*February 16*).
- Spoke about “Soil Acidification for Phytophthora Root Rot Management” to the Pacific Northwest Christmas Tree Growers Association (100 attendees) (*February 19*).
- Spoke to the Pesticide Inspector Regional Training virtual meeting hosted by CT DEEP about “Rational Use of Neonics” and “Prepare for Another Invasion: The Box Tree Moth” (40 attendees) (*February 24*).
- Presented virtually “Scale Management: Say Nix to Neonics?” (40 attendees) (*May 5*) and “Soil Acidification for Phytophthora Root Rot Management” for the Massachusetts Christmas Tree Association (23 attendees) (*May 13*). Both presentations are archived on the CAES website.
- Discussed “Disease, Mite, and Insect Management” at a Twilight Meeting of the Connecticut Christmas Tree Growers Association held in Preston (40 attendees) (*June 22*).

#### CREIGHTON, MARK H.

- Hosted a beekeeping webinar for the Scoville Memorial Library in Salisbury (10 participants) (*August 27, 2020*).
- Participated and presented at the virtual Connecticut Beekeepers Association annual Beekeepers School. The new beekeepers were introduced to the art of beekeeping, seasonal management goals, disease and pest management, honey bee registration, and neighbor relations (190 participants) (*January 9, 16, 23, and 30, 2021*).
- Participated in the Apiary Inspectors of America annual conference with regulators from the USA and Canada. Several talks were presented on varroa mite management, the latest news on the Asian giant hornet (*Vespa mandarina*), resistance to amitraz products, and updates from the USDA Beltsville honey bee laboratory (*January 12-14*).
- Attended a virtual New England Apiary Inspectors conference and discussed the upcoming season and shared bordering state Health Inspection data (*April 2*).
- Gave a virtual talk on the history of beekeeping in Connecticut to the Drum Hill Chapter of the Daughters of the American Revolution (25 attendees) (*April 15*).
- Held a mini field day at the Montessori School of Greater Hartford in New Hartford, where 25 students met him at the school apiary, opened the hives, and reviewed basic bee anatomy and function (*April 26*).
- Gave an online presentation about honey bees and the history of beekeeping in Connecticut to the Alumni Association of Albertus Magnus College (45 attendees) (*May 5*).
- Conducted an online presentation and hive opening demonstration at Massaro Farm in Woodbridge, where making a “Dolittle Split,” Varroa mite evaluations, and late spring management of colonies was reviewed (98 member attendees) (*May 8*).
- Hosted a bee talk on varroa mite management to members of the Huneebee Project, which manages hives in the New Haven Area and works with young adults with disabilities, at Lockwood Farm (*May 15*).

DIMKPA, CHRISTIAN O.

- Gave a presentation entitled “Metallic Nanoparticles in Plant-Soil Interactions: Nanotoxicants and Nanofertilizers” at the virtual Center for Sustainable Nanotechnology Seminar Series (*October 7, 2020*).
- Gave a presentation via Zoom entitled “Perspectives on Scale-up and Commercialization of Nanofertilizers” at the Nanotechnology Research and Innovation Forum 2020. The meeting was organized by the African Materials Research Society (AMRS) and sponsored by the United Nations Economic Commission for Africa (UNECA). This meeting is anticipated to herald mutually beneficial research partnerships between CAES and African institutions involved in nanotechnology applications in agricultural and food systems (38 attendees) (*December 16*).
- Gave a virtual presentation entitled “Micronutrients: The Underestimated Fertilizer Agrochemicals for Improving Crop Productivity and Quality - From Conventional to Nanoscale” for the CAES Seminar Series (*December 16*).

DUGAS, KATHERINE

- Gave a half-hour update on 2020 landscape pests submitted to the CAES Insect Information Office as part of a Zoom webinar series hosted by the Connecticut Tree Protective Association (CTPA) (*August 13, 2020*).
- Gave a virtual talk via Zoom to a group of Boy Scouts working towards their Insect Study merit badge with the Scouts engaged in a discussion about insect taxonomy and biology (10 attendees) (*September 18*).
- With Dr. Gale Ridge, was interviewed about bed bugs and the misinformation and urban myths surrounding them by Brian Scott-Smith for a Coast and Country CAES Podcast (*September 29*).
- With Dr. Yonghao Li, taught a 2-hour virtual course via WebEx about insect and plant disease issues to a Master Gardener class (51 attendees) (*February 19, 2021*).
- Gave a one-hour virtual lecture on insect pest issues to the Duck River Garden Club of Old Lyme (40 attendees) (*February 22*).
- Guided an aquatic invertebrate hike and activity with Girl Scouts at Sleeping Giant State Park in Hamden (20 scouts and 4 adults) (*June 5*).

DURGY, ROBERT J.

- Participated in a virtual meeting of judges for the All-America Selections variety trials on using the Mercado evaluation app (*September 18, 2020*).
- Presented a talk entitled “Math Calculations for Pesticide Application and Sprayer Calibration” to the Pesticide Applicator Training class in Wallingford (26 attendees) (*November 9*).
- Participated in a virtual meeting of the planning committee for the New England Vegetables and Fruit Conference (*January 7, 2021*).
- Participated in a virtual meeting of the planning committee for the New England Vegetables and Fruit Conference (*February 8*).
- Presented talks entitled “Olericulture: Growing Vegetables in the Home Garden” and “Weed Ecology and Control” to the University of Connecticut Master Gardener Program in Haddam (62 attendees) (*February 13*).
- Presented talks entitled “Olericulture: Growing Vegetables in the Home Garden” and “Weed Ecology and Control” to the University of Connecticut Master Gardener Program in Stamford (37 attendees) (*February 15*).
- Presented talks entitled “Olericulture: Growing Vegetables in the Home Garden” and “Weed Ecology and Control” to the University of Connecticut Master Gardener Program in Bethel (32 attendees) (*February 18*).

- Presented talks entitled “Olericulture: Growing Vegetables in the Home Garden” and “Weed Ecology and Control” to the University of Connecticut Master Gardener Program in Farmington (49 attendees) (*February 24*).
- Participated in a virtual meeting of judges for the All-America Selections variety trials on using the Mercado evaluation app (*February 25*).
- Presented a talk entitled “Math Calculations for Pesticide Application and Sprayer Calibration” to the Pesticide Applicator Training class in Farmington (28 attendees) (*March 2*).
- Participated in a virtual meeting of the planning committee for the New England Vegetables and Fruit Conference (*March 9*).
- Presented talks entitled “Olericulture: Growing Vegetables in the Home Garden” and “Weed Ecology and Control” to the University of Connecticut Master Gardener Program in Bethel (36 attendees) (*March 12*).
- Participated in a virtual meeting of the planning committee for the New England Vegetables and Fruit Conference (*March 17*).
- Participated in a virtual meeting of judges for the All-America Selections variety trials on using the Mercado evaluation app (*April 7*).
- Participated in a virtual meeting of the planning committee for the New England Vegetables and Fruit Conference (*April 28*).
- Presented a Vegetable Question and Answer and Garden Tour to the University of Connecticut Advanced Master Gardener Program in Bethel (25 attendees) (*June 29*).

#### EITZER, BRIAN D.

- Participated in an FDA FERN cCAP conference call (*July 9, 2020*).
- Participated in an ASTM D37.03 Laboratory Subcommittee meeting (*July 13*).
- Participated in an APHL Cannabis Community of Practice call (*July 23*).
- Participated in an FDA Food Defense Planning Call (*July 28*).
- Participated in a PI call for the SCRI Ornamental Pollinator grant (*July 28*).
- Was a participant in the Association of Public Health Laboratories (APHL) State Agricultural Chemist conference call with a presentation on the structure of the APHL and impacts of COVID-19 on the laboratories (*August 11*).
- Participated in a monthly FERN cCAP conference call focused on the ending of the current 5-year grant cycle (*August 13*).
- Participated in an FDA-FERN OEIO assignment call; this assignment is a test of the new NFSDX system for exchange of data between the states and the FDA (*August 17*).
- Participated in a conference call of the North American Chemical Residue Workshop’s organizing committee (*September 10*).
- Participated in a conference call of the FDA Laboratory Flexible Funding Model where they discussed how this new grant program will work (*September 17*).
- Participated in an APHL Cannabis Community of Practice Zoom call, which reviewed a previous webinar and had a round robin discussing issues in the various states (*September 24*).
- Presented a webinar entitled “Use of LC-HRMS in the Analysis of Contaminants in Foods, Feeds, and Environmental Samples” during the Thermo Instrument Company user meeting (90 live viewers, 20 on demand viewers) (*September 29*).
- Participated in a webinar on the procedures used to close out the AFRPS program (*November 11*).
- Participated in the APHL Cannabis Community of Practice monthly call focused on updates from across the United States on laboratory and regulatory activities (*November 12*).
- Participated in a webinar on the initiation of the Laboratory Flexible Funding Model’s Human Food and Animal Food and Feed Programs and the Food Defense Program (*November 30*).
- Was a participant in the FDA FERN Food Defense and Human and Animal Food conference call

(January 11, 2021).

- Was a participant in the conference call of the organizing committee of the North American Chemical Residue Workshop (January 14).
- Participated in a conference call of the American Public Health Association Cannabis Community of Practice call (January 14).
- Participated in a conference call of the American Society for Testing and Materials D37 Subcommittee meeting for Laboratory Analysis Standards for Cannabis (January 27).
- Was a participant in the EPA/AAPCO quarterly conference call (January 27).
- Had a series of calls with Michael Rickenbach, Na Liu, and Kayliegh Ryder of the chemical analysis section of the State of Connecticut Department of Emergency Service and Public Protection to assist them in their use of liquid chromatography high resolution mass spectrometry (February 22-24).
- With Ms. Terri Arsenault, had an MS Teams call with the New Jersey Department of Health, Environmental and Chemical Laboratory Services unit to assist them with their use of the Food Emergency Response Network's analytical methods of analysis (April 7).
- Participated in the monthly call of the North American Chemical Residue Workshop's Organizing Committee (April 8).
- Participated in the monthly call of the APHL Cannabis Community of Practice Call (April 8).
- Participated in biweekly calls of the Connecticut Rapid Response Team (April 9, 21).
- Participated in the monthly FDA Laboratory Flexible Funding Model Call (April 12).
- Participated in Connecticut Rapid Response Team bi-weekly phone calls (May 5, 18).
- Participated in the Laboratory Flexible Funding Model monthly call (May 10).
- Participated in the monthly conference call of the North American Chemical Residue Workshop (May 13).
- Participated in LFFM CAP Grantee meetings (360 registered attendees) (May 24, 25, 26, 27), where he was a member of the "Chemistry: Methods and Technology" discussion panel (208 attendees) (May 25).
- Was a participant in the LFFM Human and Animal Food, and Food Defense phone calls (June 14).
- Was a participant in the Connecticut Rapid Response Team bi-weekly phone calls (June 16, 30).
- Was a participant in the Tabletop Exercise of the Rapid Response Teams of Connecticut, Rhode Island, and Massachusetts (June 24).

#### ELMER, WADE H.

- Presented a Plantopia Podcast Interview with David Gadoury for APS on "Earthworms and Soil Health" (July 28, 2020).
- Participated in an American Phytopathological Society (APS) Foundation Committee meeting (12 attendees) (August 3).
- Moderated as chair of the APS Diseases of Ornamental Plants Committee (via Zoom) at the annual APS meeting (78 attendees) (August 3).
- Participated in an Academic Unit Leader & Faculty Meeting at the Annual Meeting of the American Phytopathological Society (43 attendees) (August 4).
- Gave the Introduction Presentation entitled "Charge and Form: Obstacles of Opportunities" at the Centerwide meeting for the Center for Sustainable Nanotechnology via Zoom (43 attendees) (August 9).
- Participated in the USDA NIFA plan of work briefing (44 attendees) (August 9).
- Participated in an American Phytopathological Society (APS) Foundation Committee meeting (12 attendees) (August 18).
- Participated in the USDA NIFA plan of work briefing (44 attendees) (August 19).
- Presented a talk entitled "Nanotechnology and Plant Pathology" to Dr. Zeev Rosenzweig's class on Sustainable Nanotechnology of University of Maryland Baltimore County (9 attendees) (October 30).

- Gave a presentation via Zoom entitled “Nanotechnology in Plant Pathology” at the 4th Annual International NanoForAgri conference on Application of Nanotechnology for Sustainable, Productive and Safer Agriculture and Food Systems (17 attendees) (*November 4*).
- Met (via Zoom) with Dr. Rebecca Melanson of Mississippi State University to discuss Special sessions for 2021 APS meetings (*December 11*).
- Participated as a committee member in Cora McGehee’s PhD General defense (via Webex) (7 attendees) (*December 11*).
- Gave a presentation via Zoom entitled “Application of Nanoparticles for Disease Suppression and Enhanced Yield in Vegetables” at the Nanotechnology Research and Innovation Forum 2020 (38 attendees) (*December 16*).
- With Dr. Jason White, met via Zoom with Dr. Maliik Maaza, UNESCO UNISA IITL/NRF Africa Chair in Nanosciences & Nanotechnology) to discuss CAES cooperation with African nanotechnology projects (*December 22*).
- With Dr. Jason White and Mr. Michael Last, met with State Senator Christine Cohen, Representative Dorinda Borer, Representative Joe Gresko, and Mr. Terry Jones (Vice President, CAES Board of Control) in Jones Auditorium and toured several laboratories (*December 30*).
- With Dr. Jason White and Mr. Michael Cavadini, testified before the Commission on Human Rights and Opportunities on the CAES Affirmative Action Plan (43 attendees) (*January 13, 2021*).
- Participated via WebEx in the UConn Plant Science & Landscape Architecture (PSLA) Department Head search (10 attendees) (*February 4*).
- Presented via Zoom a keynote lecture entitled “Role of Nanoscale Cu in the Suppression of Plant Diseases” at Role of Nanotechnology in Modern Agriculture Division of Plant Pathology, SKUAST-K, Shalimar, Jammu & Kashmir, India (46 attendees) (*February 9*).
- Participated via WebEx in PSLA interviews for two candidates (12 attendees) (*February 18*).
- Participated via MS Teams in the CAES Nano updates (*March 8*).
- Participated in a web conference entitled “How Can Open-Access University Facilities Best Support Food and Nutrition Security” and in the breakout session “Pests and Pathogens” with Dr. Jason White (*March 9*).
- Participated in the Extension and Industry Update, served as a judge for the Graduate Student competition, participated in the business meeting, and gave a presentation entitled “Influence of Single and Combined Mixtures of Metal Oxide Nanoparticles on Eggplant Growth, Yield, and Verticillium Wilt Severity” (130 participants) at the annual meeting of Northeastern Division of the American Phytopathological Society (*March 10-11*).
- Participated via Zoom in the American Phytopathological Society Foundation meeting (*March 17*).
- With Drs. Jason White and Yi Wang, participated via MS Teams in the CAES-UMASS Nano S update (*March 19*).
- Participated as a member of the UConn Search Committee for the PSLA Department Head via WebEx in the interviews of Dr. Sydney Everhart and Dr. Stacey Bonos (*March 24, 25, 29, 30*).
- Participated as a member of the UConn Search Committee for the PSLA Department head via WebEx in the interviews of candidates (*April 15*).
- Participated, via Zoom, in the American Phytopathological Society Foundation meeting (*April 21*).
- Participated as a member of the UConn Search Committee for the PSLA Department Head via WebEx in the interviews of Dr. Mengmeng Gu (*April 27-28*).
- As a member of the UConn Search Committee, participated in a final selection meeting for the PSLA Department Head via WebEx (*May 4*).
- Gave a virtual presentation entitled “Role of Nanoscale Cu in Suppressing Plant Diseases” at the 3rd International Meeting on Plant Science and Research (146 attendees) (*May 10*).
- With Drs. Jason White, Christian Dimkpa, and Ishaq Adisa, participated in a NIFA grant project conference on Nano P via Zoom with Ms. Jaya Borgata for Nano P research at CAES (*May 14*).

- With Drs. Jason White and Yi Wang, participated via Zoom in the CAES-UMASS Nano S update (6 attendees) (*May 21*).
- With Drs. Jason White and Yi Wang, participated via Zoom in the CAES-UMASS Nano S update (6 attendees) (*June 1*).
- Held a Zoom conference with Drs. Robert McGovern and Meg McGrath concerning their Springer publication (*June 14*).
- With Drs. Jason White, Christian Dimkpa, and Ishaq Adisa, participated in a Zoom conference regarding a NIFA grant project on nano P with Ms. Jaya Borgatta for nano P research at CAES (*June 29*).

#### FERDOUS, ZANNATUL

- Participated in the “Biology of Vector-borne Diseases” course organized by the University of Idaho Center for Health in the Human Ecosystem (CHHE) (*June 20-26, 2021*).

#### GLORIA-SORIA, ANDREA

- Gave a virtual talk entitled “Museum Specimens Reveal the Genomics of Extinct Populations of *Aedes aegypti* in the Mediterranean” (126 attendees); appeared as co-author of a virtual talk by her postdoc Andrés Gómez-Palacio entitled “Identifying and Accounting for Ascertainment Bias in the *Ae. aegypti* SNP-Chip Using Whole Genome Sequencing” (56 attendees); and was author of two papers highlighted, all during the Annual Meeting of the Entomological Society of America (*November 11-25, 2020*).
- Presented a talk entitled “The Mosquito and the Worm” at the Center for Genetic Analysis of Biodiversity weekly virtual seminar at Yale University (15 attendees) (*June 1, 2021*).
- Gave a talk entitled “Two Subspecies of the *Aedes aegypti* Mosquito Are Found in Sudan and Originated from Recent Independent Invasion Events” at the Society for the Study of Evolution Annual meeting, Virtual Evolution 2021 (2,668 attendees) (*June 21-25*).

#### HASSANI, MOHAMED-AMINE

- Presented a seminar entitled “The Bacterial and Fungal Microbiota of Wheat” to students in Master of Science in Nutrition from School of Dietetics and Human Nutrition, Marseille, France (7 students) (*May 18, 2021*).

#### HISKES, ROSE T.

- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee meeting (*July 16, 2020*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee meeting (*July 28*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meeting (*August 11*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meeting (*August 25*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meeting (*September 8*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meeting (*September 22*).
- Co-chaired a virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meeting (*September 29*).
- Co-chaired virtual Connecticut Invasive Plant Working Group symposium planning committee Zoom meetings (*October 6*).

- Presented “Managing Autumn Olive: A Homeowner’s Perspective” and moderated the Aquatic Invasives Breakout Session at the virtual CIPWG Invasive Plant Symposium (380 attendees) (*October 7*).
- Gave a porcelain berry update from the Connecticut Invasive Plant Working Group (CIPWG) to the Connecticut Association of Conservation and Inland Wetlands Commissions (CACIWC) virtual Annual Conference (70 attendees) (*December 5*).
- Co-chaired the virtual Connecticut Invasive Plant Working Group symposium planning committee wrap-up Zoom meeting (*December 8*).
- Participated in the Invasive Plants Council WebEx meeting for the Connecticut Invasive Plant Working Group (CIPWG) (*February 16, 2021*).
- With Dr. Yonghao Li, reviewed tree diseases for the Connecticut Tree Protective Association’s Arboriculture 101 class via Zoom (53 attendees) (*February 24*).
- Chaired the virtual Connecticut Invasive Plant Working Group Outdoor Educator planning committee Zoom meetings (*March 2, 25*).

#### HUNTLEY, REGAN

- Served as a judge for the Quinnipiac Chapter of the Sigma Xi student research poster session via Zoom for five student poster presentations (*April 26, 2021*).

#### JOHNSON, REBECCA

- Judged undergraduate presentations for the virtual Quinnipiac Chapter Sigma Xi Student Research Conference (*April 26, 2021*).

#### KERIÖ, SUSANNA

- Presented a webinar entitled “Drought and Urban Trees” in the Connecticut Tree Protective Association’s annual meeting (200 attendees) (*January 21, 2021*).
- Presented a talk entitled “Perspectives on Urban Tree Health” in the Forest Health Monitoring Workshop via Zoom (76 attendees) (*March 4*).
- Presented a webinar entitled “Urban Tree Health in Connecticut” in the Quinnipiac University’s Sigma Xi Society’s meeting (42 attendees) (*April 7*).
- Presented a webinar on urban forest health for the Experiment Station Associates (*April 21*).
- Presented a webinar entitled “Drought and Urban Trees” to Connecticut tree wardens (13 attendees) (*May 13*).

#### KODATI, SRIKANTH

- Attended and presented a poster entitled “In Vitro Study on the Effect of Temperature, Leaf Wetness Period, and Cultivar Susceptibility on Boxwood Blight Incidence” as a part of the Northeastern Division of the American Phytopathological Society virtual meeting (*March 10-12, 2021*).

#### KROL, WALTER J.

- With Ms. Terri Arsenault, attended a day-long virtual annual meeting with those involved in the Multistate Research Project S1084 - “Industrial Hemp Production, Processing, and Marketing in the U.S.” and presented findings from the 2020 hemp growing season (approx. 75 attendees) (*February 11, 2021*).
- Served as a judge for the Connecticut FFA State Virtual Agriscience Fair (*May 21*).
- Was a co-author of the talk entitled “Enhancing the Analysis of Abrin Protein Through ELISA to LC-MS Platform Transfer” in the LFFM Chemistry Track section, Chemistry Method Development, which was presented by Dr. Christina Robb (*May 26*).

#### LAMONDIA, JAMES A.

- Participated in the annual meeting of the Connecticut Agricultural Experiment Station Research Foundation (*July 2, 2020*).
- Participated in an SCRI Grant project meeting (22 attendees) (*July 13*).
- Participated in an SCRI Grant project meeting (22 attendees) (*July 22*).
- Participated in an SCRI Grant project meeting (22 attendees) (*July 27*).
- Participated in the Century Farm Award presentation to Fish and Kent Farm in Suffield (*July 29*).
- Participated in the Outstanding Young Farmer Award presentation to Jimmy Bloom in Norwalk (*July 30*).
- Participated in an SCRI Grant project meeting regarding extension and outreach for boxwood blight (*August 24*).
- Was interviewed about tobacco culture, history, and impacts of the pandemic on tobacco production in Connecticut by Miasha Lee for Reminder Publications (*August 25*).
- Was interviewed about beech leaf disease in Connecticut by Brendan Crowley for the Connecticut Examiner (*September 21*).
- Participated in an SCRI Grant project outreach planning Zoom meeting (*October 2*).
- Participated in a Saunders Bros. Nursery Virtual Boxwood Field Day (*October 8*).
- Spoke about nematode management research results at the virtual annual meeting of the Northeast Regional Multistate Nematology Technical Committee (NE-1640) (15 attendees) (*October 21-22*).
- Participated in an SCRI Boxwood Blight Grant project quarterly research update Zoom meeting (*November 18*).
- Participated in a SCRI Boxwood Blight Grant project Zoom meeting (*December 4*).
- Participated in the Society of Nematologists annual meeting (*December 15-16*).
- Participated in a Connecticut Agricultural Information Council Zoom meeting to plan Ag Day at the Capitol (*January 12, 2021*).
- Participated in a Connecticut Ag Information Council Zoom meeting to plan Ag Day at the Capitol (*February 1*).
- Participated in a Beech Leaf Disease call (*February 3*).
- Participated in an SCRI extension team meeting (*February 11*).
- Spoke about “Management of Boxwood Blight” at a virtual Chesapeake Green Horticultural Symposium (130 attendees) (*February 18*).
- With Dr. Richard Cowles, presented “Boxwood Blight and Boxwood Moth, Not the End of the Industry” to the EPA Region 1 Pesticide Inspector Residential Training Program (41 attendees) (*February 2*).
- Spoke about research plans for Diaporthe leaf spot and cone blight management at the CT Hop Growers Association meeting held virtually (7 attendees) (*March 4*).
- With Dr. Robert Marra, presented Beech Leaf Disease for a Bartlett Arboretum and Arnold Arboretum Educational Webinar (168 attendees) (*March 9*).
- Participated as an expert mentor in the NED APS Careers 101 CV Workshop as a part of the virtual regional meeting (25 attendees) (*March 10*).
- Participated in the Northeast/Potomac Division meeting of the American Phytopathological Society (*March 10-12*).
- Welcomed attendees and introduced Ag Day at the Capitol as chair of the CT Agricultural Information Council, and participated in the virtual Ag Day Program (40 attendees) (*March 23*).
- Mentored a Ph.D. student in a one-on-one follow-up to the NED-APS Careers 101 CV Workshop (*March 24*).
- Conducted a boxwood blight training program including boxwood blight biology and management updates for Prides Corner Farms (8 attendees) (*April 6*).
- Participated in a national Potato Cyst Nematode Research Conference call to report research progress (12 attendees) (*April 13*).

- Conducted oral exams for candidates for the Connecticut arborist license and participated in the quarterly meeting of the Connecticut Tree Protection Examining Board in Hamden (*April 14*).
- Was interviewed about the Tobacco Station/Valley Laboratory and its role in tobacco production in relation to the 60th anniversary of the movie “Parrish” by Jenny Hawran, Howard Marsh, and Jamil Ahmed of Windsor Community Television and James Daniels of the CT Valley Tobacco Museum (*April 28*).
- Spoke with representatives of Lancaster Leaf and ITG about tobacco extension and the 100-year anniversary of the Tobacco Station/Valley Laboratory (4 attendees) (*May 3*).
- Participated in a SCRI Boxwood Blight Grant Project Directors Zoom meeting (12 attendees) (*May 19*).
- Participated in the Beech Leaf Disease Update Zoom meeting (24 attendees) (*June 2*).

#### LI, DEWEI

- Participated in the “Forest Pest Management Forum 2021,” a virtual meeting organized by Natural Resources Canada in support of the National Forest Pest Strategy (*February 16 and 17, 2021*).

#### LI, YONGHAO

- Participated in the National Plant Diagnostic Network Online Communications and Web Portal Committee Zoom meeting (8 adults) (*July 8, 2020*).
- Presented “Plant Disease Updates 2020” at the Connecticut Tree Protective Association Summer Meeting via Zoom (24 adult attendees) (*August 13*).
- Participated in the National Plant Diagnostic Network Online Communication and Web Portal Committee Meeting via Zoom (8 adult attendees) (*August 18*).
- Participated in the National Plant Diagnostic Network Online Communication and Web Portal Committee Meeting via Zoom (8 adults) (*September 9*).
- Participated in the Northeast Plant Diagnostic Network Regional Meeting via Zoom (21 adults) (*September 21*).
- Presented “Tree Diseases” for the Connecticut Tree Warden School via Zoom (38 adults) (*October 1*).
- Participated in the National Plant Diagnostic Network Online Communication and Web portal Committee Meeting via Zoom (9 adults) (*October 14*).
- Presented “All About Fungi and Fungicides - What Every Gardener Needs to Know” for UConn Master Gardener classes via Zoom (31 adults) (*November 10*).
- Participated in the National Plant Diagnostic Network Online Communication and Web Portal Committee Meeting via Zoom (9 adults) (*November 11*).
- Presented “Plant Disease Updates 2020” and “The National Plant Diagnostic Network Online Communications and Web Portal Committee Updates” at the Northeast Plant Diagnostic Network Zoom meeting (18 adults) (*December 9*).
- Spoke about the Plant Disease Information Office to visiting state legislators (6 adults) (*December 30*).
- Gave a presentation about the Plant Disease Information Office to the full Environment and Public Health Committees of the Connecticut General Assembly via Zoom (22 attendees) (*January 19, 2021*).
- Presented “Spring and Summer Gardening Tips” to members of the Leete’s Island Garden Club via Zoom (22 adults) (*February 9*).
- Participated in the National Plant Diagnostic Network Online Communication and Web portal Committee Meeting via Zoom (8 adults) (*February 10*).
- Presented “Diseases of Trees” as a class of the Connecticut Tree Protective Association Arboriculture 101 Course via Zoom (54 adults) (*February 17*).
- Presented “Plant Diseases in the Garden” as a UConn Master Gardener Class via Zoom (51 adults) (*February 19*).
- Presented “Selection and Care of Houseplants” for the Southington Library Adult Program via Zoom

- (23 adults) (*February 24*).
- Participated in a Mid-Course Review of the Connecticut Tree Protective Association Arboriculture 101 Course via Zoom (55 adults) (*February 24*).
  - Presented “Identifying & Managing Diseases in Greenhouse Tomatoes” at the 14th Annual Agriculture & Food Conference of Southeastern Massachusetts via Zoom (8 adults) (*February 28*).
  - Presented “Weather and Foliar Diseases” at the Forest Health Monitoring Workshop via Zoom (77 adults) (*March 4*).
  - Presented “Organic Disease Control” at the Connecticut and Rhode Island NOFA Winter Conference via Zoom (22 adults) (*March 6*).
  - Presented “Turfgrass Pest Identification and Management” at the SiteOne, CAES, Bayer, and Corteva Lunch and Learn via Zoom (14 adults) (*March 10*).
  - Presented “Disease Updates in Connecticut” at the 2021 American Phytopathological Society Potomac Division and Northeastern Division Joint Virtual Meeting (47 adults) (*March 10*).
  - Participated in the National Plant Diagnostic Network Online Communication and Web portal Committee Meeting via Zoom (7 adults) (*March 16*).
  - Presented “Pruning 101” for the Kensington Garden Club via WebEx (76 adults) (*March 18*).
  - Presented “Backyard Small Fruit 101” for the Avon Free Public Library Adult Program via Zoom (16 adults) (*April 12*).
  - Presented “Tree Disease Updates” for the Tree Wardens Association of Connecticut Education Program via Zoom (18 adults) (*April 13*).
  - Presented “Backyard Composting” for the Windsor Public Library – Wilson Branch Adult Program via Zoom (16 adults) (*April 17*).
  - Presented “Backyard Small Fruits” at the Wethersfield Garden Club member’s meeting in Wethersfield (24 adults) (*May 3*).
  - Participated in the National Plant Diagnostic Network Online Communication and Web portal Committee Meeting via Zoom (8 adults) (*May 12*).
  - Presented “Spring and Summer Gardening Tips” for the Rockville Public Library adult education program via Zoom (6 adults) (*May 19*).
  - Presented “Organic Disease Control” for Weston Community Garden members via Zoom (30 adult attendees) (*May 20*).
  - Presented “Backyard Small Fruits” for the Rockville Public Library Adult Education Program via Zoom (5 adults) (*June 2*).
  - Talked about Disease Management in Christmas Tree Farms at a Twilight Meeting of the Connecticut Christmas Tree Growers Association held in Preston (50 adults) (*June 22*).
  - Staffed the CAES booth at the SiteOne Open House with The Connecticut Agricultural Experiment Station and Other Supplier Partners in East Haven (*June 29*).

#### LINSKE, MEGAN A.

- Participated in a conference call with members of the Northeast Regional Center of Excellence in Vector Borne Diseases on project logistics for a proposed *Haemaphysalis longicornis* overwintering study (*September 2, 2020*).
- With Dr. Scott Williams, Mr. Michael Short, and Mrs. Jamie Cantoni, discussed and demonstrated Lyme disease ecology field work for Dr. Chris Kerantzas (Yale University Medical Fellow) (*September 23*).
- Participated in the Northeast Section of the Wildlife Society Executive Committee Fall Meeting as President-Elect and Chair of the Workshop Committee (*October 7*).
- Participated in the Northeast Regional Center for Excellence in Vector-Borne Diseases training seminar as a trainee (*October 19*).
- Participated in a planning call with Bedoukian, Inc., to discuss potential tick repellent preliminary trials

(October 28).

- Was appointed to University of Memphis doctoral student Rebecca Bingham’s graduate committee (December 1).
- Participated in a virtual meeting with members of the Wildlife Society Bylaws Subcommittee as President-Elect of the Northeast Section of the Wildlife Society (February 22, 2021).
- Gave an invited lecture about the role of wildlife diversity in tick and tickborne pathogen life cycles for the “Wildlife in Connecticut” speaker series for the Meig’s Point Nature Center, Hammonasset Beach State Park (February 27).
- As a member of her graduate committee, participated in the doctoral dissertation proposal defense of Rebecca Bingham, University of Memphis, entitled “The Search for Lyme Disease Prioritizing Areas for Wildlife Vaccine Deployment” (April 21).
- Hosted the annual NETWS members meeting as Section President and Chairperson of the Workshop Committee (April 22).
- Was interviewed about climate change impacts on ticks and tick-borne illnesses by Edward Ricciuti for *Entomology Today* (June 22).

MARRA, ROBERT E.

- Was interviewed about beech leaf disease and oak wilt by Jan Ellen Spiegel for the *CT Mirror* (July 16, 2020).
- Presented, via Zoom, a webinar entitled “Ecology of Forest Fungi” to the Daytime Gardeners Club of North Haven (12 adults) (July 28).
- Participated in a Beech Leaf Disease Working Group Zoom meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the U.S. Forest Service (30 participants) (August 4).
- Presented, via Zoom, a webinar entitled “Ecology of Forest Fungi” to the Menunkatuck chapter of the National Audubon Society (180 adults) (September 8).
- Was interviewed on beech leaf disease by Brendan Crowley for *CT Examiner* (<https://ctexaminer.com/2020/09/28/deadlybeech-leaf-disease-identified-across-connecticut-and-rhode-island/>) (September 23).
- Participated in a Beech Leaf Disease Working Group Zoom meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the US Forest Service (35 participants) (October 21).
- Presented a talk entitled “Beech Leaf Disease: A New Disease for Connecticut” at the Sussex Plant Biology Symposium via Zoom (November 6).
- Presented a 2-hour talk entitled “Weather Extremes and Their Impacts on Tree Diseases” to the Fairfield County Cooperative Extension, for the UConn Master Gardener Certification program (56 adults) (November 10).
- Participated in a meeting (via MS Teams) of State Coordinators for the Forest Ecosystem Monitoring Cooperative (December 2).
- Participated in a Beech Leaf Disease Working Group Zoom meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the US Forest Service (45 participants) (December 9).
- Participated (via MS Teams) in the Steering Committee meeting of the Forest Ecosystem Monitoring Cooperative (December 17).
- Participated in the Advisory Board meeting to plan for the annual meeting (in March) of the Connecticut Conference on Natural Resources (December 22).
- Participated in a Connecticut CAPS meeting (via Zoom) where he presented an update on Beech Leaf Disease (January 20, 2021).
- Participated in a plot network meeting of the Forest Ecosystem Monitoring Cooperative (January 28).

- Participated in a Beech Leaf Disease Working Group Zoom meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the US Forest Service (45 participants) (*February 3*).
- Participated in an organizational meeting (via Zoom) of the State Partnership Committee for the Forest Ecosystem Monitoring Cooperative (30 participants) (*February 16*).
- Participated (via MS Teams) in the State Coordinators Monthly Check-in for the Forest Ecosystem Monitoring Cooperative (20 participants) (*February 18*).
- Participated (via Zoom) in the National Invasive Species Awareness Week (NISAW) meeting (100+ participants) (*February 25*).
- Presented a talk, via Zoom, entitled “Beech Leaf Disease: Updates for Connecticut” for the Forest Health Monitoring Workshop (80 participants) (*March 4*).
- Presented a talk, via Zoom, on beech leaf disease for a webinar series held jointly by the Bartlett Arboretum and Harvard’s Arnold Arboretum (168 participants) (*March 9*).
- Met via MS Teams with beech leaf disease collaborators at the USDA-ARS and Ontario Ministry of Natural Resources to discuss current and planned research (5 participants) (*March 9*).
- Participated in and co-hosted the annual Connecticut Conference on Natural Resources, via Zoom (356 participants) (*March 15*).
- Participated in, via MS Teams, the Forest Ecosystem Monitoring Cooperative State Coordinators meeting (25 participants) (*March 18*).
- Participated in, via MS Teams, the Forest Ecosystem Monitoring Cooperative Steering Committee meeting (12 participants) (*March 18*).
- Participated, via Zoom, in the annual meeting of the American Phytopathological Society, Northeastern Division, where he presented an invited symposium talk on “Beech Leaf Disease” (130 participants) (*March 10-12*).
- Presented a talk, via Zoom, entitled “Beech Leaf Disease: Updates for Connecticut” for the Tree Wardens’ Association of Connecticut (25 participants) (*April 13*).
- Presented a talk, via Adobe Connect, entitled “Beech Leaf Disease in Connecticut: Survey Results and Research” for the USFS Beech Leaf Disease Workshop (350 participants) (*April 15*).
- Participated in, via MS Teams, the Forest Ecosystem Monitoring Cooperative State Coordinators meeting (25 participants) (*April 16*).
- Participated as a judge in the Sigma Xi Quinnipiac Chapter Poster Competition (*April 26*).
- Presented a talk, via Zoom, entitled “The Impact of Climate Change and Weather Extremes on Tree Diseases” for the Riverside Garden Club (30 participants) (*April 27*).
- Participated in, via MS Teams, reviewing competitive research proposals for the Forest Ecosystem Monitoring Cooperative (20 participants) (*April 29*).
- Participated in a Beech Leaf Disease Working Group Zoom meeting with collaborators from Ohio, West Virginia, Ontario (CA), New York, USDA-ARS, and the US Forest Service. (45 participants) (*June 2*).
- Presented a talk, via Zoom, entitled “Beech Leaf Disease in Connecticut,” for a consortium of Fairfield County Land Trusts and Conservation Commissions (215 participants) (*June 15*).
- Participated, via MS Teams, in the Forest Ecosystem Monitoring Cooperative State Coordinators meeting (25 participants) (*June 17*).

#### MAYNARD, ABIGAIL A.

- Participated in the G3 Governor’s Council on Climate Change, Agriculture/Soils Working Group Zoom meetings (*July 8, 2020*).
- Spoke about growing vegetables at Lockwood Farm in a video to be used in Lower School classes at Hamden Hall Country Day School (4 teachers) (*September 18*).
- Reported on Station activities at a quarterly meeting of the Council on Soil and Water Conservation via

Zoom (15 adults) (*September 24*).

- Spoke on “New Crops for Connecticut” to the Wethersfield Garden Club (21 adult attendees) (*October 5*).
- Participated in a Zoom meeting of the Soils and Agriculture subcommittee of the Governor’s Committee on Climate Change (*November 2*).
- Reported on Station activities at a quarterly meeting of the Council on Soil and Water Conservation (*December 17*).
- Reported on Station activities, via Zoom, to a quarterly meeting of the Council on Soil and Water Conservation (*March 18, 2021*).
- Reported on Station activities to a quarterly meeting of the Council on Soil and Water Conservation via Zoom (16 adults) (*June 17*).

McMILLAN, JOSEPH R.

- Presented a virtual lecture entitled “Efficacy of Larvicide Treatments to Suppress *Culex pipiens* Populations” and was a panelist in a CDC Vector-borne Disease Centers of Excellence seminar series (approx. 200 attendees; approx. 50 students) (*February 25, 2021*).
- Presented a virtual seminar entitled “Mosquito & Disease Ecology in CT” to the UConn New Haven Master Gardener’s 2021 Spring cohort (approx. 10 attendees) (*March 16*).

MOLAEI, GOUDARZ

- Was interviewed about tick testing procedures at the CAES-TTL and tick activity in Connecticut by the *New Haven Register* (*July 21, 2020*).
- Was interviewed about tick activity and repellents for humans and dogs by the *New York Magazine* (*July 23*).
- Was interviewed about tick activity and factors influencing tick availability and abundance by the *CT Mirror* (*July 30*).
- Gave an invited virtual talk entitled “Climate Change and Vectorborne Diseases in Connecticut” to the CT Governor’s Council on Climate Change (*August 7*).
- Was interviewed about the discovery of the Gulf Coast tick in Connecticut and its public health implication by NPR (*August 26*).
- Was interviewed about the Gulf Coast tick incursion into Connecticut by Patch Media (*August 31*).
- Was interviewed regarding tick activity by Fox 61 (<https://www.fox61.com/article/news/local/covid-concerns-west-nile-eee-lyme/520-f42ef336-679a-49e9-9aab-dc3b512026c2>) (*September 9*).
- Was interviewed regarding tick activity by the *New Haven Register* (<https://www.nhregister.com/health/article/Population-of-invasive-tick-species-discovered-in15565811.php>) (*September 14*).
- Was interviewed regarding tick activity by Fox 61 (<https://www.fox61.com/article/news/local/asian-longhorn-tick-discovered-in-fairfield-county/520-d2a5a368-22c3-4bbb-bcbfc214ed17d06e>) (*September 14*).
- Was interviewed regarding tick activity by WICC600 radio (*September 24*).
- Was interviewed regarding tick activity by Rich Kirby, editor for Patch Media (<https://patch.com/connecticut/across-ct/asian-longhorned-ticks-arelatest-bugs-set-shop-ct>) (*September 16*).
- Was interviewed about tick activity in 2020 and the recent discoveries of the invasive ticks in Connecticut by the *Republican-American* (*October 7*).
- Was interviewed about ticks by *The Day* (<https://www.theday.com/localnews/20201218/green-and-growing-line-of-defense-against-ticks-in-winter-woodlands>) (*December 2*).
- Was interviewed about ticks by News 8 (<https://www.wtnh.com/news/animalsand-wildlife/be-vigilant-for-ticks-that-remain-active-year-round/>) (*December 3*).

- Presented two talks entitled “Host Interactions of *Aedes albopictus*, an Invasive Vector of Arboviruses, in mid-Atlantic USA” and “Climatic and Environmental Determinants of the Spatial Distribution and Abundance of Disease Vectors, *Ixodes scapularis* and *Amblyomma americanum*” at the virtual meeting of the Northeast Regional Center for Excellence in Vector-borne Diseases (185 attendees) (January 12, 2021).
- Gave a short talk entitled “Tracking Ticks and Tick-borne Diseases in Connecticut” to a joint meeting of the Environment and Public Health Committees of the Connecticut General Assembly (25 attendees) (January 19).
- Was interviewed about the CAES Tick Testing Laboratory, ticks, and tick-borne diseases by NPR (January 20).
- Was interviewed about ticks by Eyewitness News 3 ([https://www.wfsb.com/news/state-sees-a-spike-in-tick-bites-due-to-warmer-weather/article\\_a39c96f6-8ce0-11eb-91a1-b7674de6f72c.html](https://www.wfsb.com/news/state-sees-a-spike-in-tick-bites-due-to-warmer-weather/article_a39c96f6-8ce0-11eb-91a1-b7674de6f72c.html)) (March 24).
- Was interviewed by the *Republican-American* <https://www.repam.com/local/localnews/2021/04/24/turns-return-to-state-with-a-vengeance/> (April 24).
- Was interviewed on the tick activity season and forecast by FOX61 (April 26).
- Was interviewed about ticks by the *Hartford Courant*, <https://www.courant.com/news/connecticut/hc-news-ct-bad-year-for-ticks-20210429-wzy74kwi6bflxbj7s4gy3zoe4a-story.html> (April 27).
- Presented a virtual talk entitled “Climate Change and Accelerating Invasion Potentials of Mosquito and Tick Vectors of Human Diseases” to Y’s Men, a community group in Meriden (26 attendees) (April 27).
- Was interviewed about ticks by NEWS 8, <https://www.wtnh.com/news/animals-and-wildlife/scientists-warn-of-bad-ticks-season-ahead-for-ct/> (April 30).
- Was interviewed about ticks by the *Connecticut Post*, <https://www.ctpost.com/news/article/Tick-tick-boom-Disease-carrying-insects-on-the-16145577.php> (April 30).
- Was interviewed on tick activity this year and measures to prevent tick exposures by *The Newtown Bee* (April 30).
- Was interviewed on ticks and tick-borne diseases by WCBS 880 Radio, <https://www.msn.com/en-us/health/medical/connecticut-sees-increase-in-tick-populations/ar-BB1giXio> (May 3).
- Was interviewed on ticks and tick-borne diseases by News 12 Connecticut, <https://connecticut.news12.com/hikers-beware-ticks-may-be-extra-active-this-year-ct-researchers-say> (May 3).
- Was interviewed on ticks and tick-borne diseases by WTIC NewsTalk 1080 AM (May 3).
- Was interviewed on ticks and tick-borne diseases by Patch Media, <https://patch.com/connecticut/wilton/ticks-are-overrunning-ct-what-can-be-done-it> (May 4).
- Was interviewed on ticks and tick-borne diseases by Channel 3, [https://www.wfsb.com/news/wet-warm-weather-causing-an-increase-in-the-tick-population-in-ct/article\\_dffa3742-ae9c-11eb-ae51-27a1ec33f675.html](https://www.wfsb.com/news/wet-warm-weather-causing-an-increase-in-the-tick-population-in-ct/article_dffa3742-ae9c-11eb-ae51-27a1ec33f675.html) (May 5).
- Was interviewed on ticks and tick-borne diseases by Fox 5 New York, <https://www.fox5ny.com/news/tick-populations-on-the-rise-across-the-tri-state> (May 5).
- Was interviewed on ticks and tick-borne diseases by the *Washington Post*, [https://www.washingtonpost.com/lifestyle/wellness/ticks-protect-lyme-deer-dog-lonestar/2021/05/22/6c41bb40-ba54-11eb-a6b1-81296da0339b\\_story.html](https://www.washingtonpost.com/lifestyle/wellness/ticks-protect-lyme-deer-dog-lonestar/2021/05/22/6c41bb40-ba54-11eb-a6b1-81296da0339b_story.html) (May 18).
- Was interviewed on ticks and tick-borne diseases by WFSB Eyewitness News 3, [https://www.wfsb.com/news/tick-season-proving-to-be-one-of-the-worst-yet/article\\_09533b10-b90c-11eb-8dd6-ebbf992adee.amp.html](https://www.wfsb.com/news/tick-season-proving-to-be-one-of-the-worst-yet/article_09533b10-b90c-11eb-8dd6-ebbf992adee.amp.html) (May 19).
- Participated in a Facebook Live webcast organized by *The Newtown Bee* and Newtown Health Department entitled “Tickborne Disease Awareness & Prevention,” <https://www.newtownbee.com/05122021/bee-webcast-focusing-on-tickborne-disease-prevention/> (May 21).

- Was interviewed on ticks and tick-borne diseases by NBC, <https://www.yahoo.com/now/warning-surge-tick-activity-americans-231139833.html> (May 25).
- Gave a virtual invited talk entitled “Public Health Importance of Ticks and Tick-Associated Diseases” to the Avon Free Public Library, <https://www.avonctlibrary.info/event/ticks-and-tick-associated-diseases/> (57 attendees) (May 25).
- Was interviewed on ticks and tick-borne disease this year in Connecticut by WFSB (June 11).
- Was interviewed on ticks and tick-borne disease this year in Connecticut by NBC Connecticut (June 11).
- Was interviewed on tick activity this year and changes in the frequency and dynamics of ticks and tick-borne diseases in Connecticut by *Southern Boating Magazine* (June 17).

#### NASON, SARA L.

- Participated in a conference call for the Benchmarks and Publications for Non-Targeted Analysis working group (July 29, 2020).
- Participated in virtual meetings of the Benchmarking and Publications for Non-Targeted Analysis working group (August 5, 6).
- Participated in a conference call on per- and polyfluoroalkyl substances (PFAS) analysis methods with scientists from CT DEEP, DPH, and the University of Connecticut (August 14).
- Participated in a conference call with representatives from CT, MA, NY, NJ, VT, NH, and ME to discuss regulatory analysis of PFAS in municipal biosolids (August 18).
- Launched the website <https://nontargetedanalysis.org> for the Benchmarking and Publications for Non-Targeted Analysis working group (August 19).
- Participated in virtual meetings of the Benchmarking and Publications for Non-Targeted Analysis working group (September 3, 11, 24).
- Participated in calls for the Benchmarking and Publications for Non-Targeted Analysis working group (October 1, 6, 22).
- Virtually coached students at the Sound School on science fair projects (October 1, 23, 27).
- Presented a poster entitled “Measuring PFAS and Assessing Phytoremediation at the Former Loring Air Force Base – A Community Based Project” at the virtual Conference, PFAS in Our World (October 13-14).
- Gave a virtual talk entitled “Validation of Novel Software for Non-Targeted Analysis of PFAS,” gave two posters entitled “Non-Targeted Analysis of Primary Sewage Sludge Collected During the COVID-19 Pandemic” and “Establishing Shared Vocabulary and Reporting for Non-Targeted Studies: An Update from the Benchmarking and Publications for Non-Targeted Analysis Working Group,” served as a panelist at the Exploring Career Choices student event, and served as a judge for student presentations, all at the SETAC SciCon2 conference (November 15-19).
- Met with Representative Dorinda Borer, Representative Joseph Gresko, and Senator Christine Cohen on their visit to CAES (December 30).
- Was interviewed via email by c-hit.org for a news article, which appeared on c-hit.org (<http://chit.org/2020/12/30/beyond-covid-19-waste-testing-a-vast-public-health-frontier/>), as well as in the *New Haven Register* and the *CT Mirror* (December 30).
- Participated in virtual meetings of the Benchmarking and Publications for Non-Targeted Analysis working group (January 7, 13, and 21, 2021).
- Presented virtually to the Connecticut legislature committees on Public Health and the Environment regarding PFAS and her research on chemical contaminants in sewage sludge during the COVID-19 pandemic (approx. 25 attendees) (January 19).
- Participated in virtual meetings of the Benchmarking and Publications for Non-Targeted Analysis working group (February 16, 18).
- Gave a virtual talk entitled “PFAS Analytical Methods” at the Association of American Pesticide

- Control Official's annual laboratory directors meeting (35 attendees) (*March 9*).
- Participated in a call for the Benchmarking and Publications for Non-Targeted Analysis working group and was officially appointed as a webmaster for a one-year term (*March 24*).
- Participated in a virtual meeting of the Benchmarking and Publications for Non-Targeted Analysis working group (*April 20*).
- Judged posters for the Quinnipiac Chapter Sigma Xi Student Research Conference (*April 26*).
- Gave a seminar entitled "Chemical Characterization of Primary Sewage Sludge Collected During the COVID-19 Pandemic: Trends in Pharmaceuticals, Drugs, and Other Molecules of Interest" for the CAES Seminar Series (approx. 75 attendees) (*April 28*).
- Presented a talk entitled "Drugs, Mental Health, and Disinfectants: Changes in Sewage Sludge Chemical Signatures During the COVID-19 Pandemic" at the virtual SETAC Europe meeting (*May 3-6*).
- Hosted intern Alex Zhong through the Doris Duke Virtual Summer Internship program (*beginning June 2*).
- Presented a virtual talk entitled "PFAS Analytical Methods" at the Midwest AOAC meeting (approx. 25 attendees) (*June 9*).

#### PATEL, RAVIKUMAR

- Assisted, via Zoom, as a judge for the 2021 Sigma Xi Quinnipiac Chapter Virtual Student Research Conference for six graduate students (*April 26, 2021*).

#### PIGNATELLO, JOSEPH J.

- Participated in a virtual grant review panel for the USDA-NIFA-AFRI - Bioenergy, Natural Resources, and Environment (BNRE) Foundational and Applied Science Program, Soil Health Program (*July 7-9, 2020*).
- Co-authored three pre-recorded talks entitled "Picolinic Acid-Mediated Fenton Oxidation of Organic Compounds in Water," "Importance of Ring Cluster Size of Carbonaceous Sorbents in their Sorption of Aromatic Compounds," and "Effect of Oxidative Conditions During Pyrolysis and Ambient Aging on the Physico-Chemical Characteristics and Sorbent Properties of Chars Toward a Hydrophobic and a Cationic Compound" for the Fall 2020 American Chemical Society Virtual Meeting and Exposition (*August 16-20*).
- Co-presented a virtual talk entitled "Dynamic Interactions Between Sorption and Biodegradation: Implications for Long-Term Performance of Activated Carbon-Based Technology for In Situ Groundwater Remediation of Chlorinated Solvents" before the Technical Review Board of SERDP (*October 14*).
- Gave a virtual seminar entitled "Interactions of Organic Compounds with Natural and Human-Made Pyrogenic Carbonaceous Materials – Sorption, Reaction, Catalysis" in the Department of Civil and Environmental Engineering, University of Nevada, Reno (*October 28*).
- Gave a virtual talk entitled "Trapping and Destroying Fumigant Vapors in Fumigation Chamber Vent Streams" at the 2020 Methyl Bromide Alternatives Outreach Conference (*November 3-5*).
- Gave a virtual talk entitled "Ring Cluster Size as an Important Intrinsic Driving Force for Sorption of Organic Compounds to Pyrogenic Carbons (Natural Chars and Biochars)" at the annual Soil Science Society of America meeting (*November 9-13*).
- Gave a virtual departmental seminar entitled "Interactions of Organic Compounds with Natural and Human-made Pyrogenic Carbonaceous Materials – Sorption, Reaction, and Catalysis" to the Department of Chemistry, Michigan Technological University (*February 19, 2021*).
- Judged middle school and high school presentations at the virtual Connecticut Science and Engineering Fair (*March 16-17*).
- Gave a lecture entitled "Factors Influencing the Biological and Physical Availability of Chemicals in

Contact with Soil Particles” to the 2021 virtual Annual Meeting of the Connecticut Association of Wetland Scientists Association (approx. 75 attendees) (*April 8*).

- Co-authored a virtual talk entitled “Optimizing Carbon Amendments that Simultaneously Adsorb and Transform Legacy and Insensitive High Explosives (ER19-1239)” before a grant review panel on progress in an awarded SERDP project (*June 9*).

#### PRAPAYOTIN-RIVEROS, KITTY

- Participated in a Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (*July 7 and 21, 2020*).
- Documented and recorded the award presentation with Dr. Jason White for the 2020 Connecticut Century Farm Award to Mr. Andy Fish at Fish and Kent Farm in Suffield, CT <https://youtu.be/0FH4VwUg> (*July 29*).
- Documented and recorded the award presentation with Dr. Jason White for the 2020 Connecticut Outstanding Young Farmer Award to Mr. Jimmy Bloom at Copps Island Oysters by Norm and Son, LLC in Norwalk, CT <https://youtu.be/BGO1KoabR7Y> (*July 30*).
- Participated in the Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (*August 4*).
- Assisted with the production of virtual Plant Science Day (*August 5*).
- Participated in the Sample Data Exchange (DX) Phase II- ORA DX 7.0 UAT support session (*August 18*).
- Participated in the Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (*August 18*).
- Assisted with the production of the CAES Seminar Series presentation entitled “Integrating Beyond Genomics: Cyberinfrastructure for Forest Health and Productivity” (*August 19*).
- Assisted with the production of the CAES Seminar Series presentation entitled “Optimizing Community Scale Surveillance Efforts for SARS CoV-2” (*September 2*).
- Assisted with the production of the CAES Seminar Series presentation entitled “Candidate Disease Resistance Genes for *Populus trichocarpa* Revealed by Genome-wide Association Mapping and Transcriptome Analysis” (*September 30*).
- Participated in the Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (*September 1, 15*).
- Assisted with the production of the CAES Seminar Series presentation entitled “PFAS Management in Connecticut and Beyond” (*October 14*).
- Assisted with the production of the CAES Seminar Series presentation entitled “Pollinator Pathways and The Green Corridor: Improving Biodiversity on Protected Land in Our Own Yards!” (*October 21*).
- Assisted with the production of the CAES Seminar Series presentation entitled “Discovery of a New Diaporthe Pathogen Affecting Hops in Connecticut” (*October 28*).
- Participated in the Sample Analysis Data Exchange - IT Implementation Phase Meeting on WebEx to discuss the NFSDX (National Food Safety Data Exchange) phase II Sample Data Elements Mapping File (*October 6, 20*).
- Presented “ORA Data Exchange (DX) - Data Sharing from the Program Standpoint” at the Roundtable Session of the 10th Manufactured Food Regulatory Program Alliance Virtual Meeting (*February 3, 2021*).
- Participated in LFFM CAP Grantee meetings (*May 24-27*) (360 registered attendees) and presented “Communication with States - Connecticut Data Flow” in the session “Communication Efforts and Laboratory Data Flow” (220 attendees) (*May 25*).

RIDGE, GALE E.

- Was interviewed about summer insects and a grasshopper named Lady Lubber by Robert Miller of the *News-Times* (July 27, 2020).
- Was interviewed about native Cicada killer/hunter solitary wasps being mistaken for giant Asian murder hornets by Jan Spiegel of the *CT Mirror* (July 30).
- Was interviewed about cicada killer wasps vs. Asian giant hornets by Mary Beikert of *The Day* (August 4).
- Was interviewed about yellowjackets and their medical significance by Robert Miller of the *News-Times* (August 25).
- Was interviewed about increased rat activity as a result of changes in human mediated waste stream, more particularly in the restaurant industry due to COVID-19, by Ed Stannard of the *New Haven Register* (August 27).
- Was interviewed about pollinators and pollinator pathways in Connecticut by Clare Dignan of the *New Haven Register* (September 3).
- Was interviewed about the brown marmorated stink bug by Joy Venderlink of the *Cheshire Citizen* (September 28).
- Was interviewed about the biology of wasps, hornets, and yellowjackets by Holly Kocet of Protect Our Pollinators (September 28).
- Was interviewed about spotted lanternfly by Harlan Levy of the *Journal Inquirer* (October 19).
- Was interviewed about a career in science in the podcast “Science Yourself” by Gustavo Requena Santos, which was translated into Spanish and Portuguese (October 22).
- Organized and ran an international symposium, part of the Entomological Society of America virtual annual meeting, with experts representing the media, entomology, hospital emergency rooms, veterinary entomology, neurology, medical parasitology, clinical parasitology, dermatology, dermatopathology, psychodermatology, and psychiatry addressing Delusions of Infestations. The thirteen speakers over a four-hour period addressed this not uncommon psychiatric/physiological disorder where people believe they are being parasitized by arthropods, fungi, nematodes, or other pathogens. Untreated, it can ravage sufferers’ lives (November 17).
- Was interviewed about delusional infestation by Sophie McKay, a reporter from London, England (January 19, 2021).
- Delivered, via Zoom, a two-part presentation on delusional infestation at the EPA Region 1 Pesticide Inspector Residential Training (February 23).
- Was interviewed about the emergence of the 17-year Cicada Brood X and its life history by Greg Little, WTIC 1080 (March 29).
- Was interviewed about cicadas and Brood X by Margaret Burnett of Gardenmaker, LLC (April 8).
- Was interviewed about spiders by Robert Miller of the *News-Times* (April 13).
- Was interviewed about elevated tick activity in Connecticut by Harlan Levy from the *Journal Inquirer* (May 7).
- Was interviewed about carpenter ants and their impact on manmade structures by Harlan Levy, *Journal Inquirer* (June 21).
- Was interviewed about cicadas and how they are preyed on by the cicada killer wasps and public confusion of this native wasp with the intercepted Asian giant hornet in Washington State by Robert Miller of the *News-Times* (June 22).
- Was interviewed about hammerhead worms seen in Old Saybrook by Brendon Crowley from the *CT Examiner* (June 22).
- Was interviewed about the four species of subterranean termites found in the United States by Harlan Levy, *Journal Inquirer* (June 28).

ROBB, CHRISTINA S.

- Participated in an FDA FERN cCap conference call (*July 9, 2020*).
- Participated in a board meeting of the Eastern Analytical Symposium (EAS) (*July 10*).
- Participated in meetings for the Eastern Analytical Symposium, for which she is a board member: board meeting (*September 11*); 2021 program meeting (*September 15*), and long-range planning meeting (*September 23*).
- Participated in an FDA FERN cCAP technical call (*September 10*).
- Participated in an FDA LFFM call (*September 17*).
- Moderated/attended the following Eastern Analytical Symposium (EAS) short courses in the capacity of Short Course Committee Chair: “Characterization of Biologics by HPLC, CE and Mass Spectrometry” (*October 12-13*), “An Introduction to High Resolution Mass Spectrometry for Qualitative and Quantitative Analysis” (*October 22-23*), and “Intact and Top-Down Protein Analysis by Mass Spectrometry” (*October 29-30*).
- Participated in a range of committee meetings for the EAS including program (*October 22*) and long-range planning (*October 6, 19*).
- Participated in an EAS board meeting and accepted election to the EAS executive committee; and participated in the FDA LFFM webinars on Animal and Human Food and Feed Program and the Food Defense Program (*November 30*).
- Attended a board meeting of the Eastern Analytical Symposium (EAS) and was elected to the Executive Committee. She will serve as secretary in 2021 and fulfill additional executive board positions before presiding over the conference in 2024 (*December 3*).
- Participated in executive committee meetings for the Eastern Analytical Symposium in her new role as secretary (*January 4, 11, 18, and 25, 2021*).
- Presented “The Analysis of L-Abrine by a Teicoplanin Stationary Phase,” virtual Pittcon 2021, Christina S. Robb and Kirk W. Gaston (Forensic Chemistry Center FDA) (*March 8*).
- Assisted in judging the Sigma Xi Student Research Conference at Quinnipiac University (*April 26*).
- Participated in Eastern Analytical Symposium (EAS) Executive Committee meetings (*May 3, 10, 17, 24*).
- Participated in an EAS board meeting (*May 14*).
- Participated in LFFM CAP Grantee meetings (360 registered attendees) (*May 24-27*).
- Presented “ZipChip Technology” in the “Platforms, Technology and New Methods” panel, Chemistry: Methods and Technology (208 attendees) (*May 25*).
- Presented “Enhancing the Analysis of Abrin Protein Through ELISA to LC-MS Platform Transfer” in the LFFM Chemistry Track section, Chemistry Method Development (186 attendees) (*May 26*).
- Participated in the FDA LFFM Human and Animal Food, and Food Defense monthly meeting (*June 14*).
- Contributed to the Eastern Analytical Symposium (EAS) Executive Committee meetings (*June 7, 14, 21, 28*).

RUTLEDGE, CLAIRE E.

- Gave an online lecture on insects that attack trees to the Connecticut Tree Warden’s School (35 adult attendees) (*October 1, 2020*).
- Gave a livestream talk on the current state of Emerald Ash Borer in Connecticut for the White Memorial Conservation Center (*November 7*).
- Taught the classes “Insects That Attack Trees and Shrubs” and “Tree Conditions Laboratory” for Arboriculture 101 for the Connecticut Tree Protective Association (*March 3 and 17, 2021*).
- Presented a talk entitled “2021, The Year of the Southern Pine Beetle?” to the Forest Health Monitoring Workshop via Zoom (*March 4*).
- Presented a talk entitled “Tracking the Elusive Wasp: Comparison of 3 Detection Techniques for Larval

Parasitoids of Emerald Ash Borer” with co-authors Roy Van Driesch and Jian Duan in the symposium “The Effects of Invasive Insects on Temperate Tree Species: How Do We Measure Injury, Decline, and Control?” at the Annual Meeting of the Eastern Branch of the Entomological Society of America (*March 23*).

- Gave a talk about insects to a second grade class at Vinton Elementary School in Lafayette, IN (25 youths) (*May 24*).
- Presented a talk entitled “Biological Control of Emerald Ash Borer in Connecticut” to the Yale-Myers Summer Research Series via Zoom (45 adults) (*June 24*).

#### SCHULTES, NEIL P.

- Presented two lectures in a three-lecture series on “Genetically Modified Plants in Agriculture” in a Yale Course Scie 031 “Current Topics in Science” (13 students) (*October 23 and 30, 2020*).
- Presented the third lecture in a three-lecture series on “Genetically Modified Plants in Agriculture” in a Yale Course Scie 031 “Current Topics in Science” (13 students) (*November 6*).
- Participated in the annual meeting of the Northeastern Division of the American Phytopathological Society (*March 10-12, 2021*).
- Served as an organizing judge for the 2021 Sigma Xi Quinnipiac Chapter Virtual Student Research Conference (50 participants) (*April 26*).

#### SHEPARD, JOHN J.

- Provided an update about the Connecticut Mosquito Trapping and Arbovirus Surveillance Program to virtual meetings of the Northeast Arbovirus Surveillance Situational Awareness (20 attendees each) (*October 1 and 15, 2020*).
- Presented virtually “Arbovirus Activity in Connecticut, 2020” at the 66th Annual Meeting of the Northeastern Mosquito Control Association (123 attendees) (*January 6, 2021*).
- Was interviewed about “Mosquito Trapping and Arbovirus Surveillance in Connecticut” and “Mosquito Colony Maintenance and Use” by Prof. Gillian Eastwood for students enrolled in her Medical & Veterinary Entomology Lab (ENT-3264) course at Virginia Tech University (80 students) (*January 7*).
- Participated in the Northeast Regional Center for Excellence in Vector-Borne Diseases 2021 Virtual Strategic Planning Meeting (approx. 50 participants) (*January 19*).
- Participated in a Board of Directors meeting of the Northeastern Mosquito Control Association (12 attendees) (*February 10*).
- Spoke on “Mosquitoes and How to Avoid Being Bitten” to members of the Church Street Elementary School (Hamden) community via Zoom (April 22) (14 households attended) (*April 22*).
- Gave three seminars for the 2021 Vector Biology Boot Camp (virtual meeting) offered by the Northeast Regional Center for Excellence in Vector-Borne Diseases: “Mosquito Collection and Processing” (45 attendees) (*May 11*), “Taxonomic Identification of Adult Female Mosquitoes” (35 attendees) (*May 13*), and “Establishing and Maintaining Mosquito Colonies” (32 attendees) (*May 19*).
- Was interviewed about mosquitoes, eastern equine encephalitis, and West Nile viruses by NBC Connecticut (*June 11*).
- Was interviewed about mosquito trapping and testing for eastern equine encephalitis, West Nile, and Jamestown Canyon viruses by the *Connecticut Post* (*June 15*).
- Participated in Arbovirus Situational Awareness conference calls organized by the Northeast Regional Center for Excellence in Vector-Borne Diseases (25-30 attendees) (*June 7, 21*).

#### SHIDORE, TEJA

- Won the Best Poster Award in the Professional Researcher Category for her poster entitled “Nanoparticle Aided dsRNA Delivery System for Tackling Plant Viruses,” which was presented at the

2021 Ohio State University Plant Sciences Symposium (*March 26, 2021*).

- Gave a guest lecture entitled “Nano Enabled Delivery of RNA Molecules for Tackling Plant Viruses” for a Molecular Biotechnology class at the University of New Haven (12 students, 2 faculty members) (*April 14*).

#### SMITH, VICTORIA L.

- Was interviewed about the recent shipment of unsolicited seeds from China by NBC30, WFSB, and WTNH (*July 28, 2020*).
- Was interviewed about gypsy moth and general forest health conditions by Jan Spiegel of the *CT Mirror* (*July 29*).
- Was interviewed about spotted lanternfly by WSHU Radio (*September 22*).
- Was interviewed about spotted lanternfly by Chris Arnott of the *Hartford Courant* (*October 16*).
- Was interviewed about spotted lanternfly by Brendan Crowley of the *CT Examiner* (*October 26*).
- Participated via MS Teams in a meeting of the U.S. Forest Service Northeastern Area Forest Cooperators, with a presentation on CT forest health conditions (35 participants) (*October 27-29*).
- Participated in a meeting of the CT GIS Workgroup, held via Zoom (*December 9*).
- Participated in a U.S. Forest Service workshop on making documents 508 compliant, held via MS Teams (27 participants) (*December 17*). A personal note: To recognize 2021 as the International Year of Plant Health, the National Plant Board held a contest for a calendar with photographs for each month. Two of my photographs were chosen from those submitted and are featured in May and July 2021.
- Participated in an MS Teams call concerning deregulation of emerald ash borer (*January 11, 2021*).
- Participated in the quarterly meeting, via Zoom, of the Experiment Station Board of Control, with a presentation on spotted lanternfly (*January 19*).
- Participated in the winter meeting, via Zoom, of the CT Cooperative Agricultural Pest Survey (CAPS) committee (*January 20*).
- Participated in a meeting, via Zoom, of the CT GIS Workgroup (*January 25*).
- Participated in a Webinar presented by the University of Massachusetts on spotted lanternfly (*January 26*).
- Participated in a meeting, via MS Teams, of the U.S. Forest Service Aerial Survey Working Group (*January 26*).
- Participated in a meeting, via MS Teams, of the U.S. Forest Service Aerial Survey Working Group (*January 27*).
- Participated in a meeting, via Zoom, of the CT Nursery and Landscape Association (*January 28*).
- Participated in a meeting, via MS Teams, of the U.S. Forest Service Aerial Survey Working Group (*January 28*).
- Participated in a webinar for Authorized Certifying Officials (ACOs) on re-export certification, sponsored by USDA Export Services (30 participants) (*February 16*).
- Met via Zoom with representatives of Prides Corner Farms, Lebanon, to discuss internet commerce of nursery stock (*March 3*).
- Hosted via Zoom the annual Forest Health Monitoring Workshop (*March 4*).
- Participated via Zoom in the quarterly call with the Eastern Plant Board (*March 5*).
- Participated via Zoom in the 95th annual Meeting of the Eastern Plant Board (*March 29-April 1*). Link for Forest Health Monitoring Workshop: <https://us02web.zoom.us/rec/share/19KD2phT8H6U31uGXswEIJqsCMNjIRC8sC6yo22EmtXQm2eNf8NgEepv9uBwX4c.plwOBnTjeJFOtdML>.
- Participated in the Durham Field Office Aerial Survey Pre-Season Meeting, held online, sponsored by the U.S. Forest Service (*April 28*).
- Participated via Zoom in the quarterly meeting of the Eastern Plant Board (*June 4*).
- Was interviewed concerning box tree moth and spotted lanternfly by Bob Miller of the *News-Times* (*June 8*).

### STAFFORD, KIRBY C. III

- Participated in a press conference at CAES for Senator Richard Blumenthal (*July 9, 2020*).
- With Dr. Ben Beard (CDC), presented a webinar on ticks and tick management for the U.S. Environmental Protection Agency Region 1 (*July 9*).
- Presented a webinar entitled “Ticks in Connecticut: It’s More Than Just Lyme Disease” for White Memorial Conservation Center (*July 15*).
- Was interviewed about ticks and Virtual Plant Science Day by Guy and Janelle Beardsley on the WPKN’s Organic Farmstand Radio Show (*July 16*).
- Was interviewed about ticks and tick-borne disease risks in Connecticut by Jan Ellen Spiegel, *CT Mirror* (*July 21*).
- Was interviewed about the seeds being received from China by Sean McCabe, News 12 (*July 29*).
- Participated in a conference call on the Asian longhorned tick (*August 18*).
- Participated in a conference call with members of the Northeast Regional Center of Excellence in Vector Borne Diseases on project logistics for a proposed *Haemaphysalis longicornis* overwintering study (*September 2*).
- Hosted Dr. Christopher Kerantzas, a Yale-New Haven Hospital Microbiology Fellow (*September 21-23*).
- Presented a webinar for NE-IPM on the role of leaf litter and climate factors on the expansion, survival, and vegetative management of blacklegged and lone star ticks (35 participants) (*October 7*).
- With Dr. Goudarz Molaei, participated in the GC3 Public Health and Safety Working Group public session (*October 7*).
- Was interviewed about spotted lanternfly by Christopher Arnott, *Hartford Courant* (*October 16*).
- Participated via Zoom in the fall 2020 annual advisory board meeting for the Midwest Center of Excellence for Vector-Borne Disease (*October 23*).
- Presented a webinar entitled “Ticks: It’s Not Just Lyme Disease Anymore - Strategies and Challenges” for the Department of Entomology, Rutgers University (38 participants) (*November 6*).
- Presented a virtual paper at the Annual Meeting of the Entomological Society of America entitled “Integrated Tick Management for the Control of the Blacklegged Tick, *Ixodes scapularis* (Acari: Ixodidae),” which was available for on-demand viewing throughout the meeting (*November 13-30*).
- Participated in a tick IPM working group call (*December 9*).
- Participated in a meeting with Dr. Laura Pischel, Yale University, to discuss climate and tick-borne diseases (*December 14*).
- Participated in a National Asian longhorned tick stakeholder call (*January 11, 2021*).
- Was interviewed about winter tick activity and new ticks in Connecticut by Kaitlyn McGrath, NBC CT (*January 11*).
- Participated in the annual meeting of the Northeast Regional Center for Excellence in Vector-Borne Diseases and presented an update on lone star tick control (168 panelists and attendees) (*January 12*).
- Participated in a monthly meeting of the Tick IPM Working Group (*January 13*).
- Was interviewed about federal EAB regulations by Patrick Skahill, Connecticut Public Radio (*January 13*).
- Participated in a spotted lanternfly conference call (*January 14*).
- Participated in the NEVBD strategic planning session via Zoom (54 participants) (*January 19*).
- Participated in the winter Cooperative Agricultural Pest Survey (CAPS) Zoom meeting (*January 20*).
- Participated in an NEVBD leadership call (*January 25*).
- Attended the virtual winter meeting of the Connecticut Nursery & Landscape Association and presented a talk on ticks, tick-borne diseases, and tick control (71 attendees) (*January 27-28*).
- Presented a talk on ticks and tick control for the EPA Region 1 Pesticide Inspector Residential Training via Zoom (40 attendees) (*February 22*).

- Presented a 3-hour virtual class entitled “Management of Ticks and Risks of Tick-Borne Disease” in cooperation with the Connecticut Environmental Council (23 attendees) (*March 3*).
- Presented a tick update at the Forest Health Monitoring Workshop via Zoom (77 participants) (*March 4*).
- Participated in the annual meeting of the Northeast Forest Pest Council and presented a state report (60 participants) (*March 10-11*).
- Participated in the Mid-Atlantic Tick Summit and presented a talk on the control of blacklegged and lone star ticks (72 attendees) (*March 23*).
- Spoke on ticks and tick management for the Southington Library (15 attendees) (*March 23*).
- Attended the 14th International Symposium on Ticks and Tick-borne Diseases and co-chaired a poster session (*March 24-26*).
- Was interviewed about ticks by Greg Little, WTIC 1080 (*March 30*).
- Presented a talk via Zoom on ticks and control of blacklegged and lone star ticks to the Old Saybrook Garden Club (*April 5*).
- Participated in an Asian longhorn tick group call (*April 12*).
- Spoke on ticks, tick control, and tick-borne diseases for the Town of Woodbridge Commission on Use of Publicly Owned Properties (12 attendees) (*April 26*).
- Was interviewed about tick populations in Connecticut by Robert Miller, *News-Times* (*April 27*).
- Was interviewed about tick activity this spring by Anthony Terzi, Fox 61 News (*April 29*).
- Participated in an IACUC administrators group call (*April 30*).
- Was interviewed about tick activity in Connecticut by Jamie Ratliff, NBC-Universal (*May 3*).
- Was interviewed about ticks on the Ray and Brian morning news talk show, WTIC 1080 (*May 5*).
- Was interviewed about rodent Lyme disease vaccines by Nicole Davis, *Hudson Valley Times Union* (*May 10*).
- Was interviewed about ticks in the state and personal protection measures by Loumarie I. Rodriguez, *Southbury VoicesNews* (*May 12*).
- Presented talks on tick taxonomy and tick control for the NEVBD boot camp (35 attendees) (*May 13-14*).
- Was interviewed about tick season by Stephanie Simoni, WTNH-TV (*May 25*).
- Was interviewed by broadcaster Brian Scott-Smith for a tick podcast (*May 26*).
- Was interviewed on tick activity in Connecticut by James Szkobel-Wolff, Connecticut Public Radio (*June 7*).
- Was interviewed about ticks, mosquitoes, box tree moth, spotted lanternfly, and other subjects by Aaron Kupec, WTIC Radio (*June 9*).
- Was interviewed about babesiosis by Ed Stannard, *New Haven Register* (*June 9*).
- Was interviewed about gypsy moth by Jordan Fenster, Hearst Media (*June 23*).
- Was interviewed about gypsy moth by Dan Corcoran, NBC Connecticut TV (*June 25*).
- Was interviewed about gypsy moth by Melissa Sheketoff, WICC Radio (*June 28*).
- Was interviewed about gypsy moth by Greg Little, WTIC (*June 29*).
- Was interviewed about gypsy moth defoliation back in 2017 by Patrick Skahill, Connecticut Public Radio (*June 29*).
- Was interviewed about gypsy moth by Brian Scott-Smith (*June 29*).
- Was interviewed about gypsy moth by Courtney Luciana, WTNH-TV (*June 29*).
- Was interviewed about gypsy moth by Brigitte Ruthman, *Republican-American* (*June 29*).

#### STEBBINS, SUMMER E.

- Gave a talk entitled “Invasive Aquatic Plants in Connecticut: How Can They Impact Your Lake?” to the Lantern Hill Valley Association at the Long Pond boat launch in North Stonington (20 attendees) (*July 18, 2020*).

- Gave a virtual talk entitled “Using GIS to Map Invasive Aquatic Plants” at the CT GIS Day hosted by the Connecticut GIS Network (*November 4*).
- Gave a virtual talk entitled “Using GIS to Map Invasive Aquatic Plants in Connecticut” at the annual spring conference for the Northeast Arc Users Group (approx. 55 attendees) (*May 18, 2021*).

#### STEVEN, BLAIRE T.

- Ben Teerlink, a student in Dr. Steven’s laboratory, presented his work to the Virtual Penn State Geobiology Symposium XXVIII. His talk was entitled “Characterization of a Novel Biological Soil Crust in a Temperate Mid Latitude Region (Southern Connecticut USA)” (55 attendees, approx. 40 were students) (*February 26, 2021*).

#### STONER, KIMBERLY A.

- Was interviewed by Amy Ziffer, who is writing a book on pollinator plants (*September 15, 2020*).
- Presented a talk entitled “Planting for the Bees’ Needs” to Monroe Girl Scouts (16 fifth-grade girls, 2 adults) (*September 21*).
- Participated in an international meeting of the COLOSS (Society for the Prevention of Honey Bee Colony Loss) Task Force on Bee Nutrition (32 participants worldwide) (*September 22*).
- Co-led a meeting of the Pollinator Committee of the Plant-Insect Ecosystem Section of the Entomological Society of America to discuss the development of a “Wildly Important Goal” for the Entomological Society to become a leading source of information on pollinators for policymakers, the media, and the public (9 participants) (*September 30*).
- Participated in a Zoom meeting with Jamie Fischer, Research Director of the White Memorial Foundation, and Carly Borken of the Taft School about pollinator research projects the students can do as part of distance learning from anywhere in the world (*July 6*).
- Participated in a telephone meeting with Jim Randazzo of the Metropolitan District Commission, Kelly Kennedy, a concerned local citizen, and Louise Washer of the Pollinator Pathway and Norwalk River Watershed Association about managing lands of the MDC for water quality and benefits to pollinators and other wildlife (*July 9*).
- Presented a talk entitled “Planting for the Bees’ Needs,” sponsored by Planet New Canaan, the New Canaan Beautification League, and the New Canaan Pollinator Pathway, via Zoom through the New Canaan Public Library (45 attendees) (*August 20*).
- Hosted by Jim Randazzo of the Metropolitan District Commission, and team members Kelly Kennedy, Pete Picone, Louise Washer, and Laura Hart, visited the MDC grounds and reservoir in West Hartford to advise on possible locations for pollinator habitat, and to make recommendations about reducing mowing and introduction of invasive plant species (*August 25*).
- Was interviewed about pollinator habitat by Greta Burroughs for the national magazine *Two Million Blossoms* (*August 28*).
- Presented a guest lecture on pollination to a Yale undergraduate class, “The Ecology of Food,” taught by Dr. Linda Puth (16 participants) (*October 7*).
- Gave a talk about pollinator habitat and bees at the opening of a new butterfly garden at the corner of Eastern and Hemingway Streets in New Haven (9 youths, 17 adults) (*October 18*).
- Hosted Mary Ellen Lemay as a speaker in the CAES Seminar Series, presenting, “Pollinator Pathways and The Green Corridor: Improving Biodiversity on Protected Land in Our Own Yards” (*October 21*).
- Presented a poster at the Annual Meeting of the Entomological Society of America entitled “Honey Bees (*Apis mellifera* L.) at Ornamental Plant Nurseries Collect Very Little Pollen from Ornamental Plants,” which was available for on-demand viewing throughout the meeting and had 69 views (*November 13-30*).

- Hosted a “Hot Topics” session on Zoom as part of the Entomological Society of America Annual Meeting to discuss ways to make the ESA a leading source of information on pollinators (30 participants) (*November 13*).
- Gave a presentation entitled “Amplifying the Buzz: Establishing the Entomological Society of America as a Leader in Developing and Disseminating Information on Pollinators” to the networking session of the Plant-Insect Ecosystems Section of the Entomological Society of America (145 attendees) (*November 17*).
- Participated in a meeting of the Soil/Agriculture subcommittee of the Working and Natural Lands Working Group of the Governor’s Council on Climate Change to discuss issues to bring forward in the final report of the Working and Natural Lands Working Group (8 participants) (*November 18*).
- Was interviewed about the Multicolored Asian Lady Beetle and biological control by Sophia Arruda, environmental journalism student at the University of Connecticut (*December 11*).
- Served on the thesis committee of James Durrell, a graduate student at the University of Bridgeport (*December 22*).
- Met by Zoom with co-editors Dr. Simone Tosi of the University of Turin and Dr. Harmen Hendrikson of the Julius Kuehn-Institut in Germany, and with Dr. Anna Shattles of the journal *Frontiers in Sustainable Food Systems*, about launching “Pollen as Food for Bees: Diversity, Nutrition and Contamination” as a Research Topic in the journal. The topic is now open for submissions at [www.frontiersin.org/research-topics/18973/pollen-as-food-for-bees-diversity-nutritionand-contamination#overview](http://www.frontiersin.org/research-topics/18973/pollen-as-food-for-bees-diversity-nutritionand-contamination#overview) (*January 26, 2021*).
- Met with Lilian Ruiz, Executive Director of the CT Council on Soil and Water Conservation, and Denise Savageau, Chair of the CT Council on Soil and Water Conservation, about soil health legislation proposed for the current legislative session (*February 5*).
- Presented “Planting for the Bees’ Needs” to the Menunkatuck Audubon Society via Zoom (25 attendees) (*April 13*).
- Was interviewed about “No Mow May” and converting lawns to pollinator habitat by Eric Parker of WFSB television (*April 22*).
- Presented “Planting for the Bees’ Needs” to the White Memorial Conservation Center, hosted by Jamie Fischer (33 attendees) (*April 27*).
- Was interviewed about planting for pollinators by Edward Stannard of the *New Haven Register* (*April 30*).
- Met with Dr. Theodora Pintou of Western Connecticut State University about graduate student projects on pollinator habitat and pollinator visitation at Tarrywile Park in Danbury (4 participants) (*May 5*).
- Met with the Asylum Hill Neighborhood Association Green Team by Zoom about the Pollinator Pathway and creating pollinator habitat in the urban environment of Hartford (13 participants) (*May 10*).
- Met with several members of the Asylum Neighborhood Association Green Team about creating a plan and planting pollinator habitat at Turning Point Park in Hartford (6 participants) (*May 24*).
- Participated in a meeting of the international COLOSS (Prevention of Honey Bee Colony Losses) Bee Nutrition Task Force via Zoom with 37 participants from many countries on four continents (<https://coloss.org/projects/nutrition/>) (*June 9*).
- Participated in a workshop and tour of the Newhallville Learning Corridor site by Doreen Abubakar of CPEN (Community Place-making and Engagement Network), along with staff from the CT NOFA Ecotype Project in New Haven (0.7 mile from our offices) (35 participants) (*June 10*).
- Participated as a member of the project team, with Dr. Christina Grozinger and Dr. Victor Gonzalez Betancourt, in a virtual presentation of the project “Amplifying the Buzz” to the Governing Council of the Plant-Insect Ecosystem section of the Entomological Society of America (12 participants) (*June 11*).
- Presented a talk entitled “Planting for the Bees’ Needs” to the Friends of Harkness Memorial State Park at Harkness Memorial State Park in Waterford (12 participants) (*June 14*).

#### TAERUM, STEPHEN J.

- With Dr. Lindsay Triplett, presented “An Improved Method for Profiling the Eukaryotic Diversity of the Phytobiome” for the American Phytopathological Society 2020 Plant Health Online meeting (*August 3, 2020*).
- Presented “Development and Validation of a PNA Clamp to Increase Protist Diversity in Rhizosphere Microbiome Research” for the International Society of Protistologists 2020 Protistology meeting (*August 14*).
- Organized the 2020 Plant Health Fellows final symposium that was presented by nine interns who each gave their five-minute presentations of their research and answered questions (38 attendees) (*August 18*).
- Presented a guest lecture entitled “Heterotrophic Protists in the Rhizosphere” for the Plant Microbial Ecology class at Auburn University (25 adults) (November 13);
- With Dr. Lindsay Triplett, was interviewed by the journal *Phytobiomes*, as their recent paper “Validation of a PNA clamping method for reducing host DNA amplification and increasing eukaryotic diversity in rhizosphere microbiome studies” was selected as Editor’s Pick in the most recent issue of the American Phytopathological Society’s magazine (*December 30*).
- Presented a talk entitled “Ecology and Evolution of Symbiotic Single Cell Eukaryotes” to the Penn State Microbiome Center (70 adults) (*March 26, 2021*).

#### TRIPLETT, LINDSAY R.

- Served as an expert reviewer for the EuroXanth COST Action CA16107 Wiki on *Xanthomonas* virulence factors (*September*).
- Presented a virtual talk entitled “The Rice That Helped America Grow” for the Avon Library (11 attendees) (*September 15*).
- Served as organizer and co-host of the Early Career Virtual Showcase of the Japan-US Seminar on Plant Pathology (four sessions with 100-120 attendees per session) (*September 28-29, October 5-6*).
- Served on the Ph.D. committee of Michigan State University graduate student, Jingyu Peng, who successfully presented and defended his dissertation virtually (*September 30*).
- Led and chaired the annual meeting of the APHIS Widely Prevalent Bacterial Diseases committee to discuss initiatives to update the list of widely prevalent bacterial diseases for each state (13 participants) (*October 15*).
- Organized and moderated a virtual workshop entitled “Know Your Roots: Introduction to Root Phenotyping for Plant Pathologists” as part of the extended activities of Plant Health 2020, the Annual Meeting of the American Phytopathological Society, which featured Dr. Larry York of the Noble Research Institute who demonstrated how to properly acquire and analyze scanned root images using the free program Rhizovision Explorer. The workshop recording will soon be available to meeting registrants at the site: <https://www.apsnet.org/meetings/mtnghwshops/phworkshops/Pages/Know-Your-RootsWorkshops.aspx> (39 participants) (*October 20*).
- Virtually visited the third-grade classes of Shepherd Glen Elementary School in Hamden to answer their questions about plant diseases and being a scientist as part of their Plant Science Unit (39 children, 4 adults) (*November 24*).
- Served on the graduate advisory committee of UConn Ph.D. student Gabrielle Corso during her dissertation proposal defense (6 attendees) (*March 17, 2021*).

#### VOSSBRINCK, CHARLES R.

- Gave a virtual lecture entitled “Three Evolutionary and Ecological Considerations for the Microsporidia” at a retreat for the laboratory of a former collaborator, Prof. Jonas Brandun, Department of Molecular Medicine, University of Umea, Sweden (15 attendees) (*October 14, 2020*).

- Judged the Quinnipiac University Chapter of Sigma Xi Student Research Conference (numerous graduate and undergraduate students participated) (*April 19, 2021*).

WARD, JEFFREY S.

- Participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (*July 13, 2020*).
- Met with Jaymie Frederick (Inland Wetlands, Town of Branford) and citizens to discuss running bamboo containment (4 attendees) (*July 16*).
- With Mr. Joseph P. Barsky, spoke on strategies for regenerating oak at the summer meeting of the Rhode Island Chapter - Society of American Foresters in Foster, RI (19 attendees) (*August 6*).
- Spoke on reducing deer browse damage during regeneration harvests at the Rhode Island Forest Conservators Organization summer twilight meeting in Foster, RI (16 attendees) (*August 6*).
- Was interviewed about managing street trees to reduce storm damage to infrastructure by Robert Miller, *News-Times* (*August 11*).
- With Mr. Joseph P. Barsky, met with McLean Game Refuge Director Connor Hogan and staff to discuss forest regeneration and deer browse (5 attendees) (*August 13*).
- Was interviewed about the importance of severe weather in creating young forest habitat by Robert Miller, *News-Times* (*September 1*).
- Participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (*September 24*).
- Participated in a conference call for the Increasing Resiliency in Southern New England Oak Forests project (*September 25*).
- Spoke on “A Short History of the Connecticut Forest” for the Long Hill Garden Club in Trumbull (26 attendees) (*September 28*).
- Gave a Zoom presentation entitled “A Short History of the Connecticut Forest” for the Cragin Memorial Library in Colchester (24 attendees) (*September 29*).
- Was interviewed about the effect of this year’s drought on tree growth and forest health by Brendan Crowley of the Connecticut Examiner (*October 6*).
- Participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (*October 8*).
- Provided requested comments on Connecticut forest management policy to DEEP Deputy Commissioner Mason Trumble, State Senator Kevin Witkos, State Representative John Hampton, Simsbury town officials, DEEP staff, and others at Stratton Brook State Park (14 attendees) (*October 16*).
- Participated in a New England Forest Foundation, Exemplary Forestry – North Central and Transition Hardwoods Advisory Committee Meeting (*October 16*).
- Presented “Deer, Invasives, Residual Density and Forest Regeneration” for the U.S. Fish & Wildlife Service, Forest Ecology and Management Webinar Series (170 attendees) (*October 20*).
- Participated in a Connecticut Invasive Plant Council meeting (*October 20*).
- Participated in an NESAF 2021 planning committee meeting (*October 22*).
- Organized and spoke at a Carbon and Multiple-Use Forest Management in Southern New England workshop (81 attendees and 18 on Zoom) (*October 27*).
- Spoke on “Oak Resiliency - Why and How” at the Increasing Resiliency in Southern New England’s Oak Forests on LS2-7 Concurrent Panel Discussion at the virtual 2020 Society of American Foresters National Convention (24 attendees) (*October 31*).
- Was interviewed about white pine cones by Robert Miller, *News-Times* (*November 3*).
- Participated in the Audubon CT/NY Science Forum (*November 5*).
- Gave an invited talk entitled “Directed Flaming to Control Invasive Plants” at the Upper Midwest Invasive Species Virtual Conference (180 attendees) (*November 6*).

- Participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (*November 9*).
- Led a field tour of silvicultural practices for Yale Forestry graduate students in North Madison (6 students) (*November 18*).
- Spoke on “Oak Resiliency - Why and How” for the Rhode Island Woodland Partnership (24 attendees) (*November 18*).
- Participated in a planning call for Oak Resiliency Virtual Town Hall for Landowners (*November 18*).
- Participated in an NESAF 2020 planning committee conference call (*November 24*).
- Participated in a conference call with state and private foresters to discuss forest management and carbon storage/sequestration (*December 1*).
- Participated in a Forest Ecosystem Monitoring Cooperator State Coordinators Zoom meeting (*December 2*).
- Participated in an NESAF 2020 planning committee conference call (*December 8*).
- Participated in a Yankee SAF Legislature Outreach Planning conference call (*December 16*).
- Participated in a Forest Ecosystem Monitoring Cooperator Steering Committee Zoom meeting (*December 17*).
- Participated in an NESAF 2020 planning committee conference call (*December 22*).
- Participated in a New England Society of American Forester (NESAF) 2021 planning committee conference call (*January 5, 2021*).
- Participated in an Oak Resiliency Landowner Group meeting (*January 8*).
- Participated in a New England Society of American Forester (NESAF) 2021 planning committee conference call (*January 8*).
- Spoke on “The Biodiversity Crisis - Invasive Species and Deer” for the Leetes Island Garden Club (12 attendees) (*January 12*).
- Participated in a New England Society of American Forester (NESAF) 2021 planning committee conference call (*January 19*).
- Met with Massachusetts DCR foresters and Yale Forestry staff to discuss precommercial release of white oak saplings (*January 22*).
- Met with a member of the Hamden Land Conservation Trust for a field discussion of forest dynamics at the Rocky Top Preserve (5 attendees) (*January 27*).
- Participated in a Forest Ecosystem Monitoring Cooperative regional meeting (*January 28*).
- Spoke on estimating deer density and reducing deer browse at the Increasing Oak Resiliency in Southern New England Landowner Townhall (107 attendees) (*February 2*).
- Participated in NESAF 2021 planning committee conference calls (*February 2, 16*).
- Participated in a Zoom meeting with DEEP Commissioner Katie Dykes, Senator Christine Cohen, Representative Vincent Candelora, DEEP staff, and foresters to discuss forest management and carbon (21 attendees) (*February 3*).
- Answered landowner questions on reducing deer browse damage during an oak resiliency Zoom workshop (21 attendees) (*February 6*).
- Organized, hosted, and spoke at the Forest Ecosystem Monitoring Cooperative FEMC Connecticut State Partnership (CT SParC) organizing meeting (26 attendees) (*February 16*).
- Participated in the Society of American Foresters national working group officers virtual meeting (*February 24*).
- Presented updates on forest carbon and resiliency research with DEEP Deputy Commissioner Mason Trumble, UConn and Yale scientists, and DEEP staff (9 attendees) (*February 25*).
- Participated in a national SAF D2 (silviculture) working group virtual annual meeting (38 attendees) (*February 25*).
- Participated in NESAF 2021 planning committee conference calls (*March 2, 9, 16, 30*).
- Spoke on the relationship of forest management on aboveground carbon storage and sequestration at

the Forest Health Monitoring Workshop via Zoom (76 attendees) (*March 4*).

- Participated in a Yankee SAF forest carbon outreach conference call (*March 12*).
- With Mr. Joseph P. Barsky, spoke on “Changes in Forest Carbon During 38 Years of Active Management” at the 16th Annual Connecticut Conference on Natural Resources (91 attendees) (*March 15*).
- Participated in a Forest Ecosystem Monitoring Cooperative State Coordinators meeting (*March 18*).
- Moderated plenary sessions, moderated a research updates technical session, and spoke on “Black Swans, Grey Rhinos, and Boiling Pots” at the NESAF annual winter meeting (126 attendees) (*March 23*).
- Was interviewed about the status of oaks in Connecticut forests by Robert Miller, *News-Times* (*March 30*).
- Was interviewed about current forest research by Mary O’Neill for the Great Mountain Forest newsletter (*April 9*).
- Participated in a Forest Ecosystem Monitoring Cooperative State Coordinators Meeting (*April 16*).
- Presented a webinar entitled “The Roots of CT’s Forest and Its Future” for the Experiment Station Associates (*April 21*).
- Participated in a Yankee Division - Society of American Foresters Forest Carbon Outreach committee meeting call (*April 26*).
- Participated in a New England Society of American Foresters Silviculture Working Group field meeting call (*April 28*).
- Participated in the Forest Ecosystem Monitoring Cooperative ecosystem monitoring proposal review committee (*April 29*).
- Spoke on current research at the Forest Management, Storm Resilient Roadside Forests & Climate Resilient Forests - Sustainable Litchfield Workshop at White Memorial Foundation in Litchfield (14 attendees) (*May 15*).
- Participated in a meeting with DEEP officials, Yale, and UConn faculty to discuss research opportunities in forestry and climate (*May 18*).
- Participated in a Forest Ecosystem Monitoring Cooperative State Coordinators meeting (*May 20*).
- Participated in the 2021 Forest Health Monitoring forest health metrics training (*May 27*).
- Was interviewed about climate change and forest resiliency by Jan Ellen Spiegel of the *CT Mirror* (*June 1*).
- Spoke on “The Roots of Connecticut’s Forest - and Its Future” at the North Branford Land Conservation Trust annual meeting (14 attendees) (*June 2*).
- Spoke in North Madison on using slash walls to improve forest regeneration to federal, state, and watershed foresters from throughout southern New England (17 attendees) (*June 7*).
- Spoke with Will Hochholzer, Alejandro Prieto, and other CT DEEP Forestry staff about improving models to estimate forest regeneration (4 attendees) (*June 7*).
- Participated in a meeting of the Connecticut Tree Protection Examining Board to revise the oral examination at Lockwood Farm (*June 9*).
- Spoke on recent forest research activities on the Oak Resiliency Team Zoom call (11 attendees) (*June 16*).
- Participated in a Forest Ecosystem Monitoring Cooperative State Coordinators Meeting (*June 17*).
- Was interviewed about defoliators and forest health by Jan Ellen Spiegel of the *CT Mirror* (*June 24*).
- Gave a talk on “Forest Management and Forest Carbon” to the Connecticut Professional Timber Producers Association at Lockwood Farm (57 attendees) (*June 25*).
- Was interviewed about the impact of gypsy moths by Zak Bennett of the Daily Mail (UK) (*June 30*).

WHITE, JASON C.

- Participated in the weekly Center for Sustainable Nanotechnology (CSN) center-wide Zoom call (*July*

1, 15, 22, and 29, 2020).

- Participated in the annual meeting of the CAES Research Foundation (July 2).
- Participated in a USDA NIFA AFRI grant review panel by Zoom (July 6-10).
- Spoke by phone with Ms. Jan Spiegel of *CT Mirror* regarding current CAES programs and research (July 13).
- Hosted the monthly CSN Nanochem-plant Zoom call (July 14).
- Spoke by phone with Prof. Jorge Gardea-Torresdey of the University of Texas El Paso regarding an upcoming special issue of *Environmental Science & Technology* focused on the “Environmental Implications of Nanofertilizers” that we are co-editing (July 15).
- Participated in an MS Teams meeting with CSN faculty and Dr. Amarjit Basra of OCP North America to discuss nanofertilizers (July 16-17).
- Participated in a USDA NIFA/Research, Education, and Economics Resources (REE) National Virtual Partnership Webinar Update (July 22).
- Participated in a CSN Summer Undergraduate Research Experience (SURE) webinar (July 28).
- Traveled to Fish and Kent Farm in Suffield, with the Commissioner of Agriculture Mr. Bryan Hurlburt, Dr. James LaMondia, and Ms. Kitty Prapayotin-Riveros, to present the 2020 Connecticut Century Farm Award on behalf of the Connecticut Agricultural Information Council (July 29).
- Traveled to Copps Island Oysters by Norm and Son, LLC in Norwalk, with Dr. James LaMondia and Ms. Kitty Prapayotin-Riveros, to present the 2020 Connecticut Outstanding Young Farmer award on behalf of the Connecticut Agricultural Information Council (July 31).
- Participated in the Department of Public Health Laboratory Preparedness monthly conference call (August 3).
- Spoke by phone with the US Drug Enforcement Agency regarding hemp/THC analysis and DEA Schedule 1 certification (August 3).
- Hosted the 110th Annual Plant Science Day virtual event and gave a Director’s update (150 attendees) (August 5).
- Hosted the quarterly CAES Board of Control meeting (August 5).
- Participated in a Zoom call for the Center for Sustainable Nanotechnology (CSN) Summer Undergraduate Research Experience (SURE) (August 6).
- Participated in CSN strategic planning calls for workgroups focused on organisms, coatings/coronas, and transformations (August 10, 13, 14).
- Hosted the monthly CSN Nanochem-Plant call (August 11).
- Participated in CSN center-wide Zoom calls (August 12, 19, 26).
- Participated in the monthly FDA FERN cCAP conference call (August 13).
- With Dr. Sara Nason, participated in a PFAS laboratory methods call organized by CT DPH and DEEP (August 14).
- As a committee member, participated in the Committee meeting of PhD student Jesus Cantu of the University of Texas El Paso (August 17).
- Participated with collaborators from Harvard University, MIT, Louisiana State University, and UTEP in a Zoom call with the National Science Foundation (NSF) regarding a proposed Engineering Research Center (ERC) (August 17).
- With Dr. Philip Armstrong, participated in an MS Teams call with the Office of the Governor, DPH, the Department of Agriculture, and DEEP regarding mosquito virus surveillance findings and EEE (August 17).
- With Dr. Sara Nason, participated in a northeast regional call to discuss PFAS analysis methods (representatives from all New England states were present) (August 18).
- Participated in a day-long CSN strategic planning meeting (August 24).
- Participated in an FDA 50-states call (August 27).
- With Dr. Wade Elmer, participated in a Zoom call with Dr. Indrajeet Chaubey (Dean of the College of

Agriculture, Health and Natural Resources, UConn) to discuss funding of the National Plant Diagnostic Network (*August 31*).

- Participated in a meeting with DAS Construction Services staff and Christopher Williams Architects regarding the New Haven campus greenhouse project (*September 1*).
- Participated in a Center for Sustainable Nanotechnology (CSN) all faculty Zoom call (*September 3*).
- Hosted the CSN monthly nanochemistry-plant working group call (*September 8*).
- Participated in the monthly FDA FERN cCAP call (*September 10*).
- Participated in a Department of Public Health Laboratory Preparedness monthly conference call (*September 14*).
- Participated in a teleconference call with CAES and USDA APHIS staff regarding the spotted lanternfly (*September 15, 25*).
- Participated in an MS Teams meeting with CT Department of Agriculture and CAES staff regarding the interagency sampling contract (*September 16*).
- Participated in a weekly CSN all center call (*September 16, 23*).
- Participated in an FDA webinar on our newly awarded Laboratory Flexible Funding Model (LFFM) grant (*September 17*).
- Participated by Zoom in the NanoInnovation 2020 Conference & Exhibition held in Rome, Italy, and gave a presentation entitled “Nanoscale nutrients to suppress disease and increase crop production” (150 attendees) (*September 18*).
- As an external committee member, participated remotely in the Ph.D. defense of Nathalie Hudson-Smith at the University of Minnesota (*September 21*).
- Participated by Zoom in the annual Northeast Experiment Station Directors meeting (*September 22*).
- Participated in an MS Teams meeting with staff from the Attorney General’s Office regarding regulation of insect pests (*September 22*).
- Participated in an EPA-sponsored webinar on the “Next Gen Fertilizer Challenge” (*September 24*).
- Participated by Zoom in the annual Experiment Station Directors meeting (*September 28-30*).
- Participated by Zoom in the annual CSN All-Hands meeting and gave a presentation entitled “Nanochem-Plant Work at CAES” and hosted a breakout session on plant and nanoparticle interactions (65 attendees) (*September 30*).
- Participated in a teleconference call with Dr. Kirby Stafford and Dr. Victoria Smith, as well as officials at the CT DEEP, CT DoAg, and USDA APHIS regarding surveillance for the spotted lanternfly (*October 2, 15, 22*).
- Participated in a Department of Public Health Laboratory Preparedness monthly conference call (*October 5*).
- Participated in the weekly calls for the NSF Center for Sustainable Nanotechnology (*October 7, 21, 28*).
- Participated in a CSN all faculty Zoom call (*October 8*).
- Gave a Zoom lecture entitled “Nanoscale Amendments to Enhance Crop Growth: Unintended Consequences in the Rhizosphere and Plant Microbiome” for the Sustainable Innovation of Microbiome Applications in the Food System (SIMBA) online training course in Rome, Italy (45 attendees) (*October 9*).
- Hosted the CAES Board of Control meeting at the Valley Laboratory and met with Senator Cathy Osten to discuss the Valley Laboratory research program and renovation project (*October 14*).
- Participated in an FDA LFFM webinar on FERN and secure information/data sharing (*October 15*).
- With Analytical Chemistry staff, participated in a Zoom call with A2LA staff regarding our upcoming ISO 17025 Accreditation 2-year assessment (*October 16*).
- With Dr. Doug Brackney, participated in a Zoom call with Rep. Pat Dillon concerning CAES work on COVID-19 detection in sewage and with the SalivaDirect assay (*October 19*).
- Participated in the monthly Northeast Regional Experiment Station Director’s call (*October 20*).

- Participated in the annual meeting of the Nanyang Technological University-Harvard University T.H. Chan School of Public Health Initiative for Sustainable Nanotechnology conference and by Zoom gave a presentation entitled “Enhancing Cu Delivery and Seedling Development with Biodegradable, Tunable, Biopolymer-Based Nanofiber Seed Coatings” (25 attendees) (*October 21*).
- Gave a lecture by Zoom entitled “Environmental Health Science Research at the Connecticut Agricultural Experiment Station (CAES)” to the Yale University School of Public Health Department of Environmental Health Sciences Seminar Series (20 attendees) (*October 21*).
- Participated in an FDA LFFM webinar on best practices for data acceptance (*October 22*).
- Gave a lecture by Zoom entitled “Sustainable Nanotechnology to Combat Global Food Insecurity” to a Sustainable Nanotechnology graduate class at the University of Maryland Baltimore County (10 attendees) (*October 26*).
- Participated in an FDA LFFM training session on the FDA ORA sample receipt and data analysis portal (*October 27*).
- Gave a lecture entitled “Nanoscale Nutrients to Suppress Disease and Increase Crop Yield” by Zoom to Amity University in Noida, India (120 attendees) (*October 29*).
- Participated in a Yale School of Public Health symposium on 1,4-dioxane (*October 30*).
- Participated in the Department of Public Health Laboratory Preparedness monthly conference call (*November 2*).
- Participated in the 4th International Conference on NanoForAgri 2020 (Virtual): Application of Nanotechnology for Sustainable Productive and Safer Agriculture and Food Systems and presented a seminar entitled “Nano-Enabled Strategies to Enhance Crop Nutrition and Protection” (65 attendees) (*November 5-6*).
- Participated in the weekly calls for the NSF Center for Sustainable Nanotechnology (CSN) (*November 4, 11*).
- Participated in teleconference calls with Dr. Kirby Stafford and Dr. Victoria Smith, as well as officials at the CT DEEP, CT DoAg, and USDA APHIS regarding surveillance for the spotted lanternfly (*November 5, 19*).
- Participated in a monthly CSN all faculty call (*November 5*).
- As a member of her graduate committee, participated in the Proposal B Defense of Yingqing Ye, a PhD student at the University of Texas El Paso (*November 9*).
- Participated in a CSN panel discussion for graduate students on grant proposal preparation and submission (*November 10*).
- Hosted by Zoom the CSN monthly “Nanochemistry-Plant” working group call (*November 10*).
- Participated in the Materials Innovation for Sustainable Agriculture (MISA) 2020 Symposium (Virtual) and gave a presentation entitled “Nano-Enabled Management of Crop Disease: Applications and Implications” (30 attendees) (*November 12*).
- Participated in the 2020 Annual Sustainable Nanotechnology Organization (SNO) Conference and gave presentations entitled “Nanoscale Micronutrients to Enhance Crop Disease Resistance: Unintended Consequences in the Rhizosphere?” (45 attendees) and “Copper Sulfide Nanoparticles Suppress *Gibberella fujikuroi* Infection in Rice Seeds by Multiple Mechanisms: Contact-mortality, Nutritional Modulation and Phytohormone Regulation” (*November 13*).
- Participated in the SETAC North America 41st Annual Meeting (Virtual) and gave a presentation entitled “Nanoscale Micronutrients to Enhance Crop Disease Resistance: Unintended Consequences in the Rhizosphere?” (25 attendees) (*November 15-16*).
- Participated in a Northeast Waste Management Officials Association (NEWMOA) call on PFAS soil leaching issues (*November 19*).
- Participated in a CT Department of Public Health call on vaccination planning for state agencies (*November 20*).

- As a member of her graduate committee, participated in Heping Shang’s Comprehensive Oral exam; Heping is a PhD student at the Stockbridge School of Agriculture at the University of Massachusetts (November 20).
- As a member of his graduate committee, participated in the Proposal A Defense of Jesus Cantu, a PhD student at the University of Texas El Paso (November 24).
- With Dr. Christian Dimkpa, hosted Special Agent John Souvlis of the FBI WMD Directorate in New Haven on a tour and discussion of programs (November 24).
- Participated in the FDA LFFM kick-off Web-Ex calls for our new Human Food and Animal Food cooperative agreement programs (November 30).
- Gave a presentation entitled “Nanotechnology in Agriculture: Applications and Implications” at the CT Environment Council (CTEC) Annual Meeting and Education Program (virtual) (60 attendees) (December 1).
- Participated in the virtual US FDA Rapid Response Teams (RRT) C2C Annual Meeting (December 1-3).
- Participated in a monthly Center for Sustainable Nanotechnology (CSN) all faculty call (December 3).
- Participated in a US FDA LFFM Chem Human and Animal Food one-on-one WebEx call (December 4).
- Was interviewed about nano-enabled agriculture by Ms. Naomi Lubick of *Chemical and Engineering News* (December 4).
- Gave a presentation entitled “Putting Science to Work for Society: Helping to Protect Connecticut’s Environment During the Pandemic” at the virtual Connecticut Association of Conservation and Inland Wetlands Commissions (CACIWC) Annual Meeting (December 5).
- Participated in the Department of Public Health Laboratory Preparedness monthly conference call (December 7).
- Participated in the weekly FDA LFFM WebEx calls for our new Human & Animal Food and Food Defense cooperative agreement programs (December 7, 14).
- Hosted by Zoom the CSN monthly “Nanochemistry-Plant” working group call (December 8).
- Participated in the weekly CSN All-Hands calls (December 9, 16).
- As Managing Editor, hosted an annual Editorial Board meeting for the *International Journal of Phytoremediation* (December 11).
- Participated in the quarterly meeting of the Northeast Region Experiment Station Directors (NERA) by Zoom (December 15).
- Gave a presentation via Zoom entitled “Increased Efficacy of Nanoscale Fertilizers” at the United Nations-sponsored Nanotechnology Research and Innovation Forum 2020 (38 attendees) (December 16).
- With Dr. Wade Elmer, hosted Representative Dorinda Borer, Representative Joseph Gresko, and Senator Christine Cohen for a tour of CAES facilities and programs (December 30).
- With the staff of the Department of Analytical Chemistry, “virtually” hosted two assessors from the Association for Laboratory Accreditation (A2LA) for our 2-year assessment of our ISO 17025 accredited programs; the assessors found only one deficiency, which the lab has addressed successfully. The Laboratory Scope of Accreditation, which was expanded to include THC/CBD analysis in hemp and fat/protein in animal feeds, has been extended to February 2023 (January 4-6, 2021).
- Was interviewed about nanotechnology and agriculture by Ms. Shi En Kim of the University of Chicago (January 11).
- Participated in a Zoom call with Representative Dorinda Borer, co-chair of the Environment Committee, about presentation of CAES research to the full Environment Committee and Public Health Committee (January 11).
- Participated in monthly FDA LFFM WebEx calls for our new Human & Animal Food and Food Defense cooperative agreement programs (January 11).

- As co-chair of his committee, attended the PhD Proposal Defense of Mr. Gurpal Singh of the University of Massachusetts Amherst (*January 12*).
- Participated in NSF Center for Sustainable Nanotechnology (CSN) weekly All-Hands calls (*January 13, 20, 27*).
- With Dr. Wade Elmer and Mr. Michael Cavadini, testified via MS Teams in front of the Commission on Human Rights and Opportunities regarding the review of the CAES Affirmative Action Plan (*January 13*).
- Participated in a monthly CSN all faculty call (*January 14*).
- Participated in the quarterly CAES Board of Control meeting (*January 19*).
- With Dr. Goudarz Molaei, Dr. Douglas Brackney, Dr. Sara Nason, Dr. Philip Armstrong, Dr. Yonghao Li, and Dr. Gale Ridge, gave a presentation of CAES research and service programs by Zoom to the full Environment Committee and Public Health Committee (*January 19*).
- Participated in the CT USDA APHIS Cooperative Agricultural Pest Survey (CAPS) Program Winter meeting (*January 20*).
- As a member of her Dissertation Committee, participated in the Proposal Defense of Ms. Beza Tuga of the University of Minnesota (*January 20*).
- Participated in an Experiment Station Associates meeting (*January 20*).
- Gave a presentation entitled “CAES 2020 Update: Putting Science to Work for Society in a Pandemic” at the annual Connecticut Tree Protective Association (CTPA) meeting (65 attendees) (*January 21*).
- Participated in the annual CSN External Advisory Board meeting (*January 21*).
- Participated in a Zoom call with Ilya A. Medina Velo of Houston Baptist University about USDA reported requirements (*January 28*).
- Participated in CSN all faculty calls (*February 2, 23*).
- Participated in the annual Manufactured Food Regulatory Program Alliance meeting (MFRPA) via Zoom (*February 2-4*).
- With Dr. Kirby Stafford, Dr. Victoria Smith, and Mr. Michael Last, participated in an MS Teams call with the Attorney General’s office to discuss the CAES regulatory response to the spotted lanternfly (*February 3*).
- Participated in weekly CSN All-Hands calls (*February 3, 10, 17, 24*).
- Gave a presentation by Zoom entitled “Nanoscale Micronutrients to Suppress Crop Disease” at the Division of Plant Pathology, SKUAST-K, Kashmir, India (100 attendees) (*February 5*).
- Participated in the monthly FDA LFFM WebEx calls for the Human & Animal Food and Food Defense cooperative agreement programs (*February 8*).
- With Dr. Wade Elmer, participated in a CSN Zoom call with colleagues at Johns Hopkins University to discuss collaborative research (*February 8*).
- Participated in an MS Teams call with the Department of Consumer Protection to discuss testing of recreational marijuana (*February 10*).
- Participated in the monthly Department of Analytical Chemistry Quality Assurance meeting (*February 16*).
- Hosted the monthly CSN Nanochemistry-Plant working group call (*February 16*).
- Participated in an NSF I-Corp interview with Ms. Lucy Adams and Professor Jamie Lead of the University of South Carolina (*February 18*).
- Gave a presentation by Zoom entitled “Chemistry at the Connecticut Agricultural Experiment Station” to the Western Connecticut State University Department of Chemistry and Biochemistry (25 attendees) (*February 19*).
- Participated in a preparatory meeting for the Food and Nutrition Security Workshop hosted by the Research Triangle Nanotechnology Network (*February 22*).
- Participated in a Zoom demonstration call hosted by the Northeast Regional Association of State Agricultural Experiment Station Directors (NERA) for the National Information Management and

Support System (NIMSS) (*February 23*).

- Participated in the Farmland Preservation Advisory Board Kick-off Meeting (*February 25*).
- Participated by Zoom in an Experiment Station Committee on Organization and Policy (ESCOP) meeting (*February 25*).
- Participated in a Zoom call with Mr. Peter Abbott, who is British Consulate-General-Boston, and staff from his Foreign, Commonwealth & Development Office to discuss ways to enhance research collaboration between the US and UK (*February 25*).
- Participated in the monthly Laboratory Preparedness Advisory Committee teleconference call with the CT Department of Public Health (*March 1*).
- Gave an NSF Center for Sustainable Nanotechnology (CSN) Professional Development workshop on the peer review process for manuscripts and journals (*March 1*).
- Gave a presentation by Zoom entitled “Nanoscale Nutrients for the Suppression of Crop Disease” at the 14th Annual Agriculture and Food Conference of Southeastern Massachusetts (SEMAP) (*March 1*).
- Participated in an MS Teams meeting with staff from OPM and OFA to discuss the development of a recreational marijuana testing program (*March 1*).
- Participated in the remote assessment of the CT Department of Agriculture’s AFRPS program by FDA staff (*March 2*).
- Participated in the weekly CSN All-Hands calls (*March 3, 10, 17, 24*).
- Participated in the monthly FDA LFFM WebEx calls for the Human & Animal Food and Food Defense cooperative agreement programs (*March 8*).
- Participated in a Research Triangle Nanotechnology Network workshop entitled “Nanotech for Food Nutrition Security Workshop” and led a breakout discussion room on “Pests and Pathogens” (*March 9*).
- Participated in a Zoom call with representatives of Elsevier regarding the journal NanoImpact (*March 11*).
- Testified by Zoom in front of the Legislature’s Conservation and Development Subcommittee (*March 12*).
- Participated in an FDA Stakeholder FSI Budget Update WebEx seminar (*March 12*).
- Held a Zoom call with colleagues at Johns Hopkins University to discuss collaborative research (*March 12*).
- Participated in the annual FDA Animal Feed Regulatory Program Standards (AFRPS) conference (*March 16-18*).
- Participated in the International Conference on Recent Advances in Agricultural Sciences (ICRAAS-2021) “Innovations and Translational Research in Agriculture” conference and gave a presentation entitled “Nanotechnology and Agriculture Feeding the World for 2050” and participated in the Inaugural and Closing Plenary sessions as an invited guest (*March 16-17*).
- Participated in the annual Editorial Advisory Board Members of *Environmental Science & Technology* and *Environmental Science & Technology Letters* (*March 16*).
- Participated in an MS Teams meeting with UM6P, OCP, and Johns Hopkins University to discuss collaborative research (*March 18*).
- Participated in the CT Department of Agriculture launch of the CT Grown 2021 campaign at Geremia Greenhouses in Wallingford (*March 22*).
- Gave an interview along with CSN graduate students to Shi En Kim of *Science News* (*March 22*).
- Participated in the annual CSN All-Hands meeting and gave a presentation entitled “Nanochemistry-Plant Interactions Work at CAES” (*March 22-23*).
- Participated in an FDA LFFM CAP All-Hands meeting (*March 26*).
- Held a call with State Senator Cathy Osten to discuss CAES programs related to animal epidemics (*March 29*).

- Testified in front of the Legislature’s Bonding Subcommittee (*March 31*).
- Participated in the monthly Laboratory Preparedness Advisory Committee teleconference call with the CT Department of Public Health (*April 5*).
- With staff from the Department of Consumer Protection Drug Control Division, visited CTPharma in Rocky Hill for a tour of the facilities and a discussion of programs (*April 6*).
- Participated by MS Teams in the bi-weekly Rapid Response Team meeting hosted by the CT Department of Consumer Protection Foods Division (*April 7, 21*).
- Participated in the weekly Center for Sustainable Nanotechnology (CSN) All-Hands calls (*April 7, 21, 28*).
- Participated in an organizational Zoom call for planning the annual FDA Laboratory Flexible Funding Model (LFFM) meeting (*April 7, 21, 28*).
- Participated in the Society of Toxicology “FDA Food Safety Colloquium: Integrated Approaches to Testing and Assessment: The Future of Regulatory Toxicology Assessment” webcast (*April 8*).
- Participated in the monthly FDA LFFM WebEx calls for the Human & Animal Food and Food Defense cooperative agreement programs (*April 12*).
- With Dr. Nubia Zuverza-Mena, participated in a Zoom call with Dr. Ileana Vera Reyes of Centro de Investigación en Química Aplicada (CIQA) in Mexico to discuss a research visit at CAES (*April 13*).
- Hosted the monthly CSN Nanochem-Plant working group Zoom call (*April 13*).
- With collaborators at the University of Minnesota, participated in a Zoom call with representatives of Bayer Crop Science to discuss interests in nano-enabled agriculture (*April 13*).
- Gave a presentation entitled “Nanoscale Micronutrients as a Sustainable Approach to Manage Crop Disease” at the American Chemical Society Spring 2021 Meeting in the AGFD Presidential Symposium “Sustainability: Advances and Applications” (*April 14*).
- Hosted the quarterly CAES Board of Control meeting held in New Haven (*April 14*).
- Gave an invited lecture entitled “Nanotechnology and Agriculture: Applications and Implications” to the University of Nevada Reno Department of Civil and Environmental Engineering (*April 14*).
- Participated by Zoom in Farmland Preservation Advisory Board meetings (*April 16, 22*).
- Was interviewed on topics related to nano-enabled agriculture by Mr. Jack Richards of the University of Pittsburgh (*April 16*).
- With Dr. Wade Elmer, participated in the annual staff evaluation for CSN researchers (*April 16*).
- Participated in an MS Teams meeting for the Annual DAS Statewide Leasing and Property Transfer Overview (*April 20*).
- Participated in the monthly CSN All-Faculty Zoom meeting (*April 20*).
- Hosted the annual meeting of the Experiment Station Associates on Zoom and gave a Director’s update on CAES activities (*April 21*).
- With Dr. Joseph Pignatello and Mr. Michael Last, participated in an MS Teams call with staff of the Attorney General’s office to discuss recent issues with the National Science Foundation (*April 22*).
- Participated in the National Nanotechnology Initiative (NNI) Public NanoEHS Webinar - What We Know about NanoEHS: Environment (*April 27*).
- Hosted a meeting of the CAES nanotechnology group (*April 29*).
- Held a Zoom called with representatives of the Northeast Regional Association of Experiment Station Directors (NERA) to discuss recent issues with the National Science Foundation (*April 30*).
- Participated in a Zoom call with colleagues at the Arizona Department of Public Health, Ohio Department of Agriculture, and Virginia Division of Consolidated Laboratory Services to discuss a presentation at the upcoming annual FDA LFFM meeting (*April 30*).
- Participated in the monthly Laboratory Preparedness Advisory Committee teleconference call with the CT Department of Public Health (*May 3*).
- Participated in the annual FDA audit of the CT Department of Consumer Protection’s Manufactured Food Regulatory Program Standards (MFRPS) project (*May 4*).

- Met with Ms. Lauren Tarde, a masters candidate at The American University of Rome, to discuss her work on “Food Studies and Sustainable Production and Consumption Policies,” with a specific focus on young CT farmers and the obstacles they encounter with regards to access to land (*May 4*).
- Participated in the biweekly meeting of the CT Rapid Response Team (*May 5, 18*).
- Participated in weekly Center for Sustainable Nanotechnology (CSN) All-Hands calls (*May 5, 12, 26*).
- Participated in an organizational Zoom call for planning the annual FDA Laboratory Flexible Funding Model (LFFM) meeting (*May 5*).
- Was interviewed about new application fields in which nano-material silicon carbide could be used by Mr. Mario Jandrisevits, who is a student at Vienna’s University of Economics and Business (*May 7*).
- Participated in an MS Teams meeting with representatives from the CT Department of Agriculture to discuss updates for next year’s sampling plan as part of the FDA LFFM Animal Food Project (*May 7*).
- Participated in the 3rd International Conference on Plant Science and Research (Virtual) and gave an invited talk entitled “Nanotechnology and Agriculture: Tuning Agrochemical Chemistry at the Nanoscale to Maximize Crop Production” (*May 10-11*).
- Participated in the monthly FDA LFFM WebEx calls for the Human & Animal Food and Food Defense cooperative agreement programs (*May 10*).
- Met with Mr. Chris Sullivan and Ms. Melissa Mostowy of the Southwest Conservation District and gave a tour of CAES facilities and programs (*May 11*).
- Participated in a Zoom call with collaborators at the University of Birmingham (UK) and China Agricultural University to discuss collaborative research (*May 13*).
- As a member of her committee, participated in a Zoom call with Ms. Jaya Borgatta of the University of Wisconsin about her PhD research (*May 13*).
- Participated in an American Chemical Society webinar entitled “Nanosafety: Emerging Research Perspectives” (*May 13*).
- Participated in a Zoom with staff of the CSN to discuss diversity, equity, and inclusion issues (*May 18*).
- Participated in a public meeting to present and discuss the upcoming quarantine of CT for the spotted lanternfly (*May 18*).
- Participated in a Zoom meeting with Professor Jorge Gardea-Torresdey of the University of Texas-El Paso to discuss a special issue of *Environmental Science & Technology* on nanofertilizers that we are guest editing (*May 21*).
- Participated in the annual face-to-face meeting (virtual) of the FDA Laboratory Flexible Funding Model Cooperative Agreement Program (*May 24-27*).
- Participated in the undergraduate thesis defense of Ms. Meghan Cahill of the University of Minnesota Department of Chemistry (Meghan is starting as a CAES Research Technician I in late July) (*May 27*).
- Participated in the biweekly meetings of the CT Rapid Response Team (RRT) (*June 2, 16, 30*).
- Participated in the weekly Center for Sustainable Nanotechnology (CSN) All-Hands calls (*June 2, 9, 16, 23*).
- Participated in the National Nanotechnology Initiative (NNI) webinar on “Nanosensors for Food and Agriculture” (*June 2*).
- Participated in the American Chemical Society (ACS) Zoom webinar entitled “Bridging the Gap: Linking Analytical Chemistry to Biological Effects” (*June 3*).
- Met with Ms. Elizabeth Holt of the New Haven Preservation Trust and gave a tour of CAES laboratories and programs (*June 3*).
- Participated in the monthly FDA RRT webinar (*June 3*).
- Participated in the monthly Laboratory Preparedness Advisory Committee teleconference call with the CT Department of Public Health (*June 7*).
- Hosted the monthly CSN Nanochemistry-Plant Zoom call (*June 8*).
- Hosted Ms. Meghan Cahill from the University of Minnesota – Meghan will be joining the Department

- of Analytical Chemistry as a Research Technician I next month (*June 10*).
- Hosted Senator Richard Blumenthal for a press conference and discussion on tickborne diseases (*June 11*).
- Participated in the kick-off meeting of the Cannabis Regulators Association (CANNRA) Public Health and Data Monitoring Special Committee (*June 11*).
- Participated in the monthly FDA Laboratory Flexible Funding Model Zoom calls for Human and Animal Food and Food Defense (*June 14*).
- Participated in the monthly Farmland Preservation Advisory Board (FPAB) meeting (*June 17*).
- Hosted the monthly meeting of the CAES J-1 Visa recipients (*June 18*).
- Participated in the CANNRA mid-year Zoom meeting (*June 21*).
- Participated in the bi-monthly Northeastern Regional Association of State Agricultural Experiment Station Directors (NERA) meeting (*June 21*).
- Participated in the Ph.D. defense of Dr. Jaya Borgatta of the University of Wisconsin Madison (*June 22*).
- Participated in the 2021 RI, MA, and CT RRT Tabletop Exercise (*June 24*).
- Participated in the FY21 USDA AFRI Pre-panel Orientation call (*June 24*).
- Participated in the bi-monthly FDA 50-State call (*June 25*).
- With Dr. Kirby Stafford and Dr. Victoria Smith, participated in a Zoom meeting with representatives of the Connecticut Nursery & Landscape Association to discuss the current spotted lanternfly quarantine (*June 25*).
- Spoke by phone with Professor Jorge Gardea-Torresdey of the University of Texas El Paso to discuss a special issue of *Environmental Science & Technology* that we are guest editing on the “Environmental Implications of Nanofertilizers” (*June 28*).
- Participated in the NIEHS Superfund Basic Research Program (SRP) Kick-off call (*June 29*).
- With Dr. Kirby Stafford and Dr. Victoria Smith, participated in a Zoom meeting with representatives of the Connecticut Greenhouse Growers Association (CGGA) to discuss the current spotted lanternfly quarantine (*June 30*).

#### WILLIAMS, SCOTT C.

- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society’s publication, *The Wildlife Professional* (*August 5*).
- Was interviewed about the impacts of climate change on ticks, wildlife, and zoonotic diseases by *CT Mirror* photographer/reporter Yehyun Kim: <https://ctmirror.org/2020/08/19/where-connecticut-covid-climate-change-and-crittersintersect/> (*August 7*).
- Conducted a small mammal trapping demonstration to students in the Wildlife Management Techniques class in the Department of Natural Resources and the Environment at the University of Connecticut (18 students, 1 professor) (*August 31*).
- Participated in a conference call with members of the Northeast Regional Center of Excellence in Vector Borne Diseases on project logistics for a proposed *Haemaphysalis longicornis* overwintering study (*September 2*).
- With Dr. Megan Linske, Mr. Michael Short, and Mrs. Jamie Cantoni, discussed and demonstrated Lyme disease ecology field work for Dr. Chris Kerantzas (Yale University Medical Fellow) (*September 23*).
- Conducted vegetation surveys with Dr. Megan Linske, Mr. Michael Gregonis (DEEP Wildlife Division), and Mr. Andy Hubbard (MDC Forester) at MDC’s Barkhamsted Reservoir property (*September 24*).
- Participated, as Immediate Past-President, in the Northeast Section of the Wildlife Society Executive Committee Fall Meeting (*October 7*).
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society’s publication, *The Wildlife Professional* (*October 8*).

- Participated in a planning call with Bedoukian, Inc., to discuss potential tick repellent preliminary trials (*October 28*).
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, *The Wildlife Professional* (*December 2*).
- Participated in the 2021 Virtual Annual Meeting of the Northeast Regional Center for Excellence in Vector-Borne Diseases (*January 12, 2021*).
- Gave a Zoom presentation to the Wildlife Biology class at Lyman Memorial High School on career development (17 students, 1 teacher) (*January 13*).
- Presented a remote, invited lecture to the Worcester (MA) Garden Club about the relationship between blacklegged ticks and Japanese barberry (42 attendees) (*January 28*).
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, *The Wildlife Professional* (*February 4*).
- Gave an invited lecture about the role of white-tailed deer in tick and tick-borne pathogen life cycles for the "Wildlife in Connecticut" speaker series for the Meig's Point Nature Center, Hammonasset Beach State Park (75 attendees) (*February 6*).
- Participated in a field visit of a piece of potential open space investigating habitat quality and connectivity with municipal officials from the Towns of Guilford and Madison (*February 17*).
- Gave an invited lecture about the relationship between Japanese barberry and blacklegged tick abundances for the Mid-Michigan Cooperative Invasive Species Management Area Virtual Municipal Training Event (70 attendees) (*February 25*).
- Participated in the CDC's Emerging Infectious Diseases virtual mid-year meeting with CT Dept. of Public Health staff (*March 2*).
- As a sitting advisory member, participated in the kickoff meeting of the new National Wildlife Tick-Borne Disease Program (*March 2*).
- Participated in the annual meeting of the Executive Committee of the Northeast Section of The Wildlife Society (*March 3*).
- Gave a talk entitled "Impacts of Deer Exclusion on Oak Regeneration in Three Different Timber Harvesting Regimes: A Collaborative Effort" at the Forest Health Monitoring Workshop via Zoom (*March 4*).
- As a sitting advisory member, participated in a biweekly meeting of the National Wildlife Tick-Borne Disease Program (*April 1*).
- Became a member of Cornell University Master's student Joseph Poggi's graduate committee (*April 5*).
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society's publication, *The Wildlife Professional* (*April 7*).
- As a sitting advisory member, participated in the biweekly meeting of the National Wildlife Tick-Borne Disease Program (*April 15*).
- As outgoing past-president participated in the Northeast Section of The Wildlife Society's annual membership meeting (*April 22*).
- Participated in the virtual Northeast Fish and Wildlife Conference (*April 26, 27*).
- Presented an invited Zoom lecture on the link between public and forest health to members of the New Hartford Land Trust (32 attendees) (*May 11*).
- Presented an invited in-person talk on ticks, forests, and public health for the Friends of Topsmead Park in Litchfield (29 attendees) (*May 13*).
- As a sitting advisory member, participated in a biweekly meeting of the National Wildlife Tick-Borne Disease Program (*May 27*).
- Participated in a conference call for the Editorial Advisory Board for The Wildlife Society publication, *The Wildlife Professional* (*June 3*).
- Gave a talk about the link between forest health and public health to the Connecticut Professional

Timber Producers Association at Lockwood Farm (57 attendees) (June 25).

#### ZARRILLO, TRACY

- Was interviewed about specialist bees in Connecticut and promoting “wild lawns” for bee forage, particularly for *Andrena violae*, a specialist mining bee that only uses violet pollen to feed its young, by Theresa Barger for Connecticut Magazine (January 27, 2021).
- In January, Ms. Zarrillo was invited by Dr. Kathleen Engelmann of the University of Bridgeport to give a talk about her coastal wild bee study at the Northeast Natural History Conference in April.
- Was invited by Dr. Marta Wells of Yale University to mentor a senior at Yale University, doing a senior honors thesis on wild bee diversity.
- Was invited by Peter Picone of CT DEEP to collaborate on a project that will track pollinator diversity over time in a newly planted pollinator habitat restoration in Robbins Swamp Wildlife Management Area in Canaan, CT (January).
- Was interviewed about mason bee diversity in CT and the use of bee hotels by James Sirch of the Yale Peabody Museum for his blog “In Your Backyard” (March 23).
- Was interviewed about the importance of pollinators in eastern CT, specifically addressing the status and variety of bees in the area, by Ms. Fran Kefalas from The Last Green Valley organization for their member magazine *National Heritage Corridor* (April 1).
- Gave an oral presentation entitled “The Bee Fauna of an Atlantic Coastal Plain Tidal Marsh Community in Southern New England, USA” at the virtual New England Natural History Conference (26 attendees) (April 16).
- Was interviewed about wild bee diversity in Connecticut by Susannah Wood, *Norfolk Now* (June 18).

#### ZENG, QUAN

- Participated in the Plant Health 2020 Conference (online), participated in the Bacteriology Committee meeting (August 6), Phyllosphere Committee meeting (August 7), organized and moderated a special session “Let’s Work Together and Get Things Done: Pathogen Synergism During the Infection of Plants” where he gave a presentation entitled “*Dickeya dadantii* Differentiates into Two Subpopulations to Multitask on Virulence and Growth During the Infection of Potato” (August 13, 2020).
- Served on a grant review panel for a competitive research program of a U.S. federal agency (October 13-16).
- Participated in the 82nd New England, New York & Canadian Fruit Pest Management Workshop and presented “Pathogen Entry Points and Colonization of *Erwinia amylovora* on Apple Leaves” (72 participants) (October 19).
- Delivered a departmental seminar entitled “Flower Microbiome and Its Impact to Plant Health” for the Department of Entomology and Plant Pathology at the University of Arkansas via Zoom (40 adults) (October 5).
- Gave an oral presentation entitled “Epiphytic Proliferation and Entry Points of the Fire Blight Pathogen *Erwinia amylovora* to Apple Leaves” at the Sussex Plant Symposium organized by Yale University via Zoom (35 adults) (November 6).
- Participated in the graduate admission committee meeting of the Department of Plant Science and Landscape Architecture at the University of Connecticut via Zoom (10 adults) (November 24).
- Joined the graduate student admission meeting with faculty members of the Department of Plant Sciences and Landscape Architecture from the University of Connecticut (December 14).
- With Dr. David Rosenberger, Mr. Glen Koehler, and Dr. Dan Cooley, shared their perspectives on “Stupid Questions of Fire Blight” to a group of extension agents, educators, and professors at the Northeastern Tree Fruit IPM Working Group via Zoom (25 attendees) (January 12, 2021).
- Gave four presentations entitled “How Do Apple Trees Produce Apples” to four groups (Daisy, Brownie, Junior, Senior) of Girl Scouts of Connecticut for the “Arbor Day” event in Stamford (85

- children, 10 adults) (*May 15*).
- Participated in an online editorial board meeting of the journal *Phytopathology* (*June 1*).

## ADVANCES IN KNOWLEDGE

### DEPARTMENT OF ANALYTICAL CHEMISTRY

Service, research, and outreach activities in the Department are conducted within the focus areas of **Food Safety** and **Environmental Monitoring/Remediation**. Activities within each area are often complimentary. A breakdown of samples based on submitting agency is shown below for the period July 1, 2020 – June 30, 2021.

Source of Sample	Numbers of samples analyzed
Department of Agriculture	479
Department of Consumer Protection	499
Department of Energy and Environmental Protection	80
FDA, Health Depts., Cities/Towns, Misc. Foundations	72
Proficiency Test Samples	8
University Research Collaborators	6
CAES Departments	39
<b>Grand Total</b>	<b>1183</b>

#### **I. SERVICE ACTIVITIES**

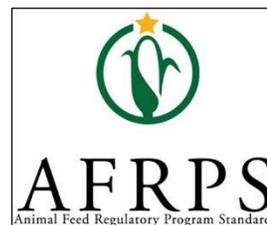
Analyses in the Department of Analytical Chemistry are conducted on a wide range of sample types submitted by other state and federal agencies, municipalities, law enforcement, non-profit groups, businesses, university collaborators, and other departments at the Connecticut Agricultural Experiment Station (CAES). This list is not intended to be all-inclusive.

##### **1. ANALYSES ON BEHALF OF CONNECTICUT DEPARTMENT OF AGRICULTURE**

The Department of Analytical Chemistry has three long-standing programs with the CT Department of Agriculture (DoAg) involving the chemical analysis of commercial feed and fertilizer products.

###### *a. Animal Feeds:*

- **Analysts:** John Ranciato, Terri Arsenault, Kitty Prapayotin-Riveros, Walter Krol, Brian Eitzer
- **Goal:** To assure products are in compliance with stated label guarantees and that levels of aflatoxins and pesticides, if present, are below regulatory limits.
- **Summary:** This was one of the primary analyses of the Station in the late 1890s. Products for household pets and commercial agricultural operations are collected by inspectors from DoAg. Analytical results are reported to DoAg, who in turn report findings to the product dealer and/or manufacturer and conduct regulatory response as required. In addition, data are reported to the FDA through an online data exchange platform called eLEXNET.



**Results:** From July 1, 2020, to June 30, 2021, we received 151 feed samples for analysis of aflatoxins, 80 samples for pesticides, and 61 samples for proximate (protein, fat, and fiber) analysis. Joint funding with the DoAg has been acquired from the FDA to facilitate inclusion in the Animal Feed Regulatory Program Standards (AFRPS) and the Laboratory Flexible Funding Model (LFFM); this 5-year cooperative agreement has enabled the Department to bring aflatoxin analysis in animal feeds by liquid chromatography high resolution mass spectroscopy (LC-HRMS) under the scope of ISO accreditation, effective February 2018. In addition, protein by combustion, and fat by gravimetric extraction, were brought under scope in January 2021. Pesticide testing of food was accredited to the ISO standard under the MFRPS program in 2016. All samples were analyzed by the methods for aflatoxin extraction and quantitation (by LC-HRMS) in feed as part of the AFRPS. All but two samples were officially logged out with no aflatoxins detected; one sample had Aflatoxin B1 at  $1.0 \pm 0.5 \mu\text{g/Kg}$ , and another sample had Aflatoxin B1 at  $1.5 \pm 0.7 \mu\text{g/Kg}$ ; well below the tolerance of  $20 \mu\text{g/Kg}$  total aflatoxin. Those samples were also analyzed for protein, fat, and fiber. One sample also failed to meet the protein label guarantee – 14.5% found - minimum for sample to pass was 17.4%. From July 1, 2020, through June 30, 2021, a total of 80 animal feed samples were analyzed for pesticide residues. Of the 80 samples analyzed, 18 (22.5%) contained a total of 24 residues. There were 7 different pesticide active ingredients found at an average concentration of  $0.126 \mu\text{g/Kg}$ . No illegal residues were found. This program has continued to allow for providing safer feed products for pets and other domesticated animals in the state.



*b. Fertilizers:*

- **Analyst:** John Ranciato
- **Goal:** To assure products are in compliance with stated label guarantees.
- **Summary:** This was one of the primary analyses of the Station in 1875. Products from residential and commercial agricultural operations are collected by DoAg inspectors. Analytical results are reported to DoAg, who in turn reports findings to the product dealer and product manufacturer and takes regulatory response as needed.
  - **Results:** From July 1, 2020, to June 30, 2021, we received and completed analysis of 34 samples for macronutrients, including nitrogen, phosphorus, and potassium, and for secondary and micronutrients, including but not limited to boron, sulfur, cobalt, magnesium, and iron. Four samples (6%) were found to be deficient in one or more analytes (determined according to the investigational allowances outlined in the Official Publication of the Association of American Plant Food Control Officials). Analytical findings are turned over to the CT Department of Agriculture for regulatory action. This program ensures that farmers are provided with appropriately labeled and guaranteed nutrient-fertilizer inputs.



*c. Analysis of seaweed samples:*

- Analysts: Terri Arsenault, Craig Musante, Michael Ammirata, Walter Krol, Brian Eitzer
- Goal: To assess potential contamination of seaweed prior to release for sale.
- Summary: A newer program with the CT DoAg Bureau of Aquaculture involves the chemical and microbial analysis of seaweed grown commercially in CT for sale to restaurants. The CAES Department of Analytical Chemistry conducts the chemical analysis; the microbial analysis happens at the Department of Public Health (DPH) Laboratory Environmental Microbiology Section. During the current reporting period, 9 samples were received for analysis of moisture content, pesticides by both liquid and gas chromatography with mass spectrometry (LC-MS; GC-MS), polychlorinated biphenyls (PCBs) by GC with electron capture detection (GC-ECD) and select heavy metals by inductively coupled plasma mass spectrometry (ICP-MS). Results are reported to DoAg Aquaculture staff for a decision on regulatory action. No pesticides or PCBs were found, and heavy metals were within acceptable limits for sales of the product.



*d. Analysis of hemp samples:*

- Analysts: Terri Arsenault, Kitty Prapayotin-Riveros
- Goal: To determine the tetrahydrocannabinol (THC) content of hemp grown by state farmers prior to the sale of the product
- Summary: This new program was initiated by the 2018 Farm Bill, which allowed hemp to be grown in the state. In this bill, hemp was defined as *Cannabis sativa* L with less than 0.3% total delta-9 THC. The state plan requires that each hemp variety is tested two weeks prior to harvest. From July 1, 2020, to June 30, 2021, a total of 104 preharvest samples were submitted for analysis. These samples were analyzed by gas chromatography with flame ionization detection. The analysis was brought under the scope of accreditation in January 2021 and ongoing proficiency is demonstrated by successfully passing the University of Kentucky hemp proficiency testing annually. Twelve of the submitted samples (12%) exceeded the allowable amount of THC. These data are reported back to the Department of Agriculture, which has regulatory authority over the disposition of the crop.



**2. ANALYSES ON BEHALF OF CONNECTICUT DEPARTMENT OF CONSUMER PROTECTION, FOOD AND STANDARDS DIVISION**

Analyses conducted on food and consumer product samples submitted by the CT Department of Consumer Protection (DCP) are important to public safety. The results of these analyses are reported quickly and can lead to the recall of products that have levels of chemical residues, heavy metals, fungi/mold, or fecal contamination that are deemed unacceptable by DCP. If products are imported into CT from other states or countries, the US Food and Drug Administration leads the regulatory response.

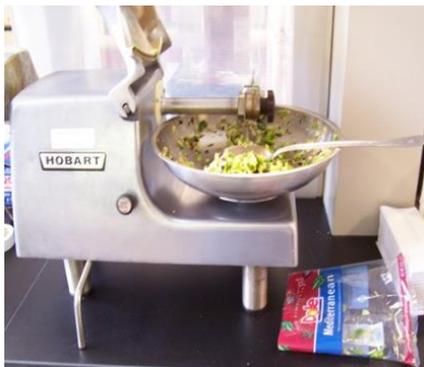
*a. Pesticide residues and arsenic in human food:*

- **Analysts:** Walter Krol, Brian Eitzer, Michael Ammirata, Terri Arsenault, and Kitty Prapayotin-Riveros

- **Summary:** As part of the Manufactured Food Regulatory Program Standards (MFRPS) and Laboratory Flexible Funding Models (LFFM), we determine concentrations of pesticides and total arsenic in fresh and processed foods from local, domestic, and imported sources offered for sale in CT and assure compliance with established tolerances. MFRPS surveillance samples are collected by DCP Inspectors and results are published in periodic Station Bulletins available by mail and at [www.ct.gov/caes](http://www.ct.gov/caes). From July 1, 2020, through June 30, 2021, a total of 102 samples of human food were analyzed for pesticide residues. Of the 102 samples analyzed, 49 (48.0%) contained a total of 116 residues. Of these 49 samples, there were 3 samples that contained illegal residues. A sample of nopal (prickly pear cactus) from Mexico was found to contain dimethoate and carbofuran, both no tolerance violations. A sample of squash from the US was found to contain acephate, which was also a no tolerance violation. A sample of greenhouse lettuce from Connecticut was found to contain an over tolerance of chlorfenapyr. The CT finding was investigated by the CT DEEP and DoAg. Four additional compliance samples were submitted for testing by the DoAg as part of their investigation. There were 48 different pesticide active ingredients found at an average concentration of 0.135 µg/Kg.

- With US FDA funding and support, the Department has received and expanded ISO/IEC 17025 Accreditation from the American Association for Laboratory Accreditation (A2LA) for this program.

- **Impact:** The Department's MFRPS serves as the sole surveillance and monitoring effort in the state, assuring that the food supply within CT is safe and free from chemical and heavy metal contamination.



*Miscellaneous samples:*

- **Analysts:** John Ranciato, Brian Eitzer

- **Summary:** From July 1, 2020, to June 30, 2021, several consumer complaint samples were submitted by CT DCP for analysis, including foreign material identification, fecal content determination, product adulteration or tampering, and off taste. For some samples, we rely on the expertise in other CAES Departments, including Plant Pathology and Ecology, Entomology, and Forestry and Horticulture. Samples during the current period included Beef Patties, White Rice, Canned Corn, Bottled Water, Cashews, coconut water, Bacon, Egg roll and shrimp, and Organic Garlic Kraut.

### 3. ANALYSES ON BEHALF OF DEPARTMENT OF CONSUMER PROTECTION, LIQUOR CONTROL

#### DIVISION

Alcoholic beverages sold must be registered and labeled correctly. This requires knowledge of the ethanol content of products.

- Analyst: Terri Arsenault
- Goal: To provide percent ethanol content for label registration and taxation purposes.
- Summary: We analyzed 2 products (wines) for ethanol content. Results were submitted to DCP in support of product label registration.



### 4. ANALYSES ON BEHALF OF DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION (DEEP), WASTE MANAGEMENT BUREAU

#### *a. Analysis of PCBs (polychlorinated biphenyls):*

- Analysts: Michael Ammirata, Terri Arsenault
- Goals: To determine the extent of polychlorinated biphenyl (PCB) contamination in submitted samples, with matrices including soil, water, oil, sediments, and surface wipes.

• Summary: From July 1, 2020, to June 30, 2021, 55 samples were analyzed from pre-existing sites or new locations in CT. Sample collection is performed by the DEEP PCB Enforcement Unit as part of mandatory long-term monitoring of these areas. The findings are reported to DEEP for assessment of continued regulatory compliance or to establish remediation criteria. In addition, a proficiency test was completed as part of this program.

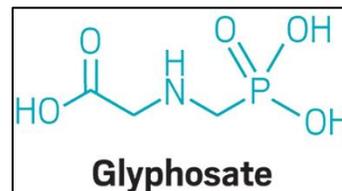


#### *b. Analysis of pesticides:*

- Analysts: Brian Eitzer, Terri Arsenault, Walter Krol, Christina Robb
- Goals: To ascertain pesticide concentration associated with misapplication or drift in support of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Additional samples are analyzed in support of DEEP surface and groundwater monitoring programs. We also analyzed a set of samples of sediment contaminated after a truck containing pesticides caught on fire. Submitted sample matrices include soil, water, oil, sediments, tank mixes, and surface wipes.

• Summary: From July 1, 2020, to June 30, 2021, 18 samples were analyzed under this program.

**Impact:** The analysis of samples collected from surveillance programs for soil, surface/groundwater, and sediments, as well as those that are part of active misapplication investigations, enable DEEP to enforce current state and federal regulations on pesticides and to promote overall environmental and public health.



### 6. ANALYSES ON BEHALF OF MUNICIPAL AND FEDERAL AGENCIES

#### *a. Analysis of samples for FDA Food Emergency Response Network (FERN):*

- Analysts: Craig Musante, Terri Arsenault, Brian Eitzer, Christina Robb, Walter Krol, Kitty Prapayotin-Riveros, John Ranciato, Christian Dimkpa, Jason C. White.

- **Summary:** The Department of Analytical Chemistry continued its work with the FDA as part of the Food Emergency Response Network Chemistry Cooperative Agreement Program (FERN cCAP). This program enables research and analyses on contaminants in food such as pesticides, poisons, toxins, and heavy metals. During the past year, a pilot test program was initiated by FDA, in which samples were shipped to labs by the FDA inspectors and results of sample analysis were uploaded directly to the FDA ORA Partners Portal (ORAPP). Some of the samples in this initiative included an actionable import sample. In this initiative, we were among the first state labs to join the ORA Sample Analysis Workgroup. Moreover, we were the first state lab to complete the NFSDX mapping with our LIMS. During the course of the year, we successfully submitted five pilot samples (for pesticides analysis) via the ORAPP option-three Excel uploads. DAC also participated in the analysis of surveillance samples that included hemp infused drinks imported across state line.



- Lastly, Brian Eitzer and Ms. Terri Arsenault are both instructors for FDA courses on LC-MS and GC-MS FERN methods, respectively; these training courses are open to FDA staff and other state laboratories; however, the courses were canceled due to COVID-19.

**Impact:** The Department’s participation in FERN has resulted in the acquisition of highly sensitive analytical equipment and significant funding to support staff, including postdoctoral researchers. In addition to being used for FDA work, these resources are also applied to our state programs in a manner that directly benefits the public health of Connecticut residents.

*b. Analysis of samples for municipalities, law enforcement, and other groups:*

- **Analysts:** Terri Arsenault, Brian Eitzer, Walter Krol, Craig Musante, John Ranciato
- **Summary:** From July 1, 2020, through June 30, 2021, Department staff analyzed 13 samples for municipalities or other groups. Among these, we analyzed foods and other products for heavy metals at the request of the New Haven Health Department, Quinnipiac Valley Health District, and Connecticut State Police and soils on behalf of a community garden. An unknown white powder sample was analyzed for Yale New Haven Hospital. The Department’s analyst also consulted with the Chemical Analysis Section.
  - State of CT - Department of Emergency Services & Public Protection to assist with instrumentation set up.
  - **Impact:** Analyses in support of these organizations can allow them to make decisions that will impact human health.

**7. ANALYSES ON BEHALF OF OTHER STATION DEPARTMENTS**

*a. Elemental and Molecular Analysis - Department of Plant Pathology and Ecology:*

- **Analyst:** Craig Musante, Nubia Zuverza-Mena, Yi Wang, Jason C. White
- **Summary:** In conjunction with scientists in the Department of Plant Pathology and Ecology, elemental and molecular analysis of several hundred samples of various crops grown in the presence or absence of nanoscale micronutrient amendments was again conducted. This work is being done under a USDA AFRI NIFA grant on nanoscale sulfur for plant nutrition, disease suppression, and food safety. This 3-year, \$500,000 grant began September 1, 2020, and includes co-investigators at the University of Massachusetts, Amherst. This ongoing work continues to evaluate effects of nanoscale S on fungal

interaction with food crops. More updates on this effort are presented under Project 3 of the Research Activity Section, and in the Department of Plant Pathology and Ecology section of this document.

## 8. ANALYSIS OF CHECK SAMPLES

- **Analysts:** Walter Krol, Terri Arsenault, Brian Eitzer, Craig Musante, Michael Ammirata, Kitty Prapayotin-Riveros

- **Summary:** Thirty samples were analyzed during the reporting period as part of annual proficiency testing related to our FDA FERN work, FDA ISO Accreditation program (MFRPs), Animal Feed Regulatory Program (AFRPs), as well as performance evaluation samples for our polychlorinated biphenyl (PCB) regulatory program. All of these testing regimes serve to ensure accurate and reliable laboratory results.

## II. RESEARCH ACTIVITIES

Research projects in the Department of Analytical Chemistry include applied and fundamental investigation search. Research is often stimulated by our service work and in turn, research results often impact service activities.

### 1. FOOD SAFETY

**Project 1:** *Improvement of analytical methods for determination of pesticide residues and heavy metals in food:*

- **Investigators:** Brian Eitzer, Terri Arsenault, Walter Krol, Christina Robb, Michael Ammirata, Craig Musante, John Ranciato, Christian Dimkpa, Jason C. White

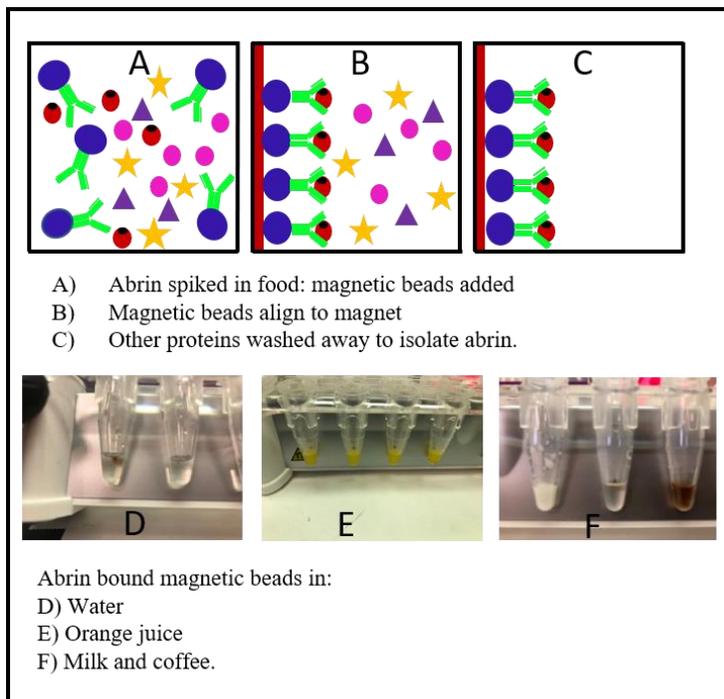
- **Summary:** We continue to participate in or lead several FDA coordinated research projects. This includes the use of high-resolution LC-MS and LC-MS/MS platforms for the screening of pesticides, toxins (fungal, plant), and poisons. During the past year, our ISO Accreditation for two separate FDA programs; one focused on human food (MFRPS) and a second focused on animal feed (AFRPS), were successfully reassessed by the accreditation body.

**Impact:** The development and validation of new, more sensitive equipment and analytical techniques will enhance food safety surveillance activities in the state and serve to better protect the public against incidental or intentional adulteration.

- **Project 2:** *Select Agent Detection in foods: abrin and abrine*
  - **Investigators:** Christina S. Robb, Walter Krol, Brian Eitzer
  - **Summary:** *Abrus precatorius* seeds contain the ribosome inactivating protein abrin. Abrin is the most toxic molecule that we investigate for the FERN program. Detection methods for abrin are of importance to homeland security, toxicology, and public health. The method development for abrin protein is highly challenging as no purified standard or high-quality antibody are commercially available. However, Dr. Christina Robb has worked with both the CDC and the FDA Forensic Chemistry Center to gain the skills to develop abrin analysis by LC-MS. The extraction of abrin from food samples by antibody coated magnetic beads, on-bead digestion by multiple proteases, and analysis of the peptides by LC-MS have been achieved. The peptides determined so far represent universal, combination and single protein indicators for the abrins a, b, c, d, and agglutinin. The refinement of these



method conditions is ongoing with input from the FDA and CDC. In tandem with this, Dr. Robb has completed the investigation of a novel teicoplanin based stationary phase for the sensitive analysis of L-abrine. L-abrine is a small molecule biomarker for the protein.



**Impact:** The new LC-MS approach to analysis presents several advantages; it is greener with an improved safety impact for the analytical chemist, it removes the requirement for commercial kits therefore enabling analysis at any time whilst lowering the cost, and it provides more detailed molecular information on the abrin proteins. A journal article “An investigation of the teicoplanin stationary phase for the LC-HRMS determination of L-abrine” was submitted to the *Journal of Liquid Chromatography*.

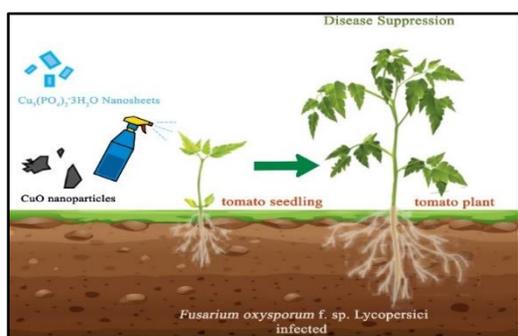
**Project 3: *Nanoparticles in agricultural systems:***

- **Investigators:** Nubia Zuverza-Mena, Craig Musante, Yu Shen, Ishaq Adisa, Carlos Tamez, Yi Wang, Ayesha Nisar, Jason C. White, and Christian Dimkpa

- **Summary:** Nanomaterials (NM) have at least one dimension less than 100 nm (one billionth of a meter) and possess unique physical and chemical properties not observed at the bulk scale. Nanotechnology, which takes advantage of these useful nanoscale properties, has become widely used in numerous sectors, including electronics, healthcare, cosmetics, pharmaceuticals, food processing, and agriculture. Our general work in this area is focused on two separate but related topics; initially on the implications of nanomaterial presence (by accident or design) in agricultural systems and, more recently, on the design and use of nanoscale nutrients as agricultural amendments to suppress plant disease, improve nutrient use efficiency, and, ultimately, increase yield. The presence of state-of-the-art analytical instrumentation has allowed us to continue to measure the uptake and translocation of these nanoparticles into plants. Studies on nanoparticle interactions in agricultural systems at the Department of Analytical Chemistry are conducted in collaboration with several partners, including the University of Parma in Italy, Harvard University T. H. Chan School of Public Health, University of Massachusetts, the University of Texas El Paso, the US National Institute of Standards and Technology, Hasselt University in Belgium, Peking University in China, The Ocean University of China, Zhejiang University, China Agricultural University, Jiangnan University, Nanjing Agricultural University, and the Chinese Academy of Sciences, among others.

One such project investigates the application of nanoscale lignin and zein as carriers of methoxyfenozide, a non-systemic pesticide. The first set of experiments, conducted with collaborators at Louisiana State University, showed that the application of free lignin or zein nanoparticles to soybean did not affect plant growth or inhibit chlorophyll production at all test concentrations (lignin) or at concentrations below 2 mg/mL. Additionally, a dose-dependent increase in enzymatic activity related to reactive oxygen species, an indicator of plant stress, was observed but did not negatively affect plants. In a second series of experiments, lignin and zein nanoparticles loaded with methoxyfenozide were shown to facilitate the translocation of methoxyfenozide from root to aerial tissues.

In another activity, two copper nanomaterials (CuO nanoparticles [NPs] and  $\text{Cu}_3(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$  nanosheets) and  $\text{CuSO}_4$  were applied to tomato (*Solanum lycopersicum*) leaves, and elemental Cu movement from the leaf surface through the cuticle and into the interior leaf tissue was monitored over 8 h. Two forms of nanoscale Cu were used to foliar treat tomato on a weekly basis in greenhouse and field experiments in the presence of the pathogen *Fusarium oxysporum* f. sp. *lycopersici*. For  $\text{CuSO}_4$ , Cu accumulation and retention in the cuticle was over 7-fold greater than the nanomaterials, demonstrating that nanoscale morphology and composition mediate Cu accumulation in leaf tissue. In the greenhouse, weekly foliar applications of the nanosheets and NPs increased seedling biomass by 90.9% and 93.3%, respectively, compared to diseased and ionic Cu controls. In the field,  $\text{Cu}_3(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$  nanosheets reduced disease progress by 26.0% and significantly increased fruit yield by over 45.5% per plant relative to the other treatments in diseased soil. These findings suggest that nanoscale nutrient chemical properties can be tuned to maximize and control movement through the cuticle and that interactions at the seedling leaf bio interface can lead to season-long benefit for tomato growing in the presence of *Fusarium* spp.



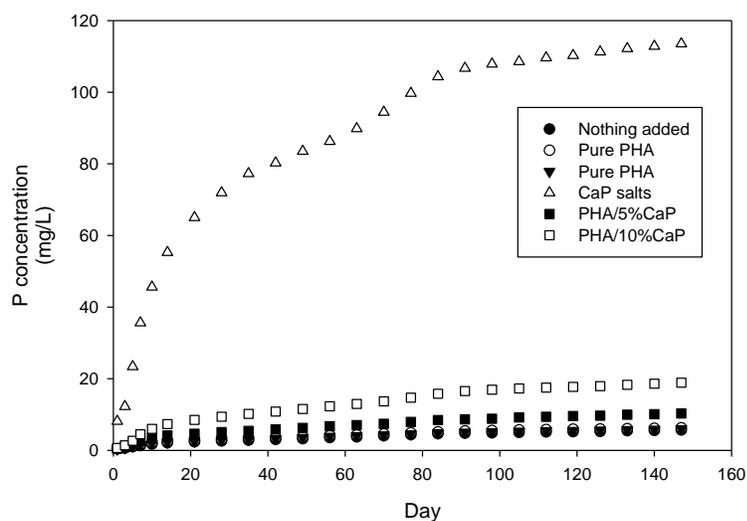
A third sub-project involves the use of nanoscale sulfur as a novel multifunctional agricultural amendment to sustainably increase yield and suppress crop disease. Collaborators on this project are colleagues at the University of Massachusetts. In this study, pristine and surface-coated sulfur nanoparticles are amended in soil that is planted with tomato (*Solanum lycopersicum*) seedlings and infested with *Fusarium oxysporum* f. sp. *lycopersici*. Bulk sulfur, ionic sulfate, and healthy controls treated with the same sulfur-containing compounds and several molecular endpoints are also included to enable mechanistic understanding. Results showed that both pristine and surface-coated nanoscale sulfur could enhance plant development (plant height, biomass, and photosynthetic activities) and suppress *Fusarium* disease. This study will ultimately provide significant mechanistic insight into non-metal, nanomaterial-based suppression of plant disease, and further optimize the sustainable approach in nano-enabled agricultural systems. A related work spearheaded by a visiting scientist from the University of the Punjab, Lahore, Pakistan, involves the synthesis and characterization of several metallic nanoparticles using bacterial cell-free growth cultures and the evaluation of these nanoparticles for application in crop disease control, especially fungal.

A fourth project is aimed at developing and evaluating tripolyphosphate (TPP) as nanofertilizer enhanced in value and plant use efficiency by formulation with chitosan and zinc oxide nanoparticles. Phosphorus (P) is the second most important crop nutrient. Despite its critical importance in plant

development and productivity, P use by crops is characterized by very low efficiency. Over 70% of applied P is lost due to fixation in the soil, or runoff into surface or underground waters. TPP is an inorganic P-containing material and is a component of numerous domestic and industrial products. This project aims to repurpose TPP as a source of crop fertilizers to supply P. We are working on the hypothesis that functionalization of TPP with chitosan and zinc oxide nanoparticles (ZnO NPs) will regulate TPP solubility, and therefore, its bioavailability to plants. As shown below, several formulations of TPP and chitosan without and with ZnO NPs have been developed, and evaluation in plants is planned to commence soon.



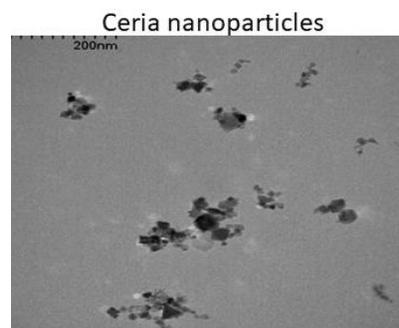
A related ongoing project in partnership with Johns Hopkins University scientists looks at the use of polyhydroxyalkanoates (PHA) to improve plant bioavailability and reduce environmental P loss in plant-soil systems. Biodegradable polymer nanocomposites containing PHA and calcium phosphate nanoparticles were synthesized and evaluated on tomato plants. This product supported plant performance comparable to conventional P fertilizers, while reducing the P content of runoff by over 80%. Given the negative consequences of eutrophication driven by P-rich agricultural runoff, significant reduction in leached P has broad implications. This finding demonstrates the significant potential of biodegradable PHA formulated with calcium phosphate nanoparticles as a platform to reduce the negative impacts of agriculture on the environment.



Several other nanoscale efforts are ongoing in the department, in collaboration with colleagues in other CAES departments. These include:

(i) ***Mitigation of perfluorooctanoic acid (PFOA) toxicity with ceria ( $\text{CeO}_2$ ) and copper oxide nanomaterials.***

PFOA was used for decades in the manufacturing of plastic coatings for water- and oil-repellent materials. Given the stable properties derived from the strong C-F bonds in the molecule, PFOA is persistent in the environment and it has been linked to health complications. Ceria has shown properties as a fertilizer and its catalytic properties have been related to the scavenging of reactive oxygen species (ROS) in plants, alleviating stress. We are investigating the role of ceria and CuO nanomaterials as soil amendments to mitigate PFAS toxicity in zucchini plants.



(ii) ***Enhancement of the phytoremediation of per- and polyfluoroalkyl substances (PFAS) using nanoparticles.***

PFAS are highly toxic, widespread environmental contaminants. There are limited technologies available for remediating PFAS-contaminated soil. Phytoremediation is an inexpensive, widely available strategy, but many PFAS have limited uptake into above-ground plant tissues. With the Yale School of Public Health and the University of Minnesota, Drs. Nason, White, and Zuverza-Mena are designing silica nanoparticles and carbon dots with high affinity to bind PFAS. These custom-made novel nanomaterials are intended to be taken up into hemp plants to enhance the phytoextraction of PFAS from contaminated soil.

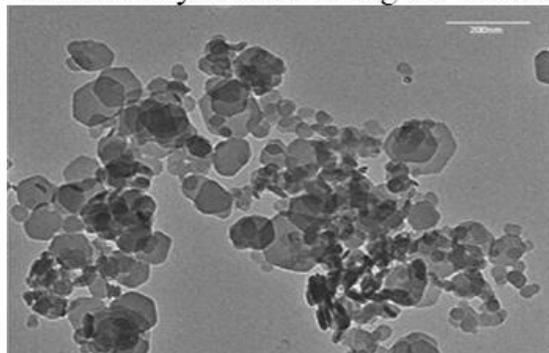
(iii) ***Enhancement of drought tolerance in chestnut seedlings treated with CuO NPs.***

CuO NPs have shown applications in agriculture not only as an efficient source of Cu nutrient. Previous studies have also shown that CuO NPs can increase the water content in plant tissues such as certain wheat species or express drought tolerance genes such as in soybean. Drought events are causing an increase in tree mortality globally. In collaboration with Dr. Susanna Kerio from the Dept. of Forestry and Horticulture, we are studying the potential of CuO NPs to mitigate drought impacts in trees by using chestnut hybrid seedlings as a model system. Preliminary observations show trends where drought-stressed seedlings treated with CuO NPs have characteristics comparable or better to non-stressed seedlings, such as height and the number and size of leaves. Results are inconclusive and more studies are underway.

(iv) *Use of nanocarriers for dsRNA delivery.*

Plants (and other living organisms) have a natural mechanism to prevent viral replication, via RNA interference (RNAi). After infection, plants can later recognize viral RNA regions and code for its destruction instead of replication. Thus, an approach to vaccinate plants is to provide viral double stranded RNA (dsRNA) to trigger the gene silencing mechanism, RNAi. However, dsRNA is easily destroyed and its effect last only a few days. Studies have shown that nanocarriers of dsRNA such as Mg-Al double layered hydroxides (LDHs) can provide dsRNA protection, prolonging its effectiveness, although the exact mode of action is not completely understood. Together with Dr. da Silva from the Dept. of Plant Pathology and Ecology, we are exploring silica and chitosan besides Mg-Al LDHs as dsRNA carriers to protect plants against potato virus Y (PVY).

In-house synthesized Mg-Al LDHs



**Impact:** Our past research has demonstrated that the toxicity of nanomaterials to crops can be significantly different from that of the corresponding bulk material. Current investigations are focused on understanding the interactions and related mechanisms of plant response so as to enable safe design and use of these important materials. For example, when used appropriately, nanoscale versions of select secondary and micronutrients can suppress crop disease and increase yield. Such techniques may be critical to sustainably increasing food production so as to achieve and maintain global food security in the coming decades. Furthermore, the enhancement of P use efficiency by plants via nanotechnology could address the P quagmire in soil and the environment.

## 2. ENVIRONMENTAL MONITORING/REMEDIATION

### Project 1: *Determining the effects of pesticide exposure on bumble bee microcolonies*

**Investigators:** Brian Eitzer, Kimberly Stoner (Department of Entomology), David Lehman (EPA), Robert Koethe (EPA)

**Summary:** While much has been learned about the effects of pesticides on honey bees, much less is known about their effects on bumble bees. This project is aimed at understanding some of those effects. Pollen was collected at ornamental nurseries and pesticide levels were determined using liquid chromatography/mass spectrometry (LC/MS). After characterization of pesticide content, acetamiprid, a neonicotinoid pesticide was added to the pollen (or syrup) at various doses and the material was fed to bumble bee microcolonies. The acetamiprid dosed pollen and acetamiprid dosed syrup were analyzed to confirm their concentrations in these materials. The colonies were then monitored for deleterious effects. After a set time period, the colonies were sacrificed, and various compartments of the colony were analyzed for acetamiprid. In the sample spiked at the highest dose, acetamiprid and two of its metabolites were observed in hive materials. The highest concentrations were seen in the nests, intermediate amounts in the nectar, fecal matter, and eggs, with lesser amounts in the bees, larvae, and pupae. These data will then help us to understand how the pesticide has impacted these bumble bees.

All of the individual pollen samples collected from this project are being analyzed for their pesticide content in addition to several types of palynological analysis. The comparison of these sets of analyses should lead to insight on which plant/pesticide combinations present the most potential risk to pollinators.

**Impact:** Knowledge of the effects of pesticides on bumble bees can help us to protect these important native pollinators.

### Project 2: Analysis of Deoxynivalenol in wheat

Investigators: Brian Eitzer, Yu Shen, Wade Elmer (Department of Plant Pathology and Ecology)

Summary: Deoxynivalenol DON (also known as vomitoxin) is a product of a fungus that can grow in wheat. To assist a project being developed by Dr. Elmer, an analytical method for the analysis of DON in wheat using HPLC-HRMS was developed. A total of 56 samples of wheat seeds were analyzed and none had DON concentrations that would raise concerns about the use of the wheat.

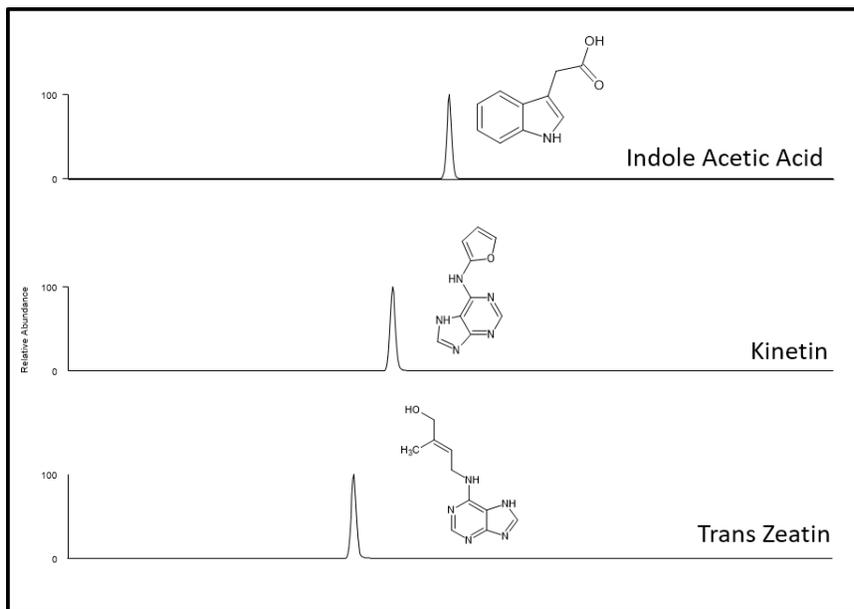
**Impact:** The ability to test for natural toxins in foods helps to assure the safety of the food supply.

## 3. PLANT HEALTH

### Project 1: Plant hormones: Linking soil microbes and predators to crop health

Investigators: Christina S. Robb, Lindsay Triplett, and Ravi Patel

Summary: Dr. Christina S. Robb and Dr. Lindsay Triplett were awarded the Connecticut Agricultural Experiment Station Louis A. Magnarelli Post-Doctoral Award for their proposal to study the role of protists in the hormonal condition of plants for 2020-2022. The main analytical objectives of this study are to develop and optimize LC-MS methodologies for plant hormone analysis. These methodologies will assist in determining the role of protists in hormone-producing soil bacteria and to determine the effect of protists on the plant hormonal status. Dr. Christina Robb and Dr. Ravi Patel have developed a reverse-phase screening method for compounds representative of multiple, main compound classes of phytohormones. This general screen will be used to analyze sample sets and when specific phytohormones are determined to be of interest, the methodology may be further enhanced for those phytohormones. An example separation of three of the compounds is shown here. This screen has been tentatively tested for plant, protists, and bacterial extracts and is being expanded.



**Impact:** This project will provide meaningful improvement to the field of plant pathology and understanding crop health.

### Project 2: Determining molecules of interest to plant pathology

Investigators: Christina S. Robb, Lindsay Triplett

Summary: Dr. Christina S. Robb in conjunction with Dr. Lindsay Triplett and Dr. Ravi Patel are working on enhanced methods for the detection of compounds of interest to plant health. This research is now

focused on the compound nicotinamide adenine dinucleotide (NAD) in toxin-antitoxin system research. A group of researchers at Pennsylvania State University, that are collaborators of the Triplett laboratory, analyzed 8 spontaneous *Pseudomonas* mutants that have increased survival to antibiotics. These mutants were determined to all fall in the same operon: a toxin-antitoxin system similar to one that modifies NAD. This toxin-antitoxin system is a phosphorylase in contrast to AvrRxo1, which was a kinase. Analytical Chemistry can assist in this project by developing a method for NAD determination and this has been accomplished.

**Impact:** A method has been developed and optimized for NAD and is ready for samples from Pennsylvania State University.

#### 4. **Hemp Research**

**Investigators:** Terri Arsenault, Christian Dimkpa

**Summary:** This project aims to (i) Test various varieties of hemp to assess compliance with THC levels throughout the growing season and maximum potential yield of CBD (ii) measure the effect of micronutrient application on the levels of CBD and THC in hemp plants.

Research to understand the second objective was only recently established. No data is available yet. Research on the first objective was initiated in 2019 and continues today to assess sampling strategies and ensure conformance to the THC limit in hemp plants grown in Connecticut. In the study, different varieties of hemp were grown in soil and analyzed using gas chromatography with flame ionization detection (GC-FID) for total delta-9 THC and total cannabidiol (CBD) contents. Samples of fresh plant material were collected weekly from mid-August until late October to examine the rate of increase during maturation for a particular variety. In addition, samples from individual plants were monitored over time, and samples from each plant within a single variety were sampled periodically. Both CBD and THC levels increased rapidly over a 1- to 2-week time frame, with maximum concentrations around the time of the autumnal equinox. Testing of every plant on the same day for three varieties showed the variability in THC to be 205%, 157%, and 10.9%, while the variability in CBD was 60.1%, 16.2%, and 11.4% respectively. The high degree of variability suggests that hemp varieties are not well developed at this time, which puts growers at risk for crop embargoes. In addition, variability within and between hemp varieties is useful to instruct field sampling strategies for regulators.

**Impact:** These data indicate that time and plant-dependent factors significantly affect the concentration of THC and CBD. The data will assist states, especially those with lot sizes of 1-2 acres, to develop better performance-based sampling strategies as allowed by the USDA final rule regarding hemp production. In addition, this data is helpful to growers trying to maximize CBD production while maintaining conformance to the legal THC limit of 0.3%.



## **PUBLIC OUTREACH**

***Telephone/Internet Inquiries:*** We receive approximately 100 calls and emails from the public each year requesting information on issues such as pesticides in food and the environment, as well as heavy metals in food, soils, and consumer products. In some instances, we refer the caller to a more appropriate CAES department or state agency.

***Station Bulletins:*** Two Station Technical Bulletins were published by our department in the past year: Technical Bulletin numbers 21 and 24. These bulletins are available in printed form and on the CAES website (<https://portal.ct.gov/caes>).

## DEPARTMENT OF ENTOMOLOGY

The Department of Entomology is involved in a variety of service, research, pest surveillance, and plant regulatory activities. The primary service activities are provided through the Insect Information Office (IIO). Staff in this office answer insect-related questions and identify insects and related arthropods for the public, government agencies, growers, and business organizations. All scientists provide information to citizens of Connecticut by answering telephone inquiries, making farm visits, participating in meetings of growers and other groups, and speaking on their research. Most of the research in the Department has a major applied aspect, addressing the integrated management of ticks, pests of field crops, nurseries, and orchards, wood-boring insects, invasive insects, honey bees, and other bee pollinators.

The Office of the State Entomologist at the Connecticut Agricultural Experiment Station, created by the Connecticut General Assembly in 1901, is part of the Department of Entomology with responsibility, in part, to ensure our nursery industry is free of plant pests and certify their products for shipment to other states and outside the United States. The Connecticut Green Industry (i.e., nursery, greenhouse, floriculture, sod, Christmas trees) is the largest agricultural business in Connecticut. The industry estimates that environmental horticulture generates \$1.022 billion gross income supporting 48,000 full- and part-time jobs in Connecticut. In conjunction with regulatory activities, Department staff conducts a surveillance program in Connecticut for a variety of established pests and for exotic plant pests, some of regulatory concern, that



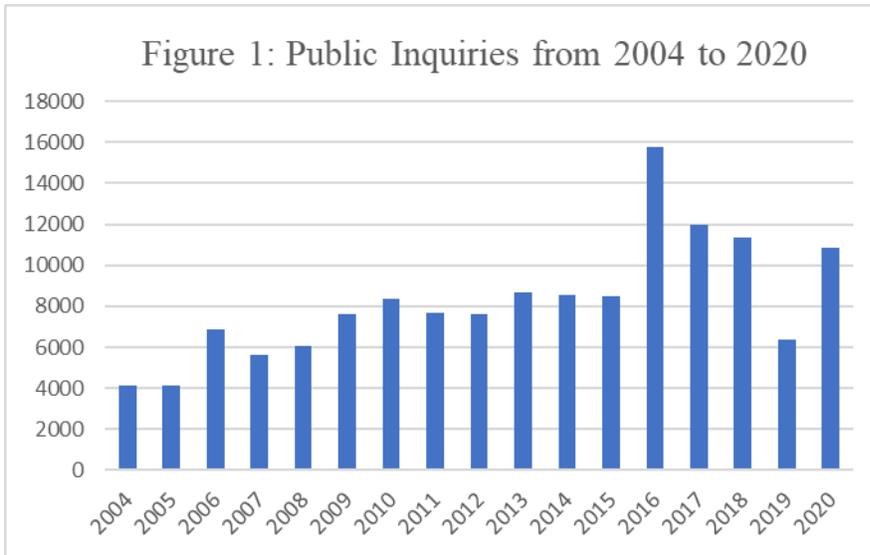
Insect Information Office in the atrium of Jenkins-Waggoner Laboratory showing the wallpaper, part of the artwork installed called *Plants & Insects: Excavating the Archives*.

represent a threat to our green industry, forests, and urban ornamental trees and shrubs. Surveillance for plant pests is performed in partnership with the United States Department of Agriculture (USDA) through the Cooperative Agricultural Pest Survey (CAPS) program, Plant Protection Act surveys, and the U.S. Forest Service. For plant diseases of regulatory concern, we work closely with the Plant Disease Diagnostic Laboratory in the Department of Plant Pathology and Ecology. We also conduct forest health surveys and a statewide aerial survey for gypsy moth defoliation (and any defoliation by other insects) and a gypsy moth egg mass survey. The results of our plant and forest surveys for 2020-2021 may be found later in the Department's research activities along with summaries of our regulatory activities. The Office of the State Entomologist and the Apiary Inspector also oversee registration of beekeepers and inspection of honey bee colonies for pests and disease. The staff of the Department of Entomology also take a lead in providing extensive outreach activities for the Experiment Station by providing information to both children and adults about the Experiment Station's research at public events and at health and agricultural fairs, which were curtailed in 2020 due to the coronavirus pandemic. The Insect Information Office is in the Jenkins-Waggoner Laboratory and has a laboratory, office, public reception, and a climate-controlled collections room.

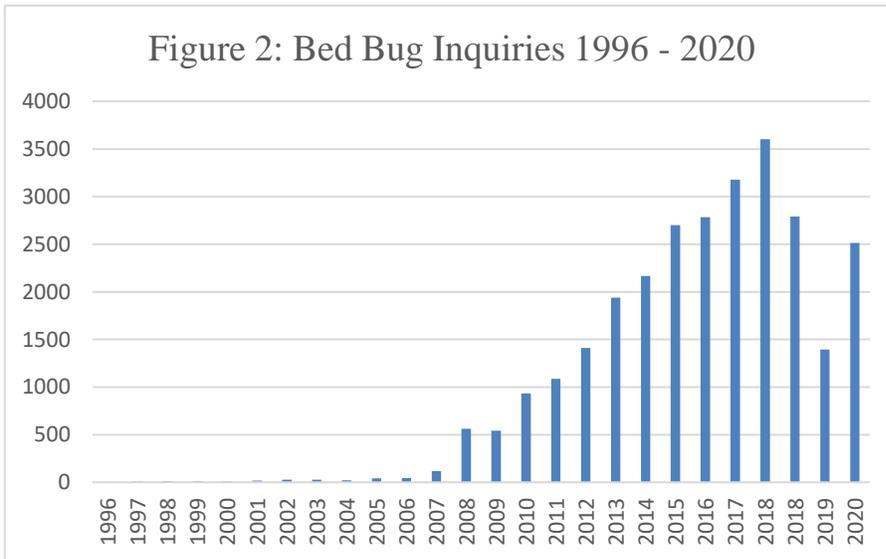
## Service Activities

### *Insect Information Office*

Dr. Gale E. Ridge works in the New Haven Insect Information Office (IIO). Insect identification services date back to nearly the inception of the institution (1875) starting with the first Annual Report of The Connecticut Agricultural Experiment Station published in 1877. The station announced that it was offering to “identify useful or injurious insects.....and to give useful information on the various subjects of Agricultural Science for the use and advantage of the citizens of Connecticut.”



Since 2000, there has been a trend away from traditional communication such as mail and visitors to cell phone and internet. Emails and iPhones are currently the most common forms of communication used by the public to submit inquiries. Since the onset of the COVID-19 pandemic, these two forms of communication have been the principal way citizens have communicated with the IIO.



The impact of the IIO is public education to reduce pesticide use and promote non-chemical management of nuisance arthropods, protection of public health, conservation of natural habitat and species, protection of agriculture, and protection of urban structures and buildings. The office directly serves private citizens, pest management professionals, the real estate industry, nurseries, land care businesses, arborists, health departments, other medical

professionals, charities, manufacturing, the hospitality industry, schools, colleges, and universities, housing authorities, museums, municipalities, libraries, law enforcement, native American tribes, state government, and the media. Between July 1, 2020, and June 30, 2021, the IIO handled 10,824 requests for information (Fig. 1).

There were 1,484 categories of inquiries including insects, arachnids, animal, pesticides, insect damage, general entomology, and horticulture. Delusional Infestation (DI) cases continued to rise from 189 in 2016, 243 (2017), 300 (2018), 357 (2019), 456 (2020), to 609 (2021). These are time-consuming medical and psychiatric cases that encompass multiple phone calls, emails, and visits, which often involve collaboration with medical professionals. DI continued to rise in part due to stress and depression (two leading drivers of DI) likely caused by home confinement and stressful work conditions from the COVID-19 pandemic. No DI clients visited the office in person, but chose to use Zoom conferencing online to meet with the entomologist.

Gypsy moth (*Lymantria dispar dispar*) activity was quiet across most of Connecticut except for the Sharon area on the western side of the state where there was a severe outbreak. This moth will no longer be called the “gypsy moth” according to the Entomological Society of America because “Gypsy” is considered a pejorative term. The name will be used until the new name for the moth is determined. Pantry pests, termite, and ant inquiries were elevated, because more people stayed in their homes due to the pandemic. The highest inquiry was human feeding bed bugs (2,514, Fig. 2) followed in order by beetles in general (1691), DI (609), and ants (273). Additionally, diversity of inquiries increased during the summer of 2020 and spring of 2021. Due to the initial severity of the pandemic in New York City (spring 2020), many residents left the city and moved to Connecticut. Having never owned property with land, these owners encountered insects and plant diseases they had never before encountered. As a consequence, they used the IIO as a continuous resource of information.

Natural resources usually lead the four categories of inquiries, which include in order of frequency: man (home, building, and medical issues), food, and undetermined. By contrast, in 2020, man and medical related inquiries exceed natural resources, which was not the normal pattern, possibly as an artifact of pandemic-driven city to country flight. Current data showed percentage of category division as 47% natural resources, 41% man and medical issues, 10% food, and 2% undetermined.

Due to a wet spring, springtail inquiries were high. Additionally, high numbers of fireflies were reported. The larval stage of these beetles parasitize earthworms, and a wet spring would favor earthworm populations. Crazy snake worm inquiries also increased with active populations seen in Guilford, Branford, North Haven, Canton, and Ridgefield. These are highly active invasive worms that homogenize soil structures making it impossible for young plants, particularly those in forest settings, to establish. The office continued to lead in public outreach.

**CAPS Survey and Outreach Programs:** The Cooperative Agricultural Pest Survey (CAPS) and Plant Protection Act Section 7721 (PPA 7721) (formerly the Farm Bill), supported by the USDA-APHIS-PPQ provides support for pest survey and educational outreach on the identification and risks posed by potential invasive insects and plant diseases. With worldwide trade and travel increasing, we are at an increased risk of foreign plant species, plant diseases, and insect pests being introduced in the U.S. In 2021, the CAPS program is conducting a Nursery Pest Survey looking for hardwood tree pests. Additional Vegetable Crops Pest Survey is supported by funding from the Plant Protection act, as well as the funding of the Forest and Agricultural Pest Outreach Program with a focus, in part, on the spotted lanternfly. The program also provides guidance on the management and control of detected invasive pests. By raising awareness of invasive pests, we hope to increase public awareness of pest management options and early reporting of potential new pest sightings to federal or state authorities.

**Bird & Butterfly Garden:** The Bird & Butterfly Garden is a partnership of the Federated Garden Club of Connecticut, the Spring Glen Garden Club of Hamden, and The Connecticut Agricultural Experiment Station. Most maintenance and improvements to the garden are done by farm manager Richard Cecarelli and his staff. The garden is normally open to the public Monday-Friday 8:30 a.m.-4:00 p.m., closed on the weekends and state holidays, but was not open to visitors during restrictions from the COVID-19 pandemic.

The garden creates several favorable habitats for our native birds, butterflies, and pollinating insects and helps us determine which plants may work best in Southern Connecticut gardens. Plants are labeled for easy identification. The Bird & Butterfly Garden at Lockwood Farm is listed in the *Nature Conservancy Open Days Directory for New England*. With a virtual Plant Science Day on August 5, 2020, normal observations of various butterfly, bird, and other species were not conducted.

### **Meetings, Conferences, and Interns:**

Dr. Kimberly Stoner was awarded the annual Bill Duesing Organic Living on the Earth Award at The Northeast Organic Farming Association of Connecticut (CT NOFA) Winter Conference in March 2021. This award is given to an individual or organization who has worked to advance organic living on our earth and supports the continuation of the life work of Bill Duesing, the founder of CT NOFA. Dr. Kimberly Stoner was a member of the Board of Directors of CT NOFA for 20 years, serving at different times as Vice-President and Secretary during those years. She was the founder of the Organic Land Care Committee, which created the first organic standards for the landscaping industry in 2001, and which continues to offer courses in organic land care across the Northeast region up to the present. She was honored for this award at a special event held at Massaro Community Farm in Woodbridge, CT.

Dr. Gale E. Ridge organized and ran (with the assistance of Ms. Katherine Dugas) a special virtual symposium on Delusional Infestation (DI) at the annual meeting of the Entomological Society of America. The event took place on November 17, 2020. There were 74 attendees. This was a first of its kind, a half day program where an international group of specialists from a number of medical and scientific disciplines addressed an underserved and misunderstood medical condition. The speakers including Dr. Ridge were:

- Dr. Dirk Elston, Chairman, Dept. of Dermatology, Medical University of South Carolina, Charleston, South Carolina.
- Ms. Erika Englehaupt, Journalist and Editor for *National Geographic*.
- Dr. Nancy Hinkle, Veterinary Entomologist, University of Georgia.
- Dr. John Koo, Vice-Chairman, Department of Dermatology, University of California San Francisco Medical Center.
- Dr. Peter Lepping, Consultant Liaison Psychiatrist and Professor at Bangor University School of Social Sciences, Wales, and Mysore Medical College and Research Institute, Mysore, India.
- Dr. Scott Norton, Chief of Dermatology at Children's National Medical Center and Professor of Dermatology and Pediatrics, George Washington University, Washington, DC.
- Dr. Michelle Magid, Associate Professor, University of Texas, Dell Medical School and Texas A&M Health Science Center.
- Dr. John Sheele, Senior Associate Consultant, Dept. of Emergency Medicine, Mayo Clinic, Jacksonville, Florida, and Associate Professor of Emergency Medicine, Mayo Clinic College of Medicine and Science.
- Dr. Bobbi Pritt, Director, Clinical Parasitology Laboratory, Division of Clinical Microbiology, Department of Laboratory Medicine and Pathology, Rochester, Minnesota.
- Dr. Jason Reichenberg, Professor in Dermatology at Dell Medical School, University of Texas, Austin, Texas.
- Dr. Richard Pollack, Senior Environmental Public Health Officer and Public Health Entomologist/Zoologist/Parasitologist, Harvard University, Boston, Massachusetts.
- Dr. Anne Louise Oaklander, Associate Professor of Neurology, Harvard Medical School and Assistant of Neurology and Neuropathology, Massachusetts General Hospital, Boston, Massachusetts.
- Dr. Lyle Buss, Insect Identification Laboratory, Department of Entomology and Nematology, University of Florida, Gainesville, Florida.

### **Interns and Students Hosted in Entomology by Dr. Claire E. Rutledge:**

Jose Ayala - Intern through the Plant Health Fellows program (a collaboration of Southern Connecticut State University and CAES sponsored by the Education and Literacy Initiative of the USDA National Institute of Food and Agriculture). In addition to regular field duties, he compared the number and species of cerambycids (longhorn beetles) attracted to two different bark beetle lures. This data was presented in a livestream seminar at CAES with other Plant Health Fellows. *June – August 2020.*

Hailey Carter – Intern from Gateway College fulfilling her laboratory internship requirement. She continued Jose’s work with the cerambycids identifying the beetles captured from August through October. *October - December 2020.*

Joselyn Clark – Honors Student at Eastern Connecticut State University working on the question of naturally occurring resistance to emerald ash borer in Native American ashes. *September 2020 – September 2021.*

## **RESEARCH ACTIVITIES**

### **Center for Vector Biology and Zoonotic Diseases**

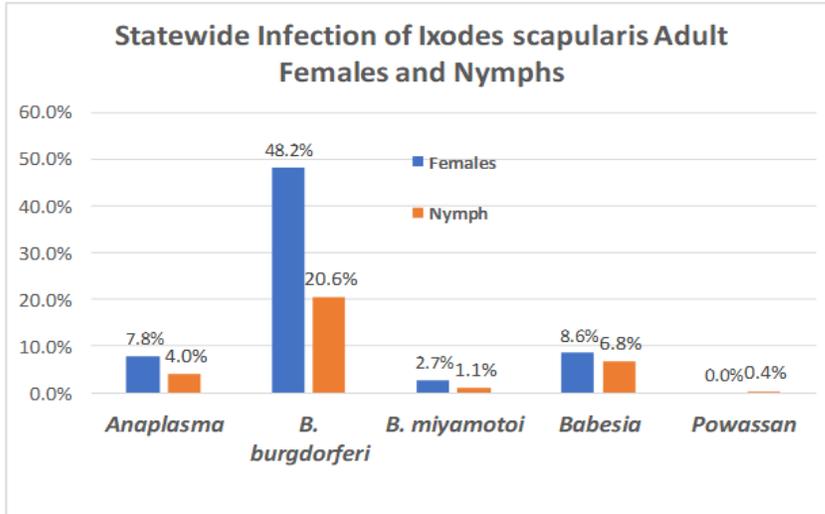
The statewide tick active surveillance program, a lone star tick control project, and an integrated tick management program involved scientists and staff from the Departments of Entomology, Environmental Sciences, and Forestry and Horticulture under the umbrella of the Experiment Station’s Center for Vector Biology and Zoonotic Diseases.

### **Tick Active Surveillance Program**

An active tick surveillance program was initiated in Connecticut in 2019 and continued in 2021 funded in part by a grant from the Centers for Disease Control and Prevention (CDC) through the Epidemiology and Laboratory Capacity (ELC) program at the Connecticut Department of Public Health. The field program is run by Dr. Scott C. Williams (Department of Forestry and Horticulture), Dr. Megan A. Linske, and Dr. Kirby C. Stafford (Department of Entomology) with sampling conducted by research assistant Jamie Cantoni. All the tick testing is conducted by Dr. Douglas E. Brackney and Duncan W. Cozens (Department of Environmental Sciences).

The blacklegged tick, *Ixodes scapularis* Say, is the primary vector for at least seven pathogens that cause human disease: *Borrelia burgdorferi*, the agent of Lyme disease, *Babesia microti* (babesiosis), *Anaplasma phagocytophilum* (anaplasmosis), *B. miyamotoi* (a relapsing fever *Borrelia*), *B. mayoni* (a new Lyme *Borrelia* spp.), the *Ehrlichia muris*-like agent, now *E. muris* subsp. *eaucalirensis* (ehrlichiosis) (known only from upper mid-west so far), and Powassan virus.

Ticks are collected at 40 paired publicly-accessible active tick surveillance sampling locations throughout CT’s eight counties (see map) from April through October with a focus on the blacklegged tick, *Ixodes scapularis*. Other tick species that are being found and tabulated include American dog ticks, *Dermacentor variabilis*, the vector of Rocky Mountain spotted fever, the lone star tick, *Amblyomma americanum*, an aggressive southern species that is becoming established in Connecticut and parts of coastal New England, and the exotic Asian longhorned tick, *Haemaphysalis longicornis*. In calendar year 2020, a total of 2,068 blacklegged ticks, 437 American dog ticks, 3 lone star ticks, and 2 Asian longhorned ticks (total 3,409 for period July 1-June 30). A multiplexed RT-qPCR assay for *Ixodes scapularis* can detect *Borrelia burgdorferi* s.l., *Babesia microti*, *Anaplasma phagocytophilum*, *Borrelia miyamotoi*, and Powassan virus lineage II. The 2020 testing results for adult blacklegged ticks are shown in the accompanying graph.



### Lone Star Tick Control Project

In June 2017, Connecticut Department of Energy and Environmental Protection (DEEP) Environmental Conservation (EnCon) and Dr. Kirby Stafford inspected a deceased deer on Manresa Island in South Norwalk that was covered with lone star ticks, *Amblyomma americanum*. The island had a large, well established lone star tick population. Dr. Kirby Stafford, Dr. Scott Williams, and Dr. Megan Linske completed a 4-poster study conducted from 2018 through 2020 for the control of the lone star tick population on the island with the assistance of technicians Heidi Stuber and Michael Short and in cooperation with staff from the Wildlife Division, CT DEEP. Four 4-posters passive topical deer treatment feeding stations were maintained each summer. They were recharged with corn and permethrin weekly. Ticks were also sampled weekly at established transects. The 4-posters were heavily utilized by the deer. The host-seeking population of *A. americanum* was reduced in adults (93%), nymphs (92%), and larvae (96%) from 2018 to 2020. We also documented a significant reduction (87%) in parasitizing adult and nymphal burdens on white-tailed deer from 2018 to 2019. Adult *A. americanum* percent infection with both *Ehrlichia chaffeensis* and *E. ewingii* declined significantly from 47% at the time of discovery in 2017 to 7.1% in 2020 (*Ehrlichia* spp. infection in nymphs remained static between 8.3 and 9.4% for all four years, possibly due to larval feeding on turkeys, common on Manresa Island). We found 4-poster devices can be effective in management of *A. americanum* and *Ehrlichia* spp., but at proper deployment density, in this extreme case, ~ 8 deer/device.



James Gathney, CDC



J. Kilburn, CT Wildlife

## Integrated Tick Management (ITM)

Lyme disease (LD) continues to be the most commonly reported vector-borne disease in the United States. According to the Centers for Disease Control and Prevention, it affected over 360,000 people in 2016. The blacklegged tick, *Ixodes scapularis*, is the vector for *Borrelia burgdorferi*, the causal agent for Lyme disease, and at least six other human pathogens.



The 4-poster utilized by white-tailed deer (left), a fipronil bait box (center), Michael Short applying Met52 (right).

An integrated tick management project was initiated by Dr. Kirby C. Stafford, Dr. Scott C. Williams, and Dr. Megan Linske, with the assistance of technicians Heidi Stuber and Michael Short in 2016-2017 in a cooperative agreement with Dr. Andrew Li at the USDA-Agricultural Research Service, which is funding the study. The five-year study continued in 2020 in the seven neighborhoods originally selected throughout Guilford based on their layout and proximity to large (> 200 acres) pieces of Town- or Land Trust-owned open spaces. The treatments in this ITM study consist of different combinations of untreated controls and homes treated with various combinations of spray applications of the entomopathogenic fungus *Metarhizium anisopliae* (Met52® EC), the fipronil-based rodent bait box (Select TCS®) and the 4-poster passive acaricide application station for the treatment of white-tailed deer (*Odocoileus virginianus*). Twelve '4-posters' (1 per 50 acres) were initially deployed in October 2017. Bait boxes and Met52 were first deployed or applied in June 2018. For 2019-2020, twelve 4-posters were re-deployed and maintained through the adult *I. scapularis* active season in the fall and spring. Again, a total of 540 fipronil-based rodent-targeted bait boxes were deployed at 54 residences and 36 of those residences were treated with Met52 (*Metarhizium anisopliae*) spray application. Dragging for questing nymphs began in mid-May by Heidi Stuber with seasonal assistant Hunter Badey. Live-trapping of white-footed mice by Dr. Scott C. Williams and Dr. Megan A. Linske with the assistance of Michael Short and seasonal assistant Daniel Duque began in June. Each captured mouse is sedated, marked with a unique ear tag, processed for ticks, and a blood sample was taken for serological analysis. Full analysis of the data for the three years of treatment in comparison to the base-line year and the controls is pending. However, initial summary of the data shows reductions in host-seeking ticks and ticks feeding on mice for all the treatment combinations in comparison to the control sites.

## Evaluation of Isoxazoline Products to Control Blacklegged Ticks on White-Footed Mice

The isoxazolines, a relatively newer systemic class of antiparasiticides; afloxolaner [Nexgard®], fluralaner [Bravecto®], sarolaner [Simparica®], and lotilaner [Credelio®] for the control of fleas and ticks on dogs, could potentially be used in a bait to control the blacklegged tick, *Ixodes scapularis* on white-footed mice, *Peromyscus leucopus*. Ms. Heidi Stuber and Dr. Kirby Stafford evaluated the potential of these agents to control nymphs of *I. scapularis* on *P. leucopus*, using commercial products at standard (wt/wt) canine doses. All the medications provided 100% control immediately following treatment, with rapidly declining levels

of control observed by day 14 and by day 28, there was no difference in engorged nymphs recovered between treated and untreated mice. With short-term efficacy, likely due to a mouse's higher metabolism, further research on isooxazoline drugs is needed for them to provide tick control in *P. leucopus*.

### **Biosurveillance for Exotic Buprestidae and the Wasp Watcher Program**

(Dr. Claire E. Rutledge and Collaborators – The Wasp Watchers, UConn Master Gardeners)

The wasp watcher program was begun in the spring of 2010. *Cerceris fumipennis* is a native digging wasp that provisions its nest with adult Buprestidae, including emerald ash borer. It is used as a tool for detecting and monitoring emerald ash borer and other invasive buprestid species by intercepting its prey as female wasps return to their nest. The wasp was responsible for the first detection of EAB in Connecticut and remains our main tool for detecting and monitoring EAB in the state. We are in the 12th year of our Wasp Watcher program. Over the course of the program we have trained 208 watchers. In 2021, due to quarantines due to the COVID pandemic, I had limited opportunities to recruit new Watchers. However, we did have 5 new watchers and 32 veteran watchers returned to cover the state. Since 2010, Watchers have collected over 10,000 beetles and detected EAB in 42 new towns. We have also used this system to examine the native buprestid fauna of Connecticut and have detected over 70 species of beetles with this tool. We have amassed one of the largest collections of buprestids in the country with over 35,000 specimens.



Our 2020 *C. fumipennis*  
masking up for safety.  
[Designed by K. Dugas]

### **Ball Fields as Habitat**

Dr. Claire E. Rutledge and Tracy Zarrillo

Sand plains are an important habitat that was once common in Connecticut. A unique fauna of sand-dwelling insects such as velvet ants, ground nesting bees and tiger beetles populate the barrens. Due to development only small pockets of this habitat are left in Connecticut, and many of its typical fauna have become rare. However, we have many artificial sand plains throughout the state, baseball infields. They mimic many of the conditions of the sand barrens, compacted sandy soil, little vegetation and exposed to the sun. The major difference is the level of disturbance due to grooming and game play. None-the-less, ball fields host many of the same groups of insects that sand plains do. We surveyed naturally occurring sand planes and baseball infields throughout the season in 2020 and are

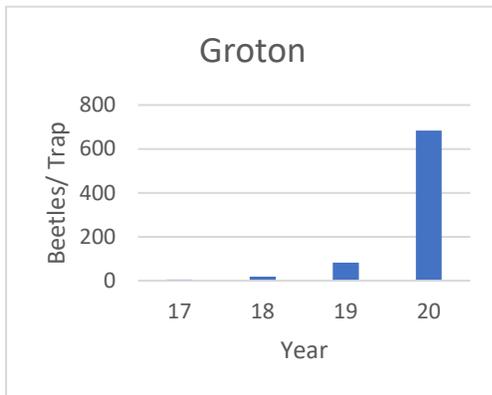


A chrysidid wasp, a nest parasite of ground nesting wasps, gets ready to enter a burrow.

continuing in 2021. We are gathering data on species richness and comparing the two types of habitat. Preliminary results indicate many of the same family and genera of insects are found in both habitats, but some of the species are unique to each habitat.

### Southern Pine Beetle

Dr. Claire E. Rutledge with collaborators Dr. Alicia Bray, Central Connecticut State University; Caroline Kanaskie, University of New Hampshire; Dr. Rayda Krell, Western Connecticut State University; DEEP Department of Forestry



Data from Candlewood Wildlife Management Area in Groton, CT showing increase in numbers of beetles trapped over the past 4 years.

The southern pine beetle has been moving north from the southeastern United States for the past 20 years due to climate change. The beetle reached Connecticut in the summer of 2014 and was first detected in 2015. We have been trapping for the beetle every year since then, and after four years with very few captures, we have started to see an increase in the number of beetles. For summer 2021, we have increased the number of trapping locations to better monitor this alarming rise. In addition to monitoring we have entered a collaboration with a graduate student at the University of New Hampshire studying the change in pine-associated fauna with the advent of southern pine beetle. This summer will be the second year of that study.

### Classical Biological Control of Emerald Ash Borer

Dr. Claire E. Rutledge with collaborators Dr. Jian Duan, USDA-ARS; Dr. Roy van Driesch, UMass Amherst; Dr. Juli Gould, USDA-APHIS; Dr. Nichole Quinn, UMass Amherst

Following the detection of emerald ash borer in Connecticut, the determination was made to join the USDA APHIS/PPQ biological control program for EAB. In May 2013, releases began of the gregarious endoparasitoid, *Tetrastichus planipennisi* and the egg parasitoid *Oobius agrili* in Middlebury and Prospect, CT. In 2016, we were able to add another species of parasitoid to the releases, *Spathius galinae*. This parasitoid is a gregarious ectoparasitoid of EAB with a much longer ovipositor than *T. planipennisi*. This means that they can parasitize larvae that are feeding in areas of the tree with much thicker bark. The parasitoids are shipped from the USDA APHIS emerald ash borer mass-rearing facility in Brighton, Michigan. Releases have been made in 14 towns and 7 counties in Connecticut.

After releases, the next step is to determine if the parasitoids have established in the environment. All three species have been recovered at least a full year after the last release. *Tetrastichus planipennisi* has been recovered at 7 sites, and *Spathius galinae*, which we just began releasing in 2016, has been recovered at 2 sites. Parasitism rates of the *S. galinae* in particular are very promising, with wasps attacking up to 45% of available EAB larvae.

Work in 2020 determined that both *T. planipennisi* and *S. galinae* had spread at least 14 km from their release sites as well as determining the phenology of both species. In 2021, we are embarking on a project to examine the factors contributing to the long-term survival of the parasitoids in an area. To do this, we are using sentinel logs to examine the persistence of *T. planipennisi* in the environment at 3 sets of sites of



Mioara Scott and Zachary Brown peeling ash to determine emerald ash borer density and rates of parasitism by the introduced parasitoids.

different release ages. We will also examine the ash demographics of these sites as well as peeling trees to determine current levels of emerald ash borer infestation. This work should help us to understand the longer-term dynamics of the system.

### **Comparing Methods to Identify Plant Sources of Pollen Collected by Honey Bees at Ornamental Plant Nurseries**

Dr. Kimberly Stoner, assisted by Mark Creighton, Tracy Zarrillo, and Morgan Lowry, and collaborating with Andrea Nurse of the Climate Change Institute at the University of Maine, Dr. Rodney Richardson of Maryland Center for Environmental Science, Dr. Robert Koethe of the US Environmental Protection Agency Region 1, and Dr. David Lehmann of the US Environmental Protection Agency Office of Research and Development

In a comparison of pollen identification using light microscopy of acetolyzed pollen to DNA metabarcoding using ITS2 and also using the median values for the three markers ITS2, *rbcL* and *trnL*, microscopic methods of palynology detected a greater diversity of plant families and genera than DNA metabarcoding. DNA metabarcoding almost completely failed to detect maize (*Zea*) and buckwheat (*Fagopyrum*) at the genus level, including in multiple samples where one or the other constituted >50% of the pollen by volume, and both methods also performed poorly at detecting these genera at the family level. DNA metabarcoding found some genera that were not detected by microscopy, particularly *Actinidia*, and provided identifications to genus for families where distinguishing some genera by microscopy is difficult, such as Asteraceae and Brassicaceae. The greater diversity of pollen detected by microscopy in this study compared to DNA metabarcoding, in contrast with previous comparisons, may be due to the specific techniques used, specifically homogenizing the pollen directly without sorting pollen loads first by color and acetolyzing the pollen. By measuring the volume of pollen types, assuming weight is proportional to volume, and assigning the proportions of pollen types from palynology to bulk samples, it is possible to estimate the contribution by weight of different plant sources of pollen across the season. These advantages of microscopy in allowing not just identification but also quantification of contributions from different plant sources, along with technical improvements such as the recent development of artificial intelligence and machine-based learning in microscopic pollen identification, will continue to make microscopic palynology useful into the future. The existing DNA metabarcoding technologies and any new technologies for pollen identification should continue to be rigorously tested with known samples against microscopic palynology and against each other before being widely used in studies of pollen as food for bees.

**Impact:** This study was done as part of a larger project looking at the extent to which ornamental plants provide resources to pollinators. This is of interest to beekeepers, who want to know about the nutritional value and possible pesticide contamination of the pollen brought in by their bees, and it is also of interest to the nurseries, who want to avoid harming bees with pesticides, and who also are interested in marketing ornamental plants that are especially important for feeding bees. Using microscopic analysis of the pollen brought back to the hive by honey bees located at major ornamental plant nurseries, we found that much of the pollen did not come from the nursery plants, but from clovers, corn, buckwheat, and weeds like poison ivy, plantain, and Virginia creeper. However, the DNA methods we also used did not detect some of the major pollen sources, like corn and buckwheat. More testing is needed of new methods for pollen identification, so that we have more accurate information about plant sources of pollen.

### **The Connecticut Long-Term Wild Bee Monitoring Program**

Tracy Zarrillo and Dr. Kimberly Stoner with assistance from Morgan Lowry, Rose Hiskes of the Valley Laboratory, Robert Durgy of the Griswold Research Center, and in cooperation with Kristina Vagos of the US Fish and Wildlife Service and James Fischer of the White Memorial Conservation Center.

A long-term wild bee monitoring program was initiated in 2010 by Tracy Zarrillo under the supervision of Dr. Kimberly Stoner (Department of Entomology) and has continued through 2021. This program was created in response to growing evidence of decline of certain wild bee fauna locally and globally and seeks to identify wild bee communities that may require conservation action. The project goals were to create a long-term, self-sustaining, easy to implement, low-cost program that surveys wild bees in diverse habitats across Connecticut with the purpose of being able to detect changes in species richness, abundance, and composition over time. Currently, the program includes sites at the White Memorial Conservation Center in Litchfield County, the Stewart B. McKinney National Wildlife Refuge in Middlesex County, and the CAES campuses at Windsor, New Haven, Griswold, and Lockwood Farm.

Wild bees are sampled from late March/early April until mid-October, using bee bowl cup traps which run continuously throughout the season. These traps are maintained by CAES staff and our cooperators, and the samples are extracted biweekly and stored until they can be retrieved by CAES staff at the end of the season for processing. The specimens collected are identified by Tracy Zarrillo, and the records are entered into the American Museum of Natural History, Division of Invertebrate Zoology Database. A collaboration with Dr. Lawrence Gall of the Peabody Museum at Yale and Dr. Neil S. Cobb of the University of Arizona is underway to move our CAES records over to a new platform, SCAN, Symbiota Collections of Arthropods Network (<https://scanbugs.org/portal/collections/misc/collprofiles.php?collid=276>), which will make our data live and available in global biodiversity data portals such as GBIF (the Global Biodiversity Information Facility), BISON (Biodiversity Information Serving our Nation - USGS), and iDigBio. This collaboration not only serves the bee monitoring program but will be advantageous for all CAES staff who wish to disseminate their data globally via GBIF and other portals.

The Connecticut long-term wild bee monitoring program is in its 11th year and is one of the few wild bee monitoring programs in the United States that has succeeded in sampling for this length of time at the same locations in the same exact way, thus being able to begin to detect changes in abundance, composition, and diversity. A US national program for monitoring native bees is being developed by 13 native bee biologists from across the United States (<https://www.usnativebees.com/>), and the Connecticut Wild Bee Monitoring Program is now a part of that endeavor (<https://www.usnativebees.com/members.html>).

Beginning in the spring of 2020, a survey of native bumble bees in Connecticut was also initiated by Tracy Zarrillo, to complement the existing program, for the purpose of documenting the occurrence of *Bombus terricola*, a state-listed bee species, in the state. Since the opportunistic detection of this declining species in 2017 by Dr. Chris Maier, several other locations have been identified where this species persists in the northwest corner of Connecticut. Further investigations will help the Connecticut Department of Energy and Environmental Protection make new status assessments for this threatened species.

## NURSERY AND PLANT INSPECTION ACTIVITIES

Plant inspection and regulatory services are coordinated and conducted through the Office of the State Entomologist, whose members are State Entomologist Dr. Kirby Stafford, Deputy State Entomologist Dr. Victoria Smith, Plant Inspectors Jeffrey Fengler and Tia Blevins, Apiary Inspector Mark Creighton, and State Survey Coordinator Gerda Magana.

**Nursery Inspection and Certification.** One hundred ninety-five nurseries were certified to conduct intra- and interstate business. There were 137 nursery inspections during the growing season.

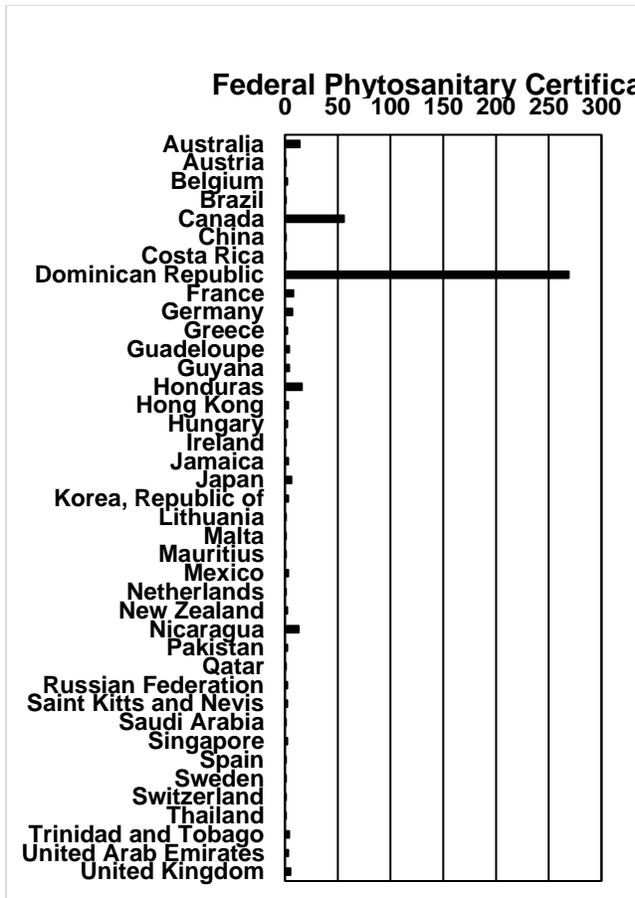
**Nursery Insects and Diseases.** The most important pests found in nurseries (in order of prevalence) were red headed flea beetle, various aphids, fall webworm, woolly aphids, and thrips. The most important diseases found in nurseries (in order of prevalence) were powdery mildew, cedar apple rust, miscanthus blight, downy mildew, and various fungal leaf spots.

**Nursery Dealer Permits.** Nursery dealer permits were issued to 93 firms.

**International Phytosanitary Certificates.** Three hundred fifty-two phytosanitary inspection certificates were issued covering the shipment of the following plant materials to 40 destinations outside the United States. Of the top three destinations, 269 consignments were bound for the Dominican Republic (tobacco), 56 to Canada (ornamental plants), and 16 to Honduras (tobacco).

<u>Product</u>			<u>Quantity</u>
<i>Coffea sp.</i>	Coffee	beans	3 pounds
<i>Dahlia, Gladiolus</i>	bulbs and corms		108 plants
Greenhouse/indoor plants	Various	plants	34 plants
<i>Hemerocallis</i>	Day lily	seed	142 bags
<i>Hemerocallis</i>	Day lily	bare root plants	326 plants
<i>Hemerocallis</i>	Day lily	Plants	36 plants
<i>Hemerocallis</i>	Day lily	Seed	1,212 packets
<i>Juglans nigra</i>	Walnut	ground shells	10 bags
<i>Juglans nigra</i>	Walnut	ground shells	488 drums
<i>Juglans nigra</i>	Walnut	ground shells	9,410 pounds
<i>Nicotiana tabacum</i>	Tobacco	leaves	4,636 bales
<i>Nicotiana tabacum</i>	Tobacco	leaves	80,161 bundles
<i>Nicotiana tabacum</i>	Tobacco	leaves	5,665 cartons
<i>Nicotiana tabacum</i>	Tobacco	leaves	260 Kg
<i>Nicotiana tabacum</i>	Tobacco	leaves	5,013,243 pounds
nursery stock	Various	bare root plants	54 plants
nursery stock	Various	containers	14,257 containers
nursery stock	Various	cuttings	4 cuttings
nursery stock	Various	stems	54 stems
<i>Paeonia suffruticosa</i>	Peony	seed	100 seeds
<i>Phytelephas aequatorialis</i>	Vegetable ivory	ground seed	19 drums
<i>Phytelephas aequatorialis</i>	Vegetable ivory	ground seed	500 Kg
<i>Prunus armeniaca</i>	Apricot	ground seed	500 Kg
<i>Tillandsia sp.</i>	Air plant	plants	961 plants
vegetables and herbs	Various	seed	363 bags
vegetables and herbs	Various	seed	36 Kg

Destinations for out-of-country exports from Connecticut.

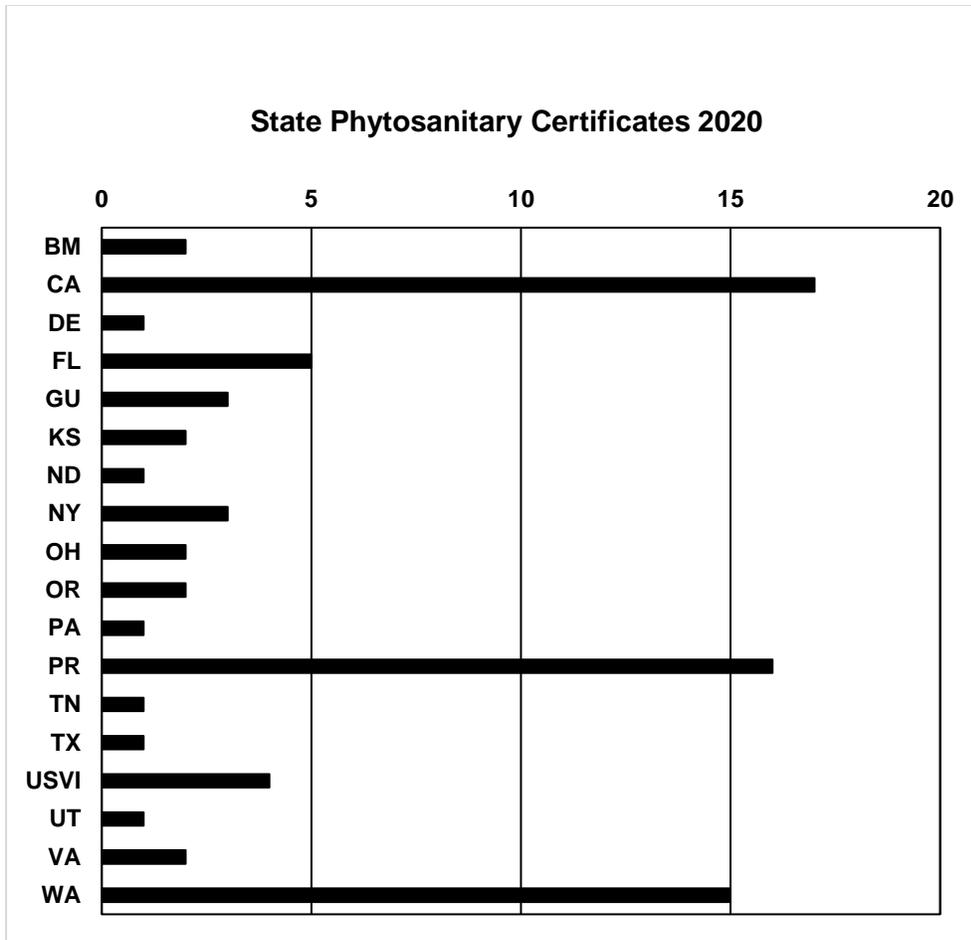


**Houseplant Inspections.** Three inspections were conducted for 45 individual plants to assist homeowners moving out of state.

**Domestic.** Seventy-nine inspections were made to assist nurseries moving the following plants interstate, either to destinations in other states or to US Territories and Puerto Rico (18 listed destinations). Of the top three destinations, 17 consignments were bound for California, 16 to Puerto Rico, and 15 to Washington.

<u>Product</u>			<u>Quantity</u>
Greenhouse/indoor plants	various	plants	137 plants
nursery stock	various	bare root plants	1,175 plants
nursery stock	various	plants	24 plants
Orchids	various	plants	1,340 plants
<i>Pelargonium</i> sp.	Geranium	plugs	856 plants
vegetables and herbs	various	seed	67 bags

Destinations for out-of-state export from CT, including US Territories and Puerto Rico.



**Permits to move live plant pests, noxious weeds, and soil.** In 2020, there were 85 PPQ 526 Permits (Permit to move live plant pests, noxious weeds, and soil) approved in CT. There were 5 Controlled Import Permits issued. There were 3 Permits to Receive Soil issued. Two permits for Post Entry Quarantine were approved.

**Boxwood Blight compliance agreements for shipment to Pennsylvania.** Three nurseries met requirements for shipment of boxwood nursery stock to Pennsylvania.

**Notification of Shipments of *P. ramorum* hosts and Associated Hosts.** There were 24 notifications of shipments of *P. ramorum* hosts and associated hosts, pursuant to 7 CFR 301.92.

## FOREST HEALTH

In general, the hardwood forests are suffering from successive years of drought stress and gypsy moth defoliation, and are under threat due to development pressure, and ash mortality due to emerald ash borer infestation is increasing. Roughly half of the ash resource is dead due to emerald ash borer. We recorded

about 172,545 acres of mortality caused by EAB and about 200 acres recently affected by emerald ash borer.

## INSECT AND DISEASE SURVEYS

By far, the most significant damage causing agent in 2021 was foliar *SALT DAMAGE* from tropical storm force winds that occurred on August 4 during TS Isaias. Roughly 16,145 acres were affected, some as far 50 miles inland from Long Island Sound. There was substantial tree and branch breakage during that weather event as well. A local tornado two weeks later also caused tree damage and mortality.

*SPOTTED LANTERNFLY*. Populations of spotted lanternfly (egg masses plus adult insects) were found at several locations in Fairfield County, near the New York State line, in September 2020. A number of single adult interceptions were also found at various locations throughout the state. The Fairfield County detections were delimited and mapped. Survey was also conducted around the interceptions, but no more individuals were found.

*GYPSY MOTH*. In 2020, we recorded 156,000 acres with significant mortality caused by gypsy moth, primarily in the eastern half of the state. About 108 acres were newly defoliated. In December 2020 through March 2021, a gypsy moth egg mass survey was conducted in 80-95% favorable host sites on a 7-mile grid (102 sites) throughout Connecticut. Egg mass counts were high only in Litchfield County, which indicates the potential for an outbreak there in summer of 2021.

*HEMLOCK WOOLLY ADELGID and ELONGATE HEMLOCK SCALE*. These pests have been present in CT for many years and continue to cause patchy damage and decline among the remaining population of hemlocks.

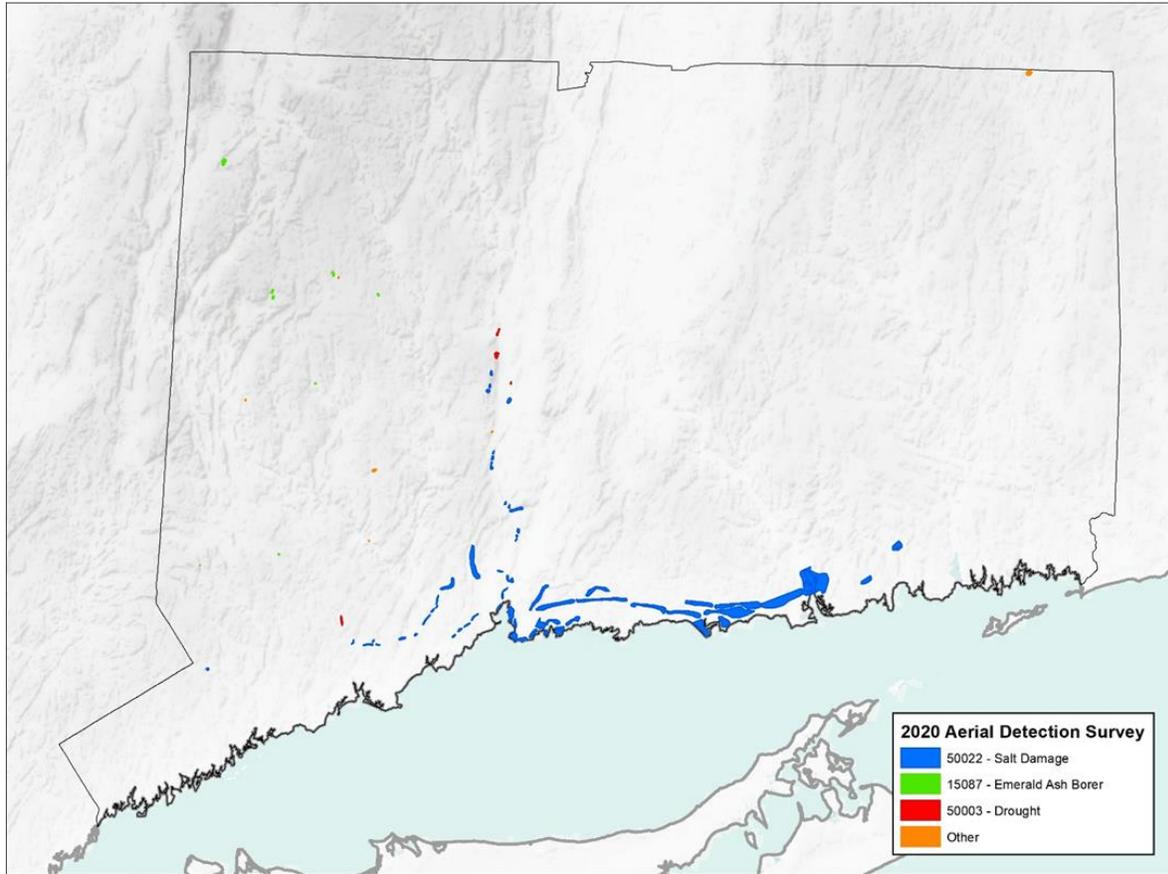
*AGROMYZID FLY*, also called the oak shot hole leaf miner, is a relatively new pest causing local damage and defoliation on oaks. We recorded 208 acres affected by this insect.

## APIARY INSPECTION

In 2020, Connecticut had over 697 registered beekeepers maintaining over 6,750 hives. During the 2020 season, 909 hives were inspected at 98 apiaries. Varroa mite infestation and the viral complex associated with varroa mite infestation continues to be the primary reason for colony mortality. Varroa mite test kit distribution started in the last quarter for 2019 and will continue through 2021 for all Connecticut beekeepers.

Connecticut beekeepers continue to lose colonies over winter in high numbers. The Bee Informed Annual Loss report for Connecticut in 2020 was 56.5%, a slight decrease from the previous year; the winter loss was 36.6%; the summer loss was 18.3%. Connecticut annual bee losses were probably closer to 65%. Package bee sales for new beekeepers and for replacement colonies is very high and is estimated to be over 7,000 units. An educational program, Biology and Management of the Varroa mite in the honey bee will continue to be presented to Connecticut beekeepers in an attempt to increase honey bee survivability. Despite these challenges, beekeeping interest is still strong with over 800 new beekeepers being trained earlier this year. Eight certificates were issued for export of honey bees out of Connecticut and over 300 certificates for interstate movement of honey bees.

The annual survey of Connecticut forests and natural lands was conducted by ground survey in 2020, due to pandemic restrictions.



Special activities:

Email/telephone inquiries concerning emerald ash borer, 1 July 2020 through 30 June 2021: 64  
 Email/telephone inquiries concerning Asian longhorned beetle, 1 July 2020 through 30 June 2021: 31  
 Email/telephone inquiries concerning spotted lanternfly, 1 July 2020 through 30 June 2021: 15  
 Email/telephone inquiries concerning box tree moth, 1 July 2020 through 30 June 2021: 6

## DEPARTMENT OF ENVIRONMENTAL SCIENCES

### I. ENVIRONMENTAL CHEMISTRY PROGRAMS

The Environmental Chemistry component of the Department has been involved in research topics dealing with the interactions of pollutants with environmental particles, the bioavailability of pollutants in environmental solids such as soils and sediments, pollution prevention and remediation, natural chemical processes in the environment, and environmental analytical chemistry applied to characterization of pollution, assessment of human exposure, and remediation options. It covers many types of pollutants, including industrial solvents and chemicals, fumigants, insecticides, herbicides, pharmaceutical compounds, personal care products, per- and polyfluoroalkyl substances, engineered nanomaterials, and greenhouse gases.

#### A. Interactions of Contaminants with Environmental Particles

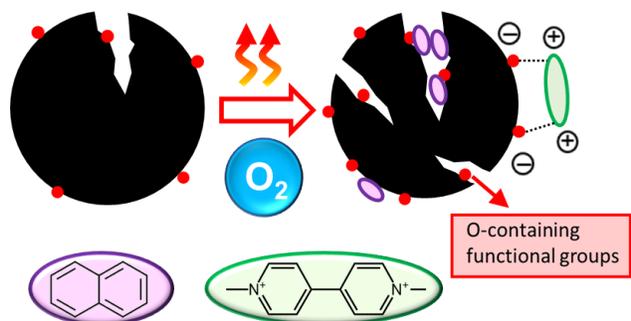
(Joseph Pignatello)

##### 1. Physico-chemical changes in biomass chars by thermal oxidation or ambient weathering and their impacts on sorption of a hydrophobic and a cationic compound.

(Joseph J. Pignatello, Yi Yang, and researchers from Brandeis University)

Biomass chars are ubiquitous components of soil and sediment as a consequence of historical wildfires and intentional burning practices. Fire-derived chars, together with fossil fuel carbonaceous soots, impact the carbon cycle and potentially affect soil microbial community structure, extracellular microbial electron transport processes, and the fate of pollutants. Char products synthesized from various biomass wastes and added to soil (“biochars”) have attracted attention for their potential to improve soil properties, suppress greenhouse gas emissions, and reduce availability of soil pollutants. Many of the functions of chars in these various applications depend on their sorptive properties towards small molecules and ions. In many places chars are present in high enough amounts in soil to play a substantial, if not dominant, role in the mobility and bioavailability of organic contaminants that may be present. We have looked extensively at the interactions of organic compounds with chars depending on their formation conditions and as they age in the environment.

This particular study examined conditions that mimic oxidative processes of biomass chars during formation and weathering in the environment. A maple char prepared at the single heat treatment temperature of 500°C for 2 h was exposed to different thermal oxidation conditions, or accelerated oxidative aging conditions prior to sorption of naphthalene or the dication paraquat. Samples subjected to strong chemical oxidation (SCO) were included for comparison. Thermal oxidation caused micropore reaming, whereas ambient oxidation and SCO much less so. All oxidative treatments incorporated O, acidity, and cation exchange capacity (CEC). Thermal incorporation was a function of headspace O<sub>2</sub> concentration and reached a maximum at 350°C due to the opposing process of burn-off. The CEC was linearly correlated with O/C, but the positive intercept together with NMR data signifies that, compared O groups derived by anoxic pyrolysis, O acquired through oxidation by thermal or ambient routes is more efficiently incorporated into CEC. Thermal oxidation increased naphthalene sorption coefficient, characteristic energy of sorption, and uptake rate, due to pore reaming. By contrast, ambient oxidation (and SCO) suppressed naphthalene sorption by creating a more hydrophilic surface. Paraquat sorption capacity was predicted by an equation that includes a CEC<sup>2</sup> term due to bidentate interaction with pairs of charges predominating over monodentate interaction, plus a term for the capacity of naphthalene as a reference representing non-specific driving forces.

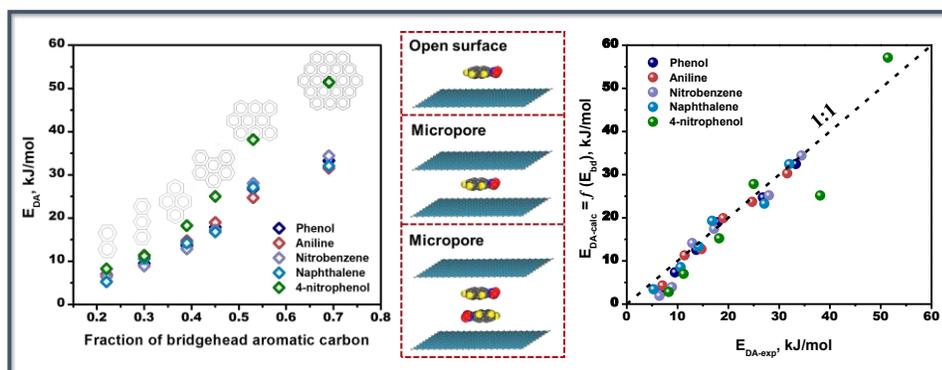


Schematic showing the changes caused by thermal oxidation of biochar particles and how these changes can affect sorption of the two model compounds, naphthalene and paraquat.

## 2. Identification of an important new interaction responsible for adsorption of organic compounds to biomass chars.

(Joseph Pignatello, Jingjing Yang, and collaborators from South China University of Technology, Guangzhou, China)

During the charring process aromatic rings of larger and larger size form, and both the porosity and specific surface area increase. Historically, surface area and porosity were regarded to be the main properties of chars governing char sorption ability. In this study, we show that the *degree of aromatic condensation* has a previously overlooked direct effect on sorption energy (but not capacity) of chars. Aromatic condensation refers to the mean polyaromatic fused ring cluster size and is a function of heating conditions. Characteristic sorption energy ( $E_{DA}$ , kJ/mole) was determined by fitting sorption isotherms to the Dubinin-Ashtakov (DA) model for each of 22 different compounds on a thermoseries of bamboo chars. The fraction of bridgehead carbon,  $\chi_{bh}$  which correlates with ring cluster size was determined by solid-state  $^{13}\text{C}$  nuclear magnetic resonance spectroscopy. For all 22 compounds a strong linear correlation was observed between  $E_{DA}$  and  $\chi_{bh}$ . The  $E_{DA}$  also correlated with a binding energy  $E_{bd}$  computed by molecular modeling using density functional theory (DFT). DFT reveals that sorption is increased with ring size due to increasing polarizability of the cluster, which strengthens dispersion forces with the sorbing molecule. The findings underscore the direct role of aromatic condensation in sorption energy and suggest that  $E_{DA}$ - $E_{bd}$  comparison can be a useful tool for gaining insight into sorption at the molecular level. The results can be found in J. Yang et al., 2020.



Left, correlation between sorption energy and the bridgehead carbon which is an index of average ring size. Center, the effect of ring size holds for monolayer sorption on an open polyaromatic sheet and both monolayer and bilayer sorption in a slit micropore composed of polyaromatic sheets. Right, experimental versus DFT-computed sorption energy.

### 3. Direct reaction of a char with a series of substituted phenols: dual oxidative and reductive pathways depending on substituents and conditions.

(Joseph J. Pignatello and colleagues from Kunming University of Science and Technology, China and the University of Massachusetts, Amherst)

Biomass chars are known to be directly redox-reactive toward some organic compounds due to the presence of oxidative or reductive ‘sites’ on their surfaces, but the mechanisms are still unclear. To address this, a char made anoxically at 500°C from pure dealkaline lignin was reacted either in the fresh state, or after aging in air for 180-day, with *p*-nitrophenol (NO<sub>2</sub>-P), *p*-hydroxybenzaldehyde (CHO-P), phenol (H-P), or *p*-methoxyphenol (MeO-P) under oxic or anoxic conditions. Degradation of the phenolic compounds occurred in all cases. Both oxidation and reduction products were identified, with yields dependent on the presence or absence of air during reaction or during the aging stage. They included oligomers, amines, and ring-hydroxylated compounds, among others. Exposure to air suppressed sorption, annihilated reducing sites on the char, and provided a source of reactive oxygen species (most importantly, hydroxyl radicals) that assisted degradation. Reaction appears to take place predominantly in the sorbed as opposed to the dissolved state of the phenolic compound. Sorption suppression was due to incorporation of hydrophilic groups by chemisorption of oxygen and possibly by blockage of sites by reaction products. Using a published technique that measures electro-chemical storage capacity of carbonaceous materials, fresh char contained comparable electron donor and acceptor capacity, while aged char contained a preponderance of electron acceptor over donor capacity. Under anoxic conditions, both oxidation and reduction occurred. Under oxic conditions or in the case of char aged in air, oxidation predominated, and linear free energy relationships were found between the rate constant and the Hammett or Brown substituent electronic parameter or the standard electrode potential of the phenol (Figure). The results demonstrate that chars possess heterogeneous redox activities depending on reaction pairs, reaction conditions, and aging. The work is published in *Environmental Science & Technology* by Li et al., 2020.

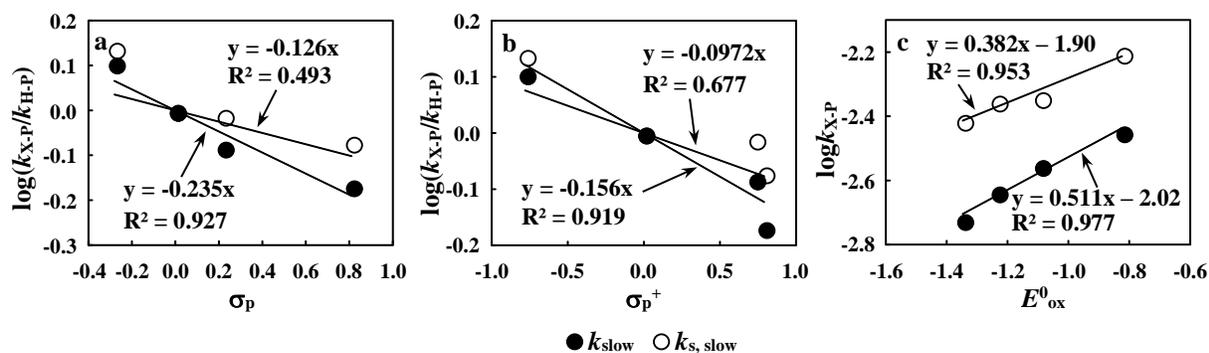


Figure. Degradation by fresh char under oxic conditions. Correlation between rate constant and Hammett (left) or Brown (center) parameters, which reflect the electron-withdrawing capability of the substituent. Right is a correlation between rate constant and the standard one-electron electrode oxidation potential of the phenolic compound ( $Ar-OH \rightarrow Ar-O^\bullet + e^- + H^+$ ).  $k_{slow}$  refers to the over-all slow phase of the reaction and  $k_{s,slow}$  refers to the slow phase pertaining to the sorbed amount only.

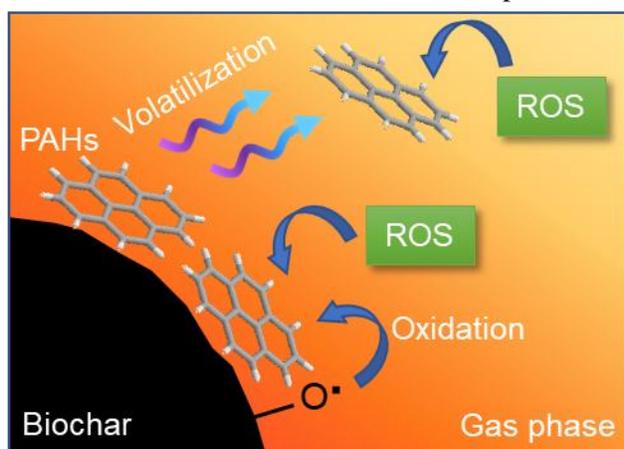
## B. Pollution Remediation

(Joseph Pignatello)

### 1. Abatement of Polycyclic Aromatic Hydrocarbon Residues in Biochars by Thermal Oxidation.

(Joseph Pignatello, Yi Yang, and researchers from Nanjing Agricultural University, China)

Biochars often form residues of polycyclic aromatic hydrocarbons (PAHs) during their preparation that can pose risks to exposed organisms and ultimately to human health. PAHs have been associated with cancer, cardiovascular disease, and developmental effects in humans, as well as oxidative stress in animals. They can be taken up by plants, posing a potential threat to the food supply. This study shows that thermal oxidation of an anoxically-produced (500°C) softwood biochar using brief post-pyrolysis thermal oxidation in air caused a substantial decline in solvent-extractable PAHs (up to 85% of Tot-PAH) and a sharp decrease (up to 82%) in the EPA Relative Potency Factor. Optimum conditions were 400°C for 20 min. An alternative approach of including 1% O<sub>2</sub> in the nitrogen flow stream during pyrolysis was less effective. PAH loss is attributed to combustion processes as opposed to outgassing. Oxidation of PAHs occurs in the gas and adsorbed phases and is promoted by pore reaming of biochar micropores and mesopores during thermal oxidation, which facilitates diffusive exchange of O<sub>2</sub>, reactive oxygen species, and PAH molecules. Oxidation also may be promoted by self-heating of the biochar body, which increases the local temperature. The results indicate that a short post-pyrolysis thermal oxidation step can reduce the risks associated with PAH residues in biochar. The results are reported in Yang et al., 2021.



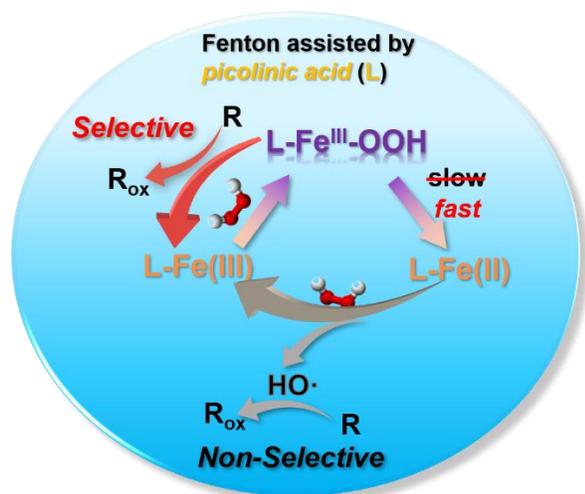
Schematic showing attack of radical oxygen species and surface radicals on PAH molecules either in the gaseous or adsorbed phases during thermal oxidation.

## 2. The Fenton reaction in water assisted by picolinic acid: accelerated iron cycling and co-generation of a selective Fe-based oxidant.

(Joseph J. Pignatello, Zhichao Yang, and researchers from Nanjing University, China)

Fenton and related reactions represent an important and well-studied class of advanced oxidation processes (AOPs) for treating contaminated water. The Fenton reaction applied to water treatment is limited by a slow rate-limiting step, a narrow pH range in the acidic region, and susceptibility of the non-selective hydroxyl radical (HO•) to scavenging by water constituents. We employed the harmless and biodegradable chelating agent picolinic acid (PICA) to address these shortcomings. Addition of PICA greatly accelerated degradation of atrazine, sulfamethazine, and various substituted phenols by H<sub>2</sub>O<sub>2</sub> at pH 5.0 compared to the classical Fenton reaction at its optimum pH of 3.0. The Fe(III)/PICA/H<sub>2</sub>O<sub>2</sub> reactions also showed autocatalysis. Hydroxyl served as the principal active oxidant; however, failure of various scavengers of HO•, superoxide, singlet oxygen, or ferryl species to suppress reaction of several compounds implicated the co-formation of an alternative oxidant. A high-spin, end-on hydroperoxo intermediate, tentatively identified as PICA-Fe<sup>III</sup>-OOH, was shown to decompose spontaneously to Fe(II) or react with the test compound. In HO•-suppressed reactions oxidation of 2,4,6-trichlorophenol released chloride and the positive slope of the Hammett correlation for a series of halogenated phenols indicates PICA-Fe<sup>III</sup>-OOH reacts as a nucleophilic oxidant in water. Compared to the HO• pathway, the PICA-Fe<sup>III</sup>-OOH pathway is less sensitive to potential scavengers in environmental water samples. Kinetic analysis and modeling reveal that PICA facilitates iron

redox cycling by accelerating Fe(III) reduction by H<sub>2</sub>O<sub>2</sub>. Autocatalysis is due to the buildup of Fe(II) resulting from reduction of Fe(III) by H<sub>2</sub>O<sub>2</sub>, as well as by PICA oxidation products. PICA assistance of the Fenton reaction may be beneficial in water treatment applications because it favors iron cycling, extends the pH range, and balances universality with selectivity. The results are published in Yang, Z. et al., 2021.



Schematic showing the critical reactions we established to take place in the PICA-assisted Fenton reaction.

### 3. Revisiting the phenanthroline and ferrozine colorimetric methods for quantification of Fe(II) in Fenton reactions.

(Joseph J. Pignatello, Zhichao Yang, and researchers from Nanjing University, China)

Colorimetric methods for Fe(II) determination based on complexation of heterocyclic amines, such as phenanthroline (Phen) and ferrozine (FZ), have been widely used for analysis of iron species in solution, both in natural waters and in the context of Fenton and related reaction systems. However, the reliability of both methods in a background of hydrogen peroxide has never been addressed. In this study, we demonstrate that serious overestimation of Fe(II) is possibly for both methods in Fenton systems, particularly for the Phen method. A systematic variation of incubation conditions reveals that the available Fe(II) concentration depends greatly on the incubation time after mixing the colorimetric reagents with the sample. Also, it is highly sensitive to pH and temperature as well as the initial concentrations of Fe(III), H<sub>2</sub>O<sub>2</sub>, and acetate buffer. The experimental results combined with simulations indicate that Fe(II) overestimation mainly results from the reduction of Fe(III)-Phen or Fe(III)-FZ complexes by residual H<sub>2</sub>O<sub>2</sub> during analysis, a reaction that is facilitated by the ligand field effect of the heterocyclic amine. An effective remedy for the instability and inaccuracy of the methods in the presence of H<sub>2</sub>O<sub>2</sub> is the addition of NH<sub>4</sub>F to the incubation mixture (55 mM for Phen and 35 mM for FZ), which converts residual Fe(III) to a colorless fluoride complex that is stable to reduction. The findings are published in Z. Yang et al., 2020.

### 4. Design of carbonaceous catalysts for environmental remediation or soil fertilization.

(Joseph Pignatello, Wael Abdelraheem, Santanu Bakshi, Xiangyu Bi, Wade Elmer, Tyler Swanson, Philip Wang, Jingjing Yang, and collaborators at Universities in the U.S. and China)

We have initiated projects on surface modification of carbonaceous materials such as chars and activated carbon for trapping or trapping and degrading environmental contaminants. Because such materials are inherently strong adsorbents, they serve to adsorb and thus concentrate contaminants out of water or soil, making them more available at reactive sites. For example, we have modified carbons to increase their

anion exchange capacity (AEC) by irreversible adsorption of the quaternary ammonium polymer, poly(diallyldimethylammonium) chloride (pDADMAC), or by doping with nano-scale coatings of magnesium oxide. The AEC-modified carbons bind phosphate, nitrate and organic anions much more effectively than do the unmodified carbons. One of these, the MgO char that strongly binds phosphate, is undergoing testing for its ability to act as a bioavailable, yet non-leachable source of P to lettuce plants. Bioavailability will be facilitated by addition of arbuscular mycorrhizal fungi, which are capable of “mining” P from the particles and conveying it to plant roots in exchange for sugars and other C nutrients from the plants.

Manures may contain considerable amounts of organophosphates (org-P) that must be enzymatically converted to inorganic phosphate to be plant available. Although adding enzymes into manures can facilitate mineralization of org-P to inorganic phosphate, enzymes that are not immobilized are easily lost through leaching, degradation, or denaturation. In a study we conducted, the immobilization of enzymes onto nine different biochar surfaces was explored. Phytase, which mineralizes a main class of org-P, was used as the model enzyme. Immobilization methods included covalent grafting accomplished by the carbodiimide cross-linker method and physical sorption. The results showed that physisorption was as effective as grafting for loading phytase to the biochars. Phytase loading after mixing 0.1 g biochar and 2 mg phytase correlated positively with biochar C:H ratio (an indicator of aromatic content) suggesting the importance of the hydrophobic effect. An increase in pH led to a decrease in phytase loading consistent with repulsion between negatively charged sites on phytase and the increasing negative charge on biochar. Less than 4% of the immobilized phytase leached after sequential extractions over seven days using manure dissolve organic matter solutions. However, the activity of immobilized phytase decreased markedly compared to the free state phytase. The specific activity of immobilized phytase was two orders of magnitude lower than that of free phytase at pH 5 and 7. Nevertheless, results showed that deactivation of phytase by biochars were reversible once the phytase was detached from the surfaces. Compared to the biochars, clay minerals (montmorillonite, kaolinite and hematite) tended to have greater loading rates and higher phytase activity. Composting manures with co-amendments of biochar and minerals may enhance both short- and long-term P mineralization potential. The results are reported by Li et al. 2020 in *Science of the Total Environment*.

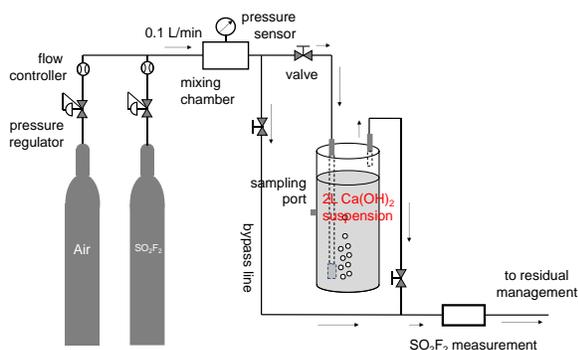
Other carbons have been modified to bind reagents that chemically react with adsorbed contaminants, accelerating contaminant degradation. For example, we are working on carbons with enhanced AEC that accelerate alkaline hydrolysis of munitions compounds by adsorbing both the munition molecules themselves and hydroxide ions, which cause their hydrolysis. We have prepared novel carbons that contain N and O atoms incorporated into their structures. These carbons greatly accelerate the oxidation of organic compounds by a peroxide (e.g., peroxymonosulfate), without the need for light, heat, or transition metal co-catalysts.

#### 5. Removal of sulfuryl fluoride from fumigant vent streams in Quarantine and Pre-Shipments (QPS) fumigation operations.

(Joseph Pignatello and Chengjin Wang in collaboration with scientists at USDA-ARS and Stanford University)

Sulfuryl fluoride (SF) is an effective and convenient fumigant for sanitizing agricultural commodities in international trade. However, it is a powerful greenhouse gas and cost-effective methods for removal of spent vapors from fumigation chamber vent streams are urgently needed. In work in progress we investigated the use of calcium hydroxide (also known as “slake lime”) in a flow-through aqueous slurry type reactor to remove SF. Calcium hydroxide, which is inexpensive and safe, is slightly soluble in water (~1 g/L) and in suspension provides a steady-state source of OH<sup>-</sup> and Ca<sup>2+</sup> ions in the dissolved phase (pH

around 12.4). At that pH, SF will undergo rapid alkaline hydrolysis, generating the byproducts, fluorosulfate ( $\text{FSO}_3^-$ ) and fluoride ions. The fluoride ions are expected to form  $\text{CaF}_2$ , which is insoluble. Fluorosulfate, whose toxicity is unknown, may be removed by adding a nucleophilic catalyst, which can bring about its hydrolysis ultimately to sulfate and fluoride ions. We have success so far using hydrogen peroxide which is strongly nucleophilic in its anionic form. Strategies for improving mass transfer rates of SF to the liquid phase where reactions occur are being investigated.



Setup to test the effectiveness of using  $\text{Ca}(\text{OH})_2$  slurry to remove sulfuranyl fluoride in a flow-through reactor.

## 6. Biochar Amendment as a Remediation Strategy for Surface Soils Impacted by Crude Oil. (Joseph Pignatello and researchers from University of California, Davis)

The impact of organic bulking agents on the biodegradation of petroleum hydrocarbons in crude oil impacted soils was evaluated in batch laboratory experiments. Crude oil impacted soils from three separate locations were amended with fertilizer and bulking agents consisting of biochars derived from walnut shells or ponderosa pine wood chips produced at 900°C. The batch reactors were incubated at 25°C and sampled at pre-determined intervals to measure changes in total petroleum hydrocarbons (TPH) over time. Prior to each sampling event, the sample was manually stirred and the soil moisture content was adjusted to 55 – 60%. Results show that the addition of fertilizer and bulking agents increased biodegradation rates of TPH. Soil samples amended with ponderosa pine wood biochar achieved the highest biodegradation rate, whereas the walnut shell biochar was inhibitory to TPH reduction. The impact of biochars on TPH biodegradation was more pronounced for a soil impacted with heavier hydrocarbons compared to a soil impacted with lighter hydrocarbons. This study demonstrates that some biochars, in combination with fertilizer, have the potential to be a low-technology and eco-friendly remediation strategy for crude oil impacted soils. The results are published in *Environmental Pollution* by Fungai et al., 2020.

## C. Chemistry of the Environment (Joseph Pignatello)

### 1. Charge-assisted hydrogen bonding as a cohesive force in soil organic matter. (Joseph Pignatello, Philip Wang, and Hiro Murano from Meijo University, Japan)

Naturally occurring organic matter (OM) is a heterogeneous mixture of molecules derived from the degradation of lignin, cellulose, lipids, proteins and other biological polymers. These molecules have different masses, charges, properties, and reactivities. Because OM is ubiquitous in aquatic and terrestrial waters and soils, it plays critical roles in the biogeochemical cycling of carbon, carbon storage, the physical and chemical properties of soil, soil microbial activity, soil structure, mineral weathering, nutrient availability to plants, and the fate and transport of anthropogenic compounds. Solid and adsorbed forms of

OM (“SOM”) strongly influence soil formation and structure, biological activity, mineral dissolution, metal-ion sequestration, redox reactions, and pH buffering, which are all related to soil health.

Weak bonds between molecular segments and between separate molecules of natural organic matter (OM) govern its solubility, adsorption, supramolecular association in solution, and complexation with metal ions and oxides. We are testing the hypothesis that especially strong hydrogen bonds, known as (negative) charge-assisted hydrogen bonds, (-)CAHB, contribute significantly to OM cohesion. The (-)CAHB is exemplified by structures such as  $(-\text{CO}_2\cdots\text{H}\cdots\text{O}_2\text{C}-)^-$  and  $(-\text{CO}_2\cdots\text{H}\cdots\text{O}-)^-$ . It may form between weak acids with similar proton affinity, and is shorter, more covalent, and much stronger than ordinary hydrogen bonds. Previous published work in the group has shown that disruption of such bonds can result in increased water solubility of SOM and increased sorption of acidic pollutants to carbonaceous solids that have acidic groups on their surfaces capable of undergoing (-)CAHB. Using a combination of methods, especially size exclusion chromatography, we have shown that addition at pH ~6 of small weak acid anions such as formate, disrupt intra-strand CAHB in dissolved Suwanee River Humic Acid (an OM reference standard) and cause their disaggregation into smaller molecules.

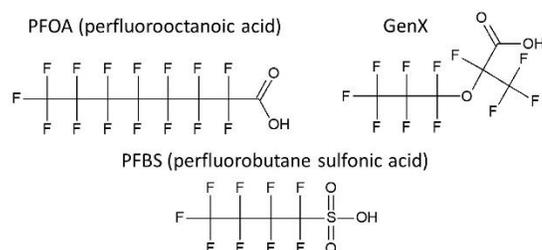
## D. Applied Environmental Analytical Chemistry

(Sara L. Nason)

The Applied Environmental Analytical Chemistry program is an interdepartmental effort between Environmental Sciences and Analytical Chemistry. We focus on developing and testing methods for analyzing environmental contaminants in samples and on applying our methods to field samples and studies that characterize pollution, assess human exposure to contaminants, and investigate contaminant remediation options. Our emphasis is on organic chemical contaminants and our primary analytical technique is liquid chromatography coupled with high resolution mass spectrometry (LC-HRMS) We currently have several projects that focus specifically on per- and polyfluoroalkyl substances (PFAS) and several others that focus more broadly on contaminants in wastewater related matrices.

### 1. Per- and Polyfluoroalkyl Substances

Per- and polyfluoroalkyl substances (PFAS) are a widespread, emerging class of highly toxic environmental contaminants. PFAS are a key ingredient in aqueous film forming foam (AFFF), used for fighting fires, and have been used in consumer products, such as waterproof and stainproof coatings, Teflon pans, and car waxes, since the 1940s. They are very persistent in the environment as their chemical structure is based on extremely strong the carbon-fluorine bonds. While PFAS are not currently regulated at the federal level, an increasing number of states (including Connecticut) are defining their own limits for PFAS in drinking water, groundwater, and other matrices. Good methods for measuring PFAS and for removing PFAS from the environment will be necessary as knowledge about and regulation of these chemicals increases. We participated in a PFAS Symposium at Yale University in December 2019 that provided an overview of current research on PFAS. A literature review based summary of the symposium was published in *Science of the Total Environment* (Hagstrom et al., 2021).



*Chemical structures of three common PFAS*

#### a) FluoroMatch: novel software for non-targeted analysis of PFAS in environmental samples.

(Sara Nason and collaborators from Yale, the University of Florida, and others)

Over 7,500 PFAS exist, but analytical standards are available for less than 2% of compounds, complicating their analysis. Therefore, approaches such as non-targeted analysis using liquid chromatography coupled with high resolution tandem mass spectrometry (LC-HRMS/MS) are necessary for complete sample characterization. Typically, data processing for this type of analysis is a slow and complicated process. We developed, released, and validated FluoroMatch: a new open source, vendor neutral software program for annotating PFAS in LC-HRMS/MS data. Our software is an important new resource for making this type of analysis more effective and accessible than previous approaches. The initial publication on FluoroMatch (Koelmel et al., 2020, *Analytical Chemistry*) introduces the software and a second (Nason et al., 2020, *Journal for the American Society of Mass Spectrometry*) provides a comparison of the new software to an established non-targeted analysis program. A third publication introduces a new version of FluoroMatch with increased functionality (Koelmel et al., 2021, *Analytical and Bioanalytical Chemistry*).

b) Phytoremediation of PFAS at the former Loring Air Force Base.

(Sara Nason, Nubia Zuverza-Mena, and collaborators)

The use of Aqueous Film-Forming Foams (AFFFs) has caused widespread contamination with PFAS in areas that have been used for fire-fighter training. Such is the case at the Burn House site of the former Loring Air Force Base in northern Maine, USA (pictured), where the land now belongs to the Aroostook band of the Micmac nation. PFAS have been dubbed “forever chemicals” as they are extremely persistent in the environment, and exposure to PFAS has been linked to cancer and other diseases.



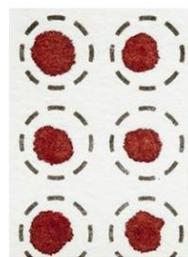
The Burn House at the former Loring Airforce Base.

A group of concerned citizens is attempting phytoremediation at the Burn House site in an attempt to reduce the contamination levels, and we are assisting them with assessing the effectiveness of their efforts. So far, we have determined that perfluorooctane sulfonic acid (PFOS) is the primary PFAS contaminant at the site and have detected a total of 68 PFAS in the soil. Soil samples from this site were used for testing FluoroMatch software (described above).

In summer of 2019, we conducted a pilot study testing the use of industrial hemp plants for PFAS phytoremediation and found that 4 out of 19 quantified PFAS decreased in soil over the course of the growth season, with an additional 5 PFAS showing some evidence of decrease in soil. We detected 8 PFAS in hemp tissue, including PFOS. Continued work in 2020 showed decreases in PFOS levels in two hemp growth plots. Hemp is a promising plant for phytoremediation due to its large size, fast growth rate, and high water usage. This work will be featured in a backstory article for the journal *iScience* (in press).

c) Measuring PFAS to assess human exposure.

(Sara Nason and collaborators from the Yale School of Public Health)



Dried blood spots.

While PFAS have been in use for decades, we have only recently become aware of their potential health impacts. Therefore, PFAS contamination is extremely widespread, but there are not yet standardized methods for measuring them in most sample matrices. We worked to develop methods (including sample preparation, instrumental analysis, and data processing) for measuring PFAS in dried blood spots and whole blood samples. As PFAS have only recently become a health concern, we do not have long-term records human exposure. However, long term blood spot archives exist, and could be an important resource for characterizing historic human exposures. Method development has been completed, and a methods-based manuscript is in preparation.

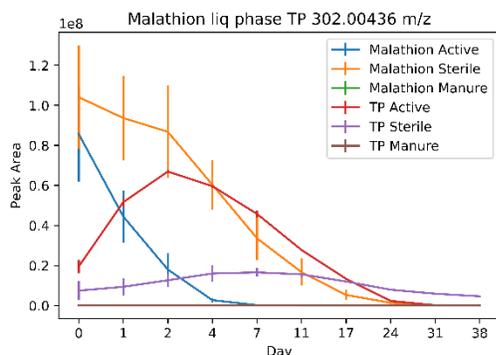
We are actively working with samples from multiple study cohorts for projects focused on links between PFAS levels and cancer and other diseases.

## 2. Organic Microcontaminants (OMCs) in wastewater and related matrices.

### a) Contaminant transformation during anaerobic digestion

(Sara Nason and collaborators at Johns Hopkins University)

Anaerobic digestion is a common strategy used to produce biogas from waste materials from both farms and wastewater treatment plants. While many organic microcontaminants (OMCs) are present in the sludge and manure used for digestion, we know little about the fate of these chemicals. Digestate is often land applied to agricultural fields, so contaminants and toxic transformation products not destroyed during digestion may reach soil, groundwater, or crop plants intended for human or animal consumption. We designed experiments to examine the transformation of contaminants during anaerobic digestion. Our work has focused on veterinary drugs and pesticides that are likely to be present in digestion in agricultural areas. We found that the pesticides malathion and carbaryl transform extensively during anaerobic digestion and have identified 24 transformation products for malathion and 15 for carbaryl. Continued work focuses on transformation of additional OMCs.



Graph showing degradation of malathion and the formation of a transformation product with a mass to charge ratio of 302.00436 in both active digestion samples and sterile controls.

### b) Assessing the impacts of reclaimed wastewater reuse for agricultural irrigation.

(Sara Nason, Nubia Zuverza-Mena, and collaborators from the University of Maryland Baltimore County)

Water scarcity is a problem throughout the modern world and is expected to increase as human population expands and climate change intensifies. Wastewater effluent reuse for agricultural irrigation is an important strategy to reduce demand from surface and ground water sources and is gaining momentum as obtaining freshwater from other sources becomes more difficult. While an important strategy for combating water scarcity, wastewater reuse for agriculture is not without risks. Wastewater effluent can contain higher levels of bacteria, heavy metals, salts, and other contaminants than conventional water sources. Specifically, there is increasing concern over organic microcontaminants (OMCs) such as pharmaceuticals, pesticides, and endocrine disrupting compounds that may be taken up into irrigated crop plants. We have begun to test non-targeted screening methods that will be a novel way to analyze wastewater used for irrigation and exposed food crops. A grant from USDA-NIFA was awarded for this project and began 5/1/21.

### c) Chemical trends in wastewater sludge during the COVID-19 pandemic.

(Sara Nason, Brian Eitzer, and collaborators at Yale)

Many organic microcontaminants (OMCs) are present in wastes that enter wastewater treatment plants. OMCs include chemicals from many different sources such as pharmaceuticals, personal care products, pesticides, and illicit substances. The use of many of these chemicals was affected by the COVID-19 pandemic. The Peccia Lab at Yale began collecting primary sludge samples from the New Haven Water Pollution Control Authority on March 19, 2020 – shortly before the stay-at-home order began in Connecticut. While the initial purpose of these samples was to analyze virus concentrations, we used the extra material to conduct analysis of OMCs and assess trends in their levels over the course of the pandemic and shutdown. Our work uses novel data collection techniques designed to identify and analyze as many OMCs as possible.



CAES researchers visit the New Haven Water Pollution Control Authority.

## II. MOSQUITO PROGRAM

### A. Mosquito Trapping and Testing Program

(Philip M. Armstrong, John Shepard, Tanya Petruff, Michael Misencik, Angela Bransfield)

Mosquito-borne viral diseases constitute an annual threat to human health in Connecticut. A comprehensive surveillance program complemented by science-based controls and timely public outreach are the most effective ways of protecting the public and reducing the risk of human disease. Experiment Station scientists and technicians monitor mosquitoes and eastern equine encephalitis (EEE) and West Nile virus (WNV) activity at 108 locations throughout Connecticut from June-October. The objectives of the surveillance program are to provide: 1) early evidence of local virus activity; 2) information on the abundance, distribution, identity and infection rates of potential mosquito vectors and; 3) information that is used to assess the threat of WNV and EEE to warn



the public and guide the implementation of disease prevention and control measures. The CAES is responsible for conducting all mosquito trapping and testing activities.



In 2020, statewide mosquito trapping was conducted from June 1 through October 15. Approximately one-third of the sites were located in densely populated residential locales along an urban/suburban corridor in the coastal southwestern corner of the state extending up through the Connecticut River Valley. Trap sites typically included parks, greenways, golf courses, undeveloped wood lots, sewage treatment plants, dumping stations, and temporary wetlands associated with waterways. Trapping locations in the other regions of the state were established in more sparsely populated rural settings that included permanent fresh-water swamps (red maple/white cedar) and bogs, coastal salt marshes, horse stables, and swamp-forest border environs.

Mosquito trapping was conducted with CO<sub>2</sub> (dry ice)-baited CDC miniature light traps equipped with aluminum domes, and gravid mosquito traps baited with a lactalbumin-yeast-hay infusion. Traps were placed in the field in the afternoon, operated overnight, and retrieved the following morning. Trapping frequency was minimally made once every ten days at each trap site over the course of the entire season. Adult mosquitoes were transported alive to the laboratory each morning in an ice chest lined with cool packs. Mosquitoes were immobilized with dry ice and transferred to chill tables where they were identified to species with the aid of a stereo microscope (90X) based on morphological characters. Female mosquitoes were pooled in groups of 50 or fewer by species, collection date, trap type, and collection site and stored at -80°C until processed for virus.

Aliquots of each mosquito pool were inoculated into Vero cell cultures for detection of West Nile virus (WNV), eastern equine encephalitis (EEE), and other mosquito-borne arboviruses of public health importance. Isolated viruses were identified by Real Time (TaqMan) reverse transcriptase polymerase chain reaction (RT-PCR) or standard RT-PCR using virus-specific primers. All of the virus isolation work was conducted in a certified Bio-Safety Level 3 laboratory at the CAES.

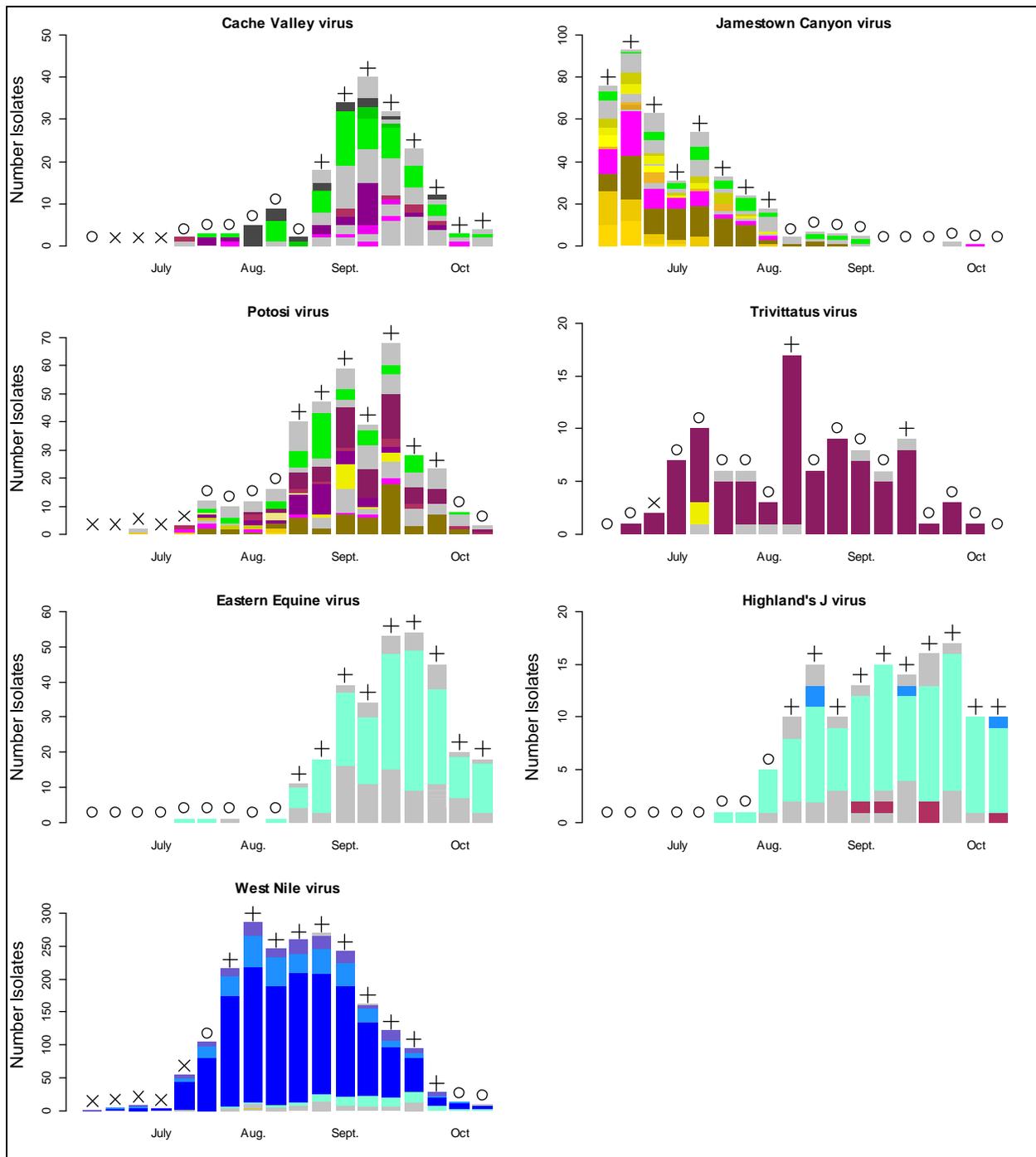


During 2020, a total of 193,191 mosquitoes representing 15,665 pools were trapped and tested for arboviruses. There were 143 isolations of West Nile virus made from 4 species: *Culex pipiens* = 125, *Cx. restuans* = 16, *Cx. salinarius* = 1, *Ochlerotatus japonicus* = 1, collected from 27 locations in 21 towns in three counties (Fairfield, Hartford, New Haven). The first WNV positive mosquitoes were collected on July 8, and last on October 1. The majority of WNV activity was detected in densely populated urban and suburban regions in Fairfield, Hartford, and New Haven counties. Eight human cases (6 = neuroinvasive, 2 = fever) of WNV-associated illness were reported, with dates of onset of symptoms from July 10, to October 1. Patients ranged from 24 to 76 years of age. All human cases were locally acquired, with no out-of-state travel reported.

Eastern Equine Encephalitis (EEE) virus was isolated from *Culiseta melanura* collected from 2 locations in 2 towns in two counties (New London, Windham) collected on August 5 and August 12. There were no EEE infections reported in humans or equines. Other mosquito-borne viruses isolated included: Cache Valley virus = 25 isolates from 8 species (July 13 - September 28), Jamestown Canyon virus = 13 isolates from 8 species (June 3 - September 23), and Potosi virus = 56 isolates from 7 species (July 13 - September 16).

**Impact:** Participation in the statewide surveillance program provides timely information about levels of virus activity in the mosquito population which is used to monitor virus amplification within enzootic transmission cycles, and assess risk of human infection. This information is used to inform the public and health care providers of these risks, guide disease prevention and mosquito control efforts, and prevent disease outbreaks. In addition, this large-scale sampling effort also informs our understanding of the ecology of mosquitoes and mosquito-borne viruses. Additional studies on the role of different mosquito species to serve as vectors of viral pathogens may be used to target anti-vector interventions more effectively.

## **B. Population Genetics of Mosquitoes and Epidemiology of Mosquito-borne Viral Diseases**

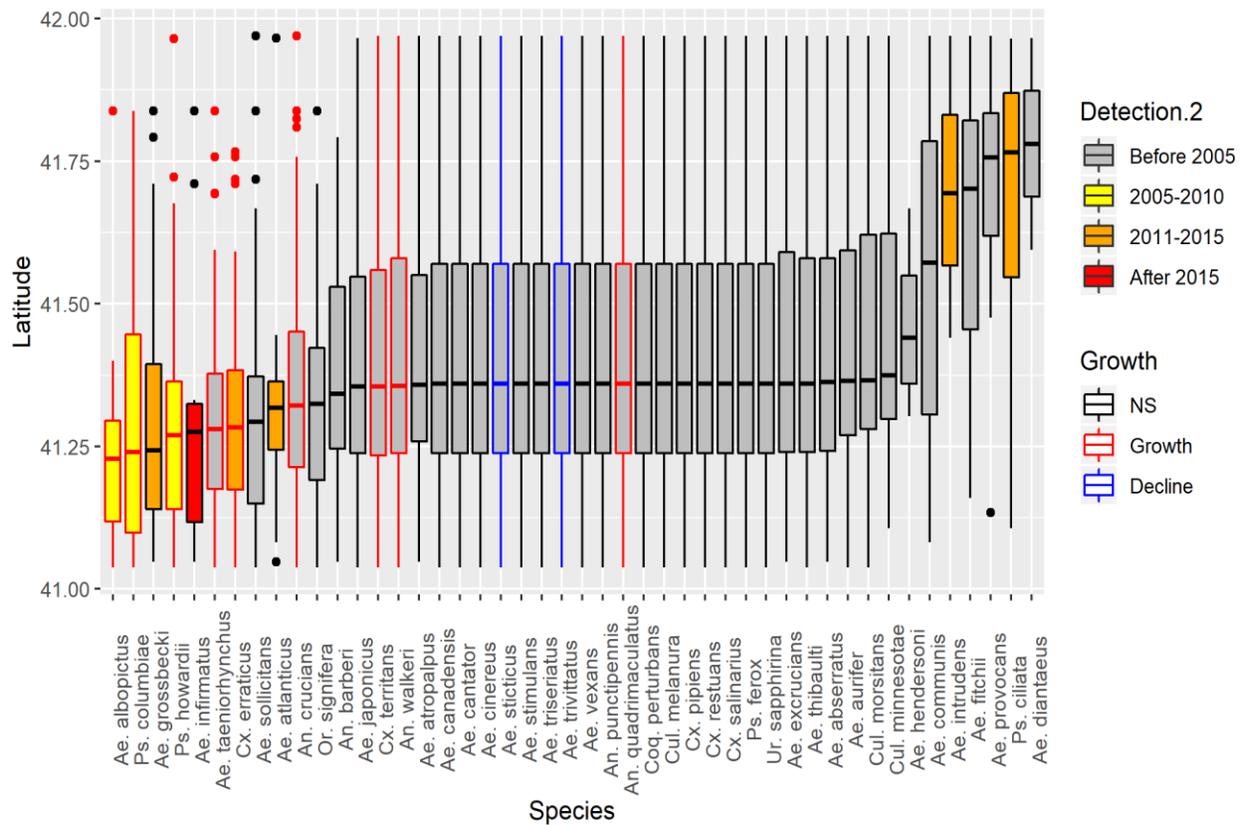


Epidemic curves for arboviruses by mosquito species. Only mosquito species with a significant positive association with the arbovirus are shown in color in each plot; all other species are represented in gray.

1. Increased Mosquito Abundance and Species Richness in Connecticut, United States 2001-2019.  
(Tanya Petruff, Joseph McMillan, John Shepard, Theodore Andreadis, and Philip Armstrong)

Historical declines in multiple insect taxa have been documented across the globe in relation to landscape-level changes in land use and climate. However, declines have either not been universally observed in all regions or examined for all species. Because mosquitoes are insects of public health importance, we

analyzed a longitudinal mosquito surveillance data set from Connecticut (CT), United States (U.S.) from 2001 to 2019 to identify changes in mosquito community composition over time. We first analyzed annual site-level collections and metrics of mosquito community composition with generalized linear/additive mixed effects models; we also examined annual species-level collections using the same tools. We then examined correlations between statewide collections and weather variables as well as site-level collections and land cover classifications. We found evidence that the average trap night collection of mosquitoes has increased by ~60% and statewide species richness has increased by ~10% since 2001. Total species richness was highest in the southern portion of Connecticut, likely due to the northward range expansion of multiple species within the *Aedes*, *Anopheles*, *Culex*, and *Psorophora* genera. How the expansion of mosquito populations in the northeast U.S. will alter mosquito-borne pathogen transmission in the region will require further investigation.



**Impact:** Mosquitoes are an important grouping of insect species that, due to their ability to vector pathogens among humans and between humans and wildlife, require constant surveillance. The resulting datasets produced from these efforts provide long-term data to test the generalizability of insect declines that have been observed in other taxa. We have shown that in the northeast region of the U.S., overall mosquito abundance has increased annually and there have been multiple introductions of native and invasive species into the region in the previous 20 years. These changes in mosquito community composition will likely impact the transmission mosquito-borne pathogen transmission in the future.

## 2. Local Persistence of Novel Regional Variants of La Crosse Virus in the Northeast United States. (Gillian Eastwood, John Shepard, Michael Misencik, Theodore Andreadis, and Philip Armstrong).

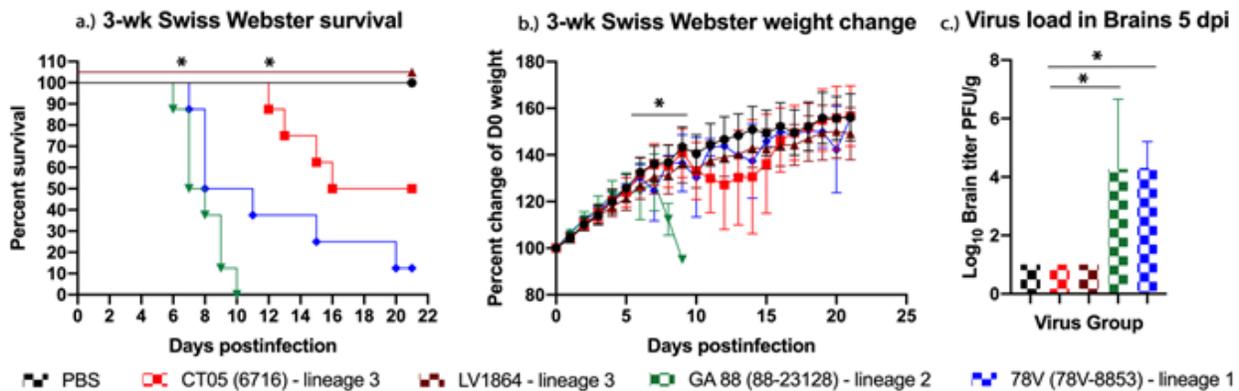


and may be involved in virus transmission in addition to the natural vector *Ae. triseriatus*. Greater awareness is needed to assess and highlight the potential health risk of LACV in the northeastern US.

### 3. La Crosse Virus Shows Strain-Specific Differences in Pathogenesis.

(Philip Armstrong and Theodore Andreadis in collaboration with Sarah Wilson, Krisangel López, Sheryl Coutermash-Ott, Dawn Auguste, Danielle Porier, Gillian Eastwood, Albert Auguste).

La Crosse virus (LACV) is the leading cause of pediatric viral encephalitis in North America, and is an important public health pathogen. Historically, studies involving LACV pathogenesis have focused on lineage I strains, but no former work has explored the pathogenesis between or within lineages. Given the absence of LACV disease in endemic regions where a robust entomological risk exists, we hypothesize that some LACV strains are attenuated and demonstrate reduced neuroinvasiveness. Herein, we compared four viral strains representing all three lineages to determine differences in neurovirulence or neuroinvasiveness using three murine models. A representative strain from lineage I was shown to be the most lethal, causing >50% mortality in each of the three mouse studies. However, other strains only presented excessive mortality (>50%) within the suckling mouse neurovirulence model. Neurovirulence was comparable among strains, but viruses differed in their neuroinvasive capacities. Our studies also showed that viruses within lineage III vary in pathogenesis with contemporaneous strains, showing reduced neuroinvasiveness compared to an ancestral strain from the same U.S. state (i.e., Connecticut). These findings demonstrate that LACV strains differ markedly in pathogenesis, and that strain selection is important for assessing vaccine and therapeutic efficacies.



**Figure.** Lineage III LACV strains shows reduced pathogenesis in 3-week-old Swiss Webster mice when compared to other lineages.

**Impact:** A complete understanding of viral pathogenesis, disease burden, and risk of emergence is essential for resource allocation efforts for targeted surveillance, vector control, or development of countermeasures such as vaccines or antivirals. LACV is an important arbovirus in North America and a leading cause of viral-induced pediatric encephalitis. To evaluate the potential public health significance and the risk and potential burden of disease after infection with a novel lineage of LACV, we explored the virulence among all three LACV lineages circulating within the United States, as well as pathogenic differences within the historically understudied lineage III clade using three previously established murine models. Our results provide evidence that lineage III strains are more attenuated than lineage I or II strains in mice, and that this is likely a result of reduced neuroinvasiveness, intrinsic to lineage III viruses.

### 4. Host interactions of *Aedes albopictus*, an Invasive Vector of Arboviruses, in Virginia, USA.

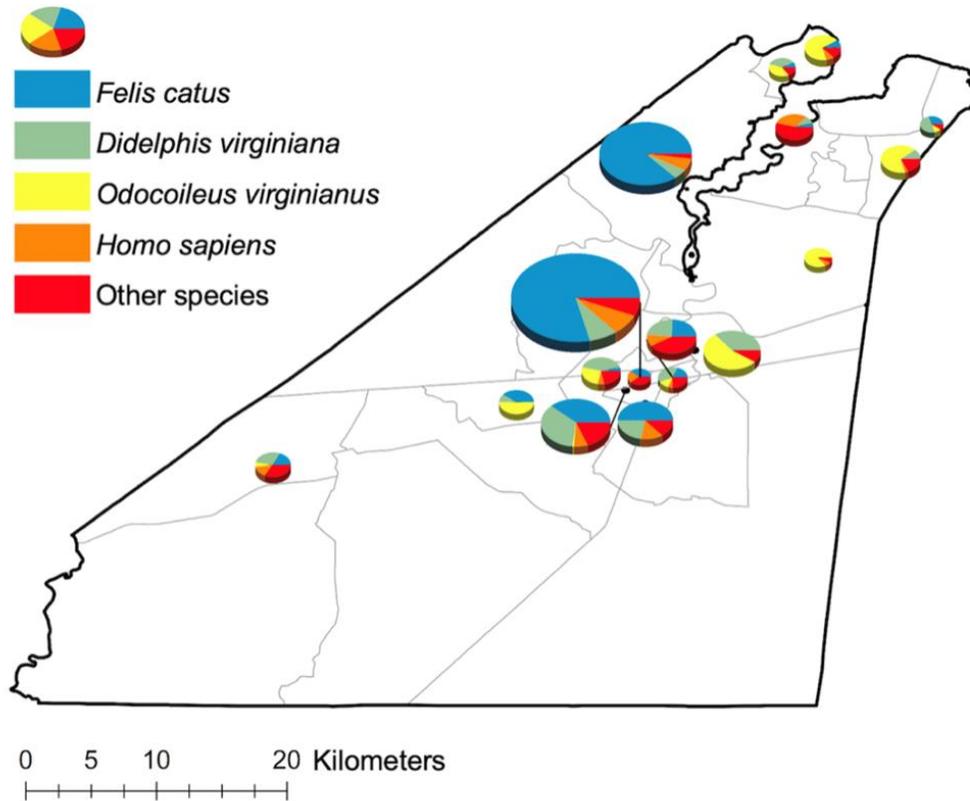
(Eliza A. H. Little, Olivia T. Harriott, Karen I. Akaratovic, Jay P. Kiser, Charles F. Abadam, John J. Shepard, and Goudarz Molaei)



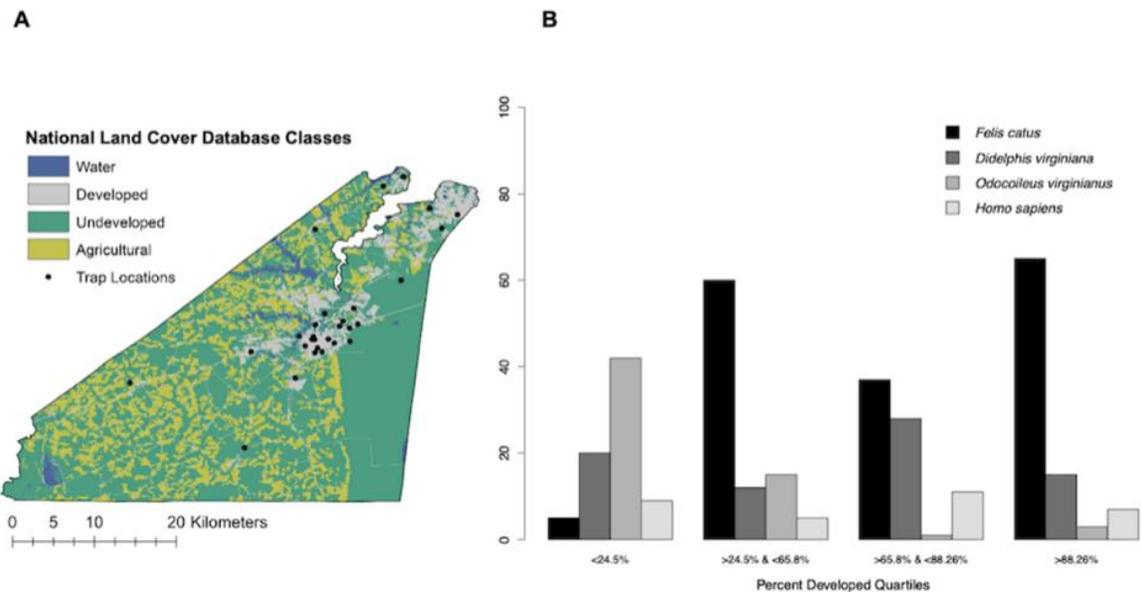
As an invasive mosquito species in the United States, *Aedes albopictus* is a potential vector of arboviruses including dengue, chikungunya, and Zika, and may also be involved in occasional transmission of other arboviruses such as West Nile, Saint Louis encephalitis, eastern equine encephalitis, and La Crosse viruses. *Aedes albopictus* feeds on a wide variety of vertebrate hosts, wild and domestic, as well as humans. In order to investigate blood feeding patterns of *Ae. albopictus*, engorged specimens were collected from a variety of habitat types using the Centers for Disease Control and Prevention light traps, Biogents Sentinel 2 traps, and modified Reiter gravid traps in southeast Virginia. Sources of blood meals were determined by the analysis of mitochondrial *cytochrome b* gene sequences amplified in PCR assays. Our aims were to quantify degrees of *Ae. albopictus* interactions with vertebrate hosts as sources of blood meals, investigate arboviral infection status, assess the influence of key socioecological conditions on spatial variability in blood feeding, and investigate temporal differences in blood feeding by season. Analysis of 961 engorged specimens of *Ae. albopictus* sampled between 2017–2019 indicated that 96%, 4%, and less than 1% obtained blood meals from mammalian, reptilian, and avian hosts, respectively. Domestic cats were the most frequently identified (50.5%) hosts followed by Virginia opossums (17.1%), white-tailed deer (12.2%), and humans (7.3%), together representing 87.1% of all identified blood hosts. We found spatial patterns in blood feeding linked to socioecological conditions and seasonal shifts in *Ae. albopictus* blood feeding with implications for understanding human biting and disease risk. In Suffolk Virginia in areas of lower human development, the likelihood of human blood feeding increased as median household income increased and human blood feeding was more likely early in the season (May-June) compared to later (July-October). Screening of the head and thorax of engorged *Ae. albopictus* mosquitoes by cell culture and RT-PCR resulted in a single isolate of Potosi virus.

Number and percentage of *Ae. albopictus* blood meals collected in Suffolk, Virginia, 2017-2019.

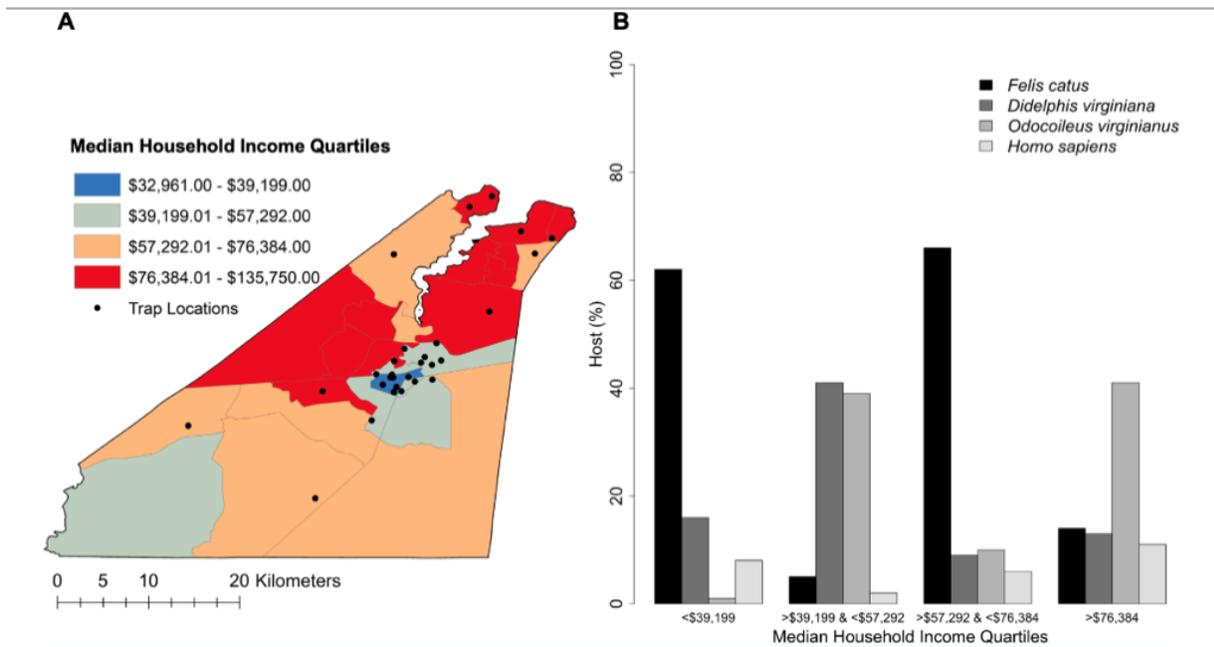
<b>Vertebrate Host</b> Common Name (Species Name)	<b>Frequency of Blood Meal</b> No. (%)
Domestic cat ( <i>Felis catus</i> )	485 (50.47 %)
Virginia opossum ( <i>Didelphis virginiana</i> )	164 (17.07%)
White-tailed deer ( <i>Odocoileus virginianus</i> )	117 (12.17%)
Human ( <i>Homo sapiens</i> )	70 (7.28%)
Common box turtle ( <i>Terrapene carolina</i> )	34 (3.54%)
Black rat ( <i>Rattus rattus</i> )	28 (2.91%)
Dog ( <i>Canis lupus familiaris</i> )	22 (2.29%)
Eastern gray squirrel ( <i>Sciurus carolinensis</i> )	19 (1.98%)
Eastern cottontail rabbit ( <i>Sylvilagus floridanus</i> )	12 (1.25%)
Raccoon ( <i>Procyon lotor</i> )	2 (0.21%)
Gray fox ( <i>Urocyon cinereoargenteus</i> )	2 (0.21%)
Eastern box turtle ( <i>Terrapene carolina carolina</i> )	2 (0.21%)
Common musk turtle ( <i>Sternotherus odoratus</i> )	1 (0.10%)
American robin ( <i>Turdus migratorius</i> )	1 (0.10%)
Common grackle & white-tailed deer ( <i>Quiscalus quiscula</i> & <i>Odocoileus virginianus</i> )	1 (0.10%)
American robin & Virginia opossum ( <i>Turdus migratorius</i> & <i>Didelphis virginiana</i> )	1 (0.10%)
Total	961



**Spatial distribution of *Ae. albopictus* blood meals.** The proportion of blood meals from domestic cats (*Felis catus*), Virginia opossums (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), and humans (*Homo sapiens*) across Suffolk.



**Human Development in Suffolk.** (A) National Land Cover Database classification for open water, developed, undeveloped, and agricultural land in Suffolk. (B) The proportion of blood meals from domestic cats (*Felis catus*), Virginia opossums (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), and humans (*Homo sapiens*) across quartiles of human development.



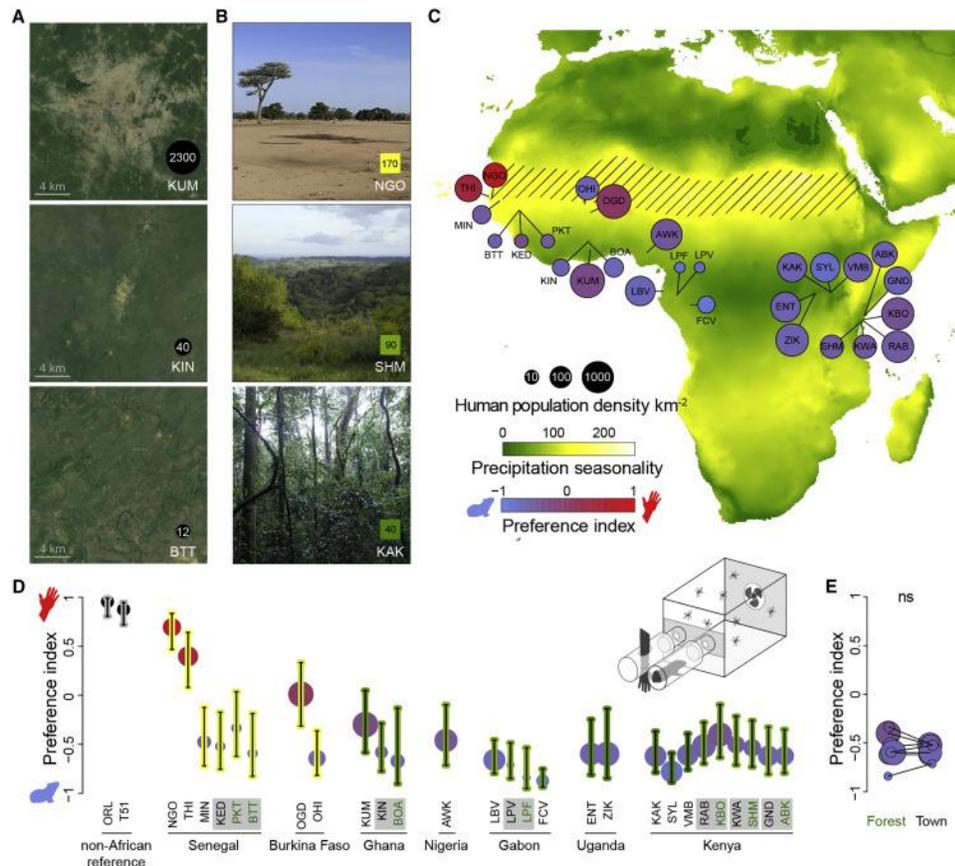
**Median Household Income in Suffolk.** (A) Median household income classified by quartile in Suffolk. (B) The proportion of blood meals from domestic cat (*Felis catus*), Virginia opossum (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), and human (*Homo sapiens*) across quartiles of median household income.

**Impact:** Understanding mosquito-host interactions in nature is vital for evaluating vectorial capacity of mosquitoes. These interactions with competent reservoir hosts support transmission, maintenance, and amplification of zoonotic agents of human diseases. Results of our study in conjunction with abundance in urban/suburban settings, virus isolation from field-collected mosquitoes, and vector competence of *Ae. albopictus*, highlight the potential involvement of this species in the transmission of a number of arboviruses such as dengue, chikungunya, and Zika to humans. Limited interaction with avian hosts suggests that *Ae. albopictus* is unlikely to serve as a bridge vector of arboviruses such as West Nile and eastern equine encephalitis in the study region, but that possibility cannot be entirely ruled out.

##### 5. Climate and Urbanization Drive Mosquito Preference for Humans.

(Andrea Gloria-Soria collaboration with researchers at Princeton and Yale Universities)

Most mosquito-borne illnesses are spread by a few mosquito species that have evolved to specialize in biting humans, yet the precise causes of this behavioral shift are poorly understood. We address this gap in the arboviral vector *Aedes aegypti*. We first collect and characterize the behavior of mosquitoes from 27 sites scattered across the species' ancestral range in sub-Saharan Africa, revealing previously unrecognized variation in preference for human versus animal odor. We then use modeling to show that over 80% of this variation can be predicted by two ecological factors – dry season intensity and human population density. Finally, we integrate this information with whole genome sequence data from 375 individual mosquitoes to identify a single underlying ancestry component linked to human preference, with genetic changes concentrated in a few chromosomal regions. Our findings suggest that human-biting in this important disease vector originally evolved as a by-product of breeding in human-stored water in areas where doing so provided the only means to survive the long, hot dry season. Our model also predicts that the rapid urbanization currently taking place in Africa will drive further mosquito evolution, causing a shift towards human-biting in many large cities by 2050.



**Figure:** Preference for human odor varies widely in *Aedes aegypti* mosquitoes across Africa. (A and B) Satellite images or photographs of mosquito collection localities with different human population densities (A) or levels of precipitation seasonality (B). Satellite images are from Google Earth, copyright Maxar Technologies and CNES/Airbus.(C) Map of collection localities. Diagonal hatched lines mark the Sahel ecoclimatic zone. (D) Host preference measured in a two-port olfactometer (inset) for all African localities plus a reference colony from Thailand (T51) and a lab colony most likely to have originated in the United States (ORL) (n = 3-14 trials with 25-110 females per trial). Bars indicate 95% confidence intervals. Circle sizes and bar colors show population density and precipitation seasonality, respectively, as in (C). Gray boxes around location names highlight adjacent forest-town pairs (forest in green text).(E) Females from adjacent forest and town habitats did not differ in preference (linear model  $p > 0.05$ ; ns, not significant).

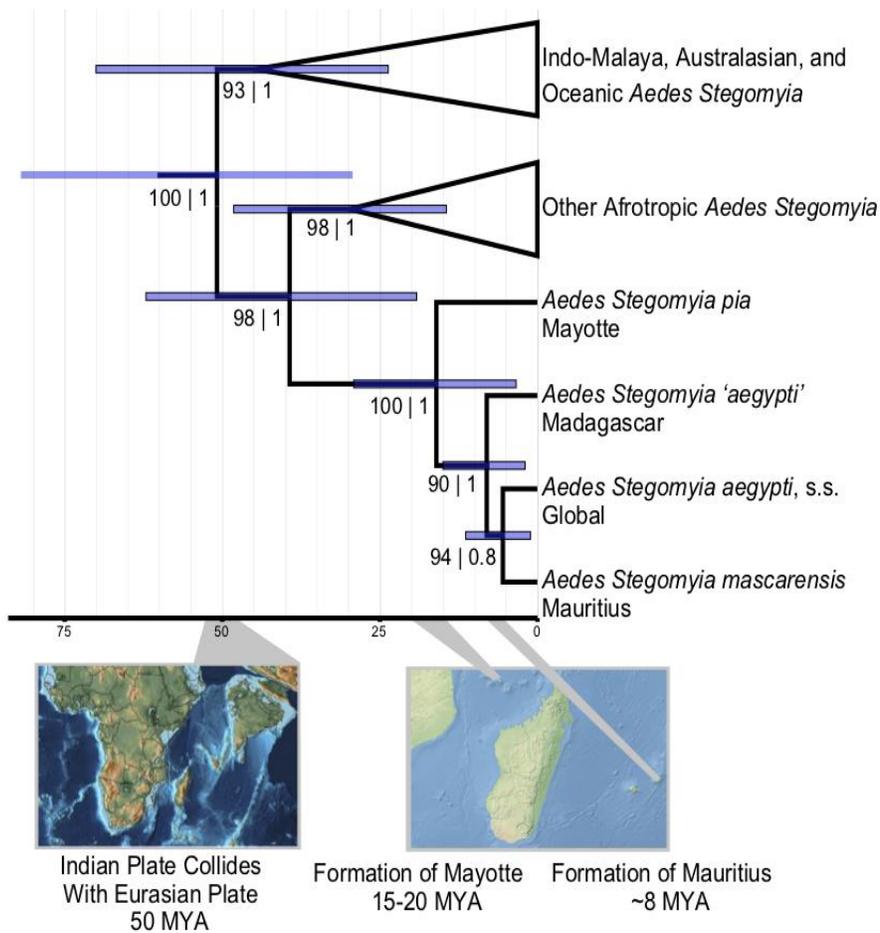
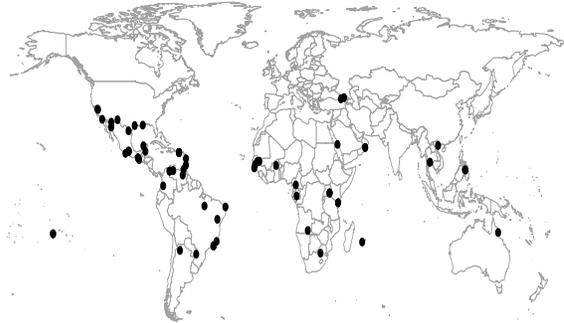
**Impact:** These results highlight how changes in climate patterns may lead to the evolution of traits that could favor disease transmission, in this case, the evolution of preference to feed on humans as the insect vector became adapted to breed in man-made containers to survive the dry season.

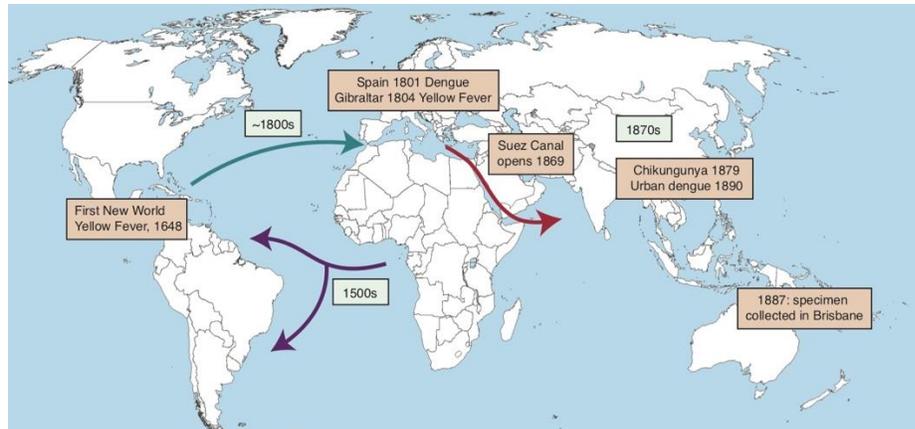
### 7. Identification of *Aedes aegypti* close relatives in the South Western Indian Ocean.

(Andrea Gloria-Soria in collaboration with Jeffrey R. Powell (Yale), John Soghigian (NC State), Vincent Robert and Gilbert LeGoff (IRD-FR), and Anna-Bella Failloux (Pasteur Institute, FR)

*Aedes aegypti* is among the best studied mosquitoes due to its critical role as vector of human pathogens and ease of laboratory rearing. Until now, this species was thought to have originated in continental Africa, and subsequently colonized much of the world following the establishment of global trade routes. However, populations of this mosquito on the islands in the southwestern Indian Ocean where the species occurs in

close proximity to its nearest relatives, referred to as the Aegypti Group, have received little study. We re-evaluated the evolutionary history of *Aedes aegypti* and its nearest relatives, using three datasets: nucleotide sequence data, 18489 SNPs, and 12 microsatellites. We found that: (1) The Aegypti Group diverged more than 16 MYA from its nearest African/Asian ancestor. (2) Southwestern Indian Ocean populations of *Ae. aegypti* are basal to continental African populations. (3) After diverging 6 MYA from its nearest formally described relative (*Ae. mascarensis*), *Ae. aegypti* moved to continental Africa less than 85,000 years ago, where it very recently (<1,000 years ago) split into two recognized subspecies *Ae. aegypti formosus* and a human commensal, *Ae. aegypti aegypti*. (4) The Madagascar samples form a clade more distant from all other *Ae. aegypti* than the named species *Ae. mascarensis*, implying that Madagascar may harbor a new cryptic species. (5) There is evidence of introgression between *Ae. mascarensis* and *Ae. aegypti* on Reunion, and between the two subspecies elsewhere in the southwestern Indian Ocean, a likely consequence of recent introductions of domestic *Ae. aegypti aegypti* from Asia. This work is currently under consideration for publication in *Molecular Ecology*.





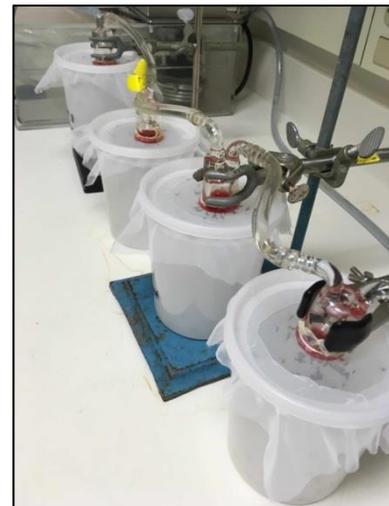
**Impact:** *Ae. aegypti* is among the best studied mosquitoes, yet from an evolutionary standpoint, there is still much to be learned. The arbovirus competence of members from the Aegypti group remains unknown. Our work aims to reveal a more complete picture of the evolutionary history of the Aegypti group to better understand how *Aedes aegypti* came to be such a good vector of arboviral diseases worldwide. This information will subsequently aid the development of tools to ultimately reduce disease burden.

## C. Virus-Vector Interactions

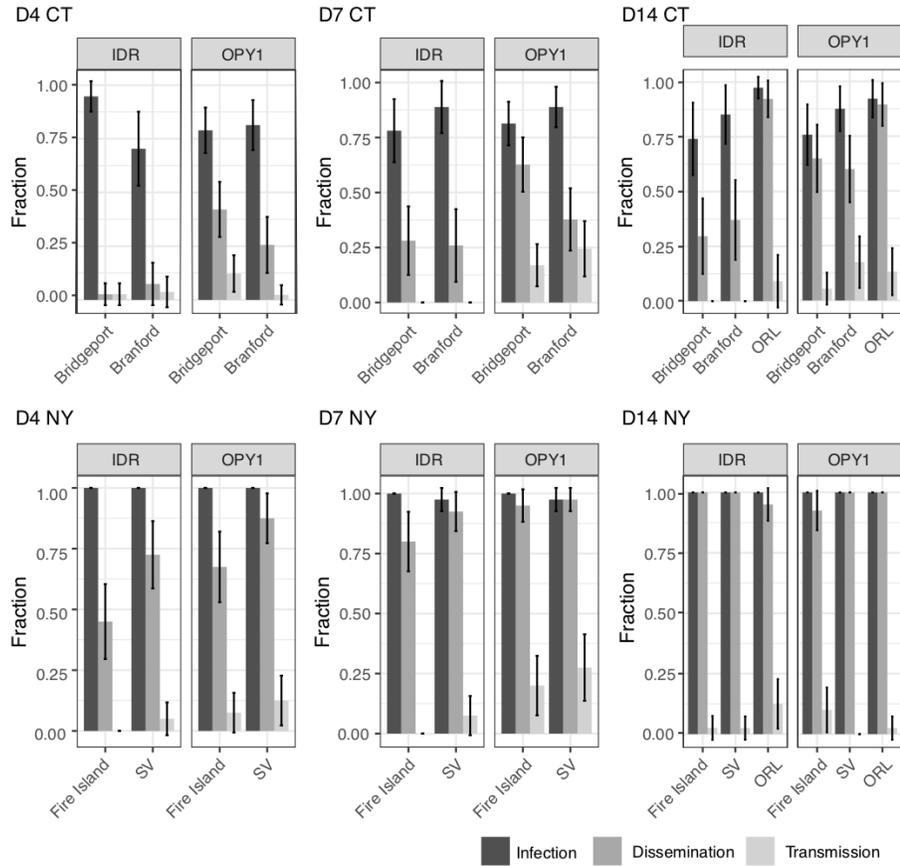
### 1. Vector Competence of *Ae. albopictus* from the Northeastern US for Chikungunya, Dengue, and Zika Viruses.

(Andrea Gloria-Soria, Philip Armstrong, Doug Brackney, Angela Bransfield in collaboration with Alex Ciota, Sean Bialosuknia, Anne Payne, and Laura Kramer).

The Asian tiger mosquito (*Aedes albopictus*) is an invasive mosquito species that has spread to over 50 countries during the last 40 years including the U.S. The first U.S. population was discovered in Houston, TX in 1985 and it has since expanded its range in the eastern U.S. with established populations as far north as NY, CT, and MA. *Aedes albopictus* has been shown to be a competent vector of 23 arboviruses in the laboratory and serves as a secondary vector of chikungunya, dengue, and Zika viruses in the tropics. Previous studies indicate that vector competence is population- and virus-dependent but there are no comprehensive vector competence studies with local *Ae. albopictus* populations from the northeastern U.S. using isolates of invasive arboviruses. Accordingly, we compared vector competence of northern *Ae. albopictus* populations for low-passage strains of chikungunya, dengue, and Zika viruses. We find that local *Ae. albopictus* populations are susceptible to all three viruses and capable of transmission. Variation in competence was observed for CHIKV and ZIKA, driven by the virus strains and mosquito population, while competence was homogeneous for DENV-2. These results suggest that under optimal circumstances, *Ae. albopictus* could start an epidemic and emphasize the importance of maintaining an extensive mosquito surveillance and vector control program to prevent *Ae. albopictus* from establishing and expanding its geographic range.

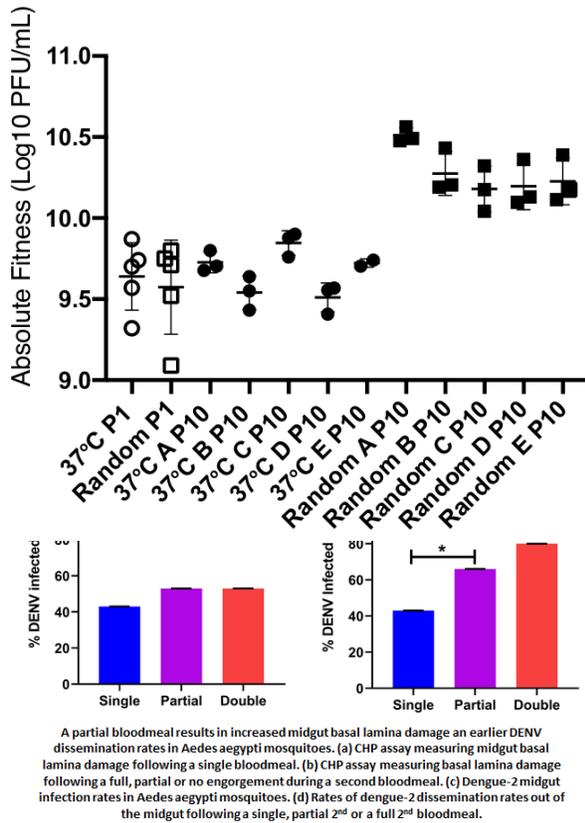


**Figure:** Chikungunya virus (CHIKV) infection, dissemination, and transmission rates of *Aedes albopictus* populations from Connecticut (CT: Bridgeport and Branford) and New York (NY: Fire Island and Spring Valley) at days 4, 7, and 14 pi. Percentages shown are based on the total number of mosquitoes tested. The virus strain used for the challenge is indicated in the top of each panel (IDR: IDR140025461, OPY1: LR2006OPY1). Error bars represent 95% CI. *Ae. aegypti* (ORL) control is shown.



**Impact:** The recent arrival and establishment of *Ae. albopictus* in Northeastern United States pose a risk

for local transmission of arboviruses that cause human disease, particularly in the absence of native herd immunity to the pathogens under consideration in this study. Zika virus, DENV-2, and CHIKV are not endemic to the region; nevertheless, imported human cases are reported annually, and our work suggests that under optimal circumstances, *Ae. albopictus* can support localized virus transmission. These results emphasize the importance of maintaining robust mosquito surveillance programs that target *Ae. albopictus* and the development of vector control programs to reduce population densities and limit further range expansion of this species.



### 3. The impact of partial blood meals on midgut damage and viral dissemination (Doug Brackney, Philip Armstrong, Rebecca Johnson, Duncan Cozens, and Zannatul Ferdous)

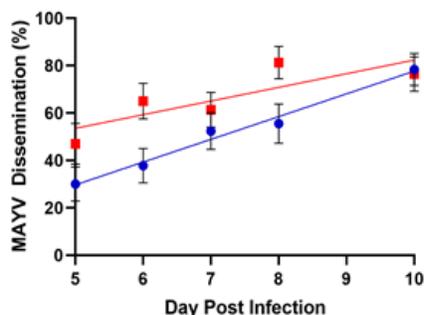
Studies of vector competence rarely consider the impacts that successive blood meals have on arboviral transmission by mosquitoes. *Aedes aegypti* mosquitoes readily feed more than once and often take partial blood meals. The impact this behavior has on viral transmission needs to be better understood and incorporated into models of mosquito-borne disease epidemics. Previously it was shown that *Ae. aegypti* infected with dengue virus (DENV) via a primary blood meal had earlier viral dissemination when given a second non-infectious blood meal three days later. Evidence suggests that gut distention during blood feeding leads to damage of the midgut basal lamina and faster viral escape. While mosquitoes are usually allowed to feed to repletion in the laboratory, mosquitoes in the wild are often interrupted and only acquire partial blood meals. Therefore, we examined the effects that partial blood feeding has on midgut basal lamina damage

and DENV dissemination. To assess midgut basal lamina integrity, we performed a collagen hybridizing assay on cohorts of *Ae. aegypti* given either a full, partial or no blood meal. *Ae. aegypti* provided a partial blood meal had an intermediate degree of damage compared to fully engorged or naive cohorts. We also assessed if midgut basal lamina damage accumulated across multiple blood meal and whether the size of a second additional blood meal impacted damage. Mosquitoes given a partial second blood meal three days after an initial full feed had less midgut damage than mosquitoes given a full second blood meal, but significantly more damage than the cohorts provided no additional blood meals. Thus, midgut damage appears proportional to distention and feeding volume and is not cumulative across multiple feedings. Consistent with this, we observed that individuals provided a partial second blood meal had an intermediate early dissemination phenotype for DENV. This indicates that damage from a partial feed is sufficient to cause accelerated dissemination, further demonstrating the significance of sequential blood meals on arbovirus epidemiology. This work has strong implications for our understanding of disease transmission in the field and this data will be useful in creating more accurate models to predict viral spread and maintenance.

### 2. Multiple blood meals enhance early dissemination of arboviruses in three medically relevant mosquito genera.

(Doug Brackney, Phil Armstrong, Zannatul Ferdous, Rebecca Johnson, and NYS Wadsworth collaborators)

(●) double feed (●) single feed



Rates of Mayaro virus dissemination from the *Aedes aegypti* midgut following either a single bloodmeal or a double blood meal.

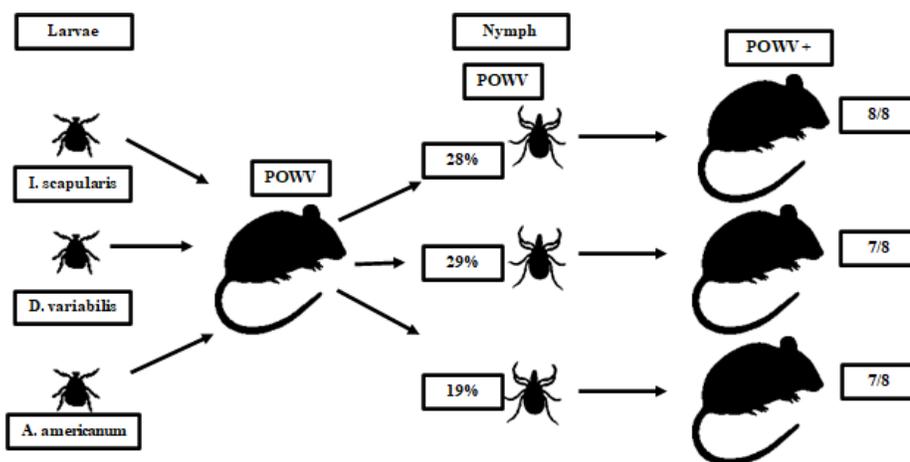
Numerous anautogenous mosquito vectors have the propensity to acquire multiple blood meals within a single gonotrophic cycle; however, incorporation of this feeding phenotype into laboratory vector competence studies is rarely done. We have previously shown that this frequent feeding behavior can enhance the early dissemination of Zika virus, dengue virus, and chikungunya virus in *Aedes aegypti* and *Aedes albopictus* mosquitoes, yet it is unknown if arboviruses show a similar trend in non-*Aedes* species mosquitoes under a sequential feeding regimen. To test this, we evaluated the impact of a second non-infectious meal on the vector competence of *Ae. aegypti*, *Anopheles quadrimaculatus*, and *Culex quinquefasciatus* for Mayaro virus (MAYV) and *Cx. quinquefasciatus* for West Nile virus (WNV). Mosquitoes were offered an infectious MAYV or WNV bloodmeal and three days later the double-feed group (DSG)

was offered a second non-infectious bloodmeal. Midgut infection and dissemination rates were determined by RT-qPCR between 5-10 days post infection. For MAYV, midgut infection rates were comparable between the single-feed group (SFG) and DFG for all three species; however, infection rates were extremely low in *Cx. quinquefasciatus* and, therefore, the double-feed phenotype is being evaluated in this species using WNV. Consistent with other viruses, MAYV dissemination rates were significantly higher in the *Ae. aegypti* DFG compared to the SFG at earlier timepoints. Similarly, the *An. quadrimaculatus* DFG displayed higher rates of dissemination compared to the SFG at earlier timepoints. Our results suggest that frequent blood-feeding improves MAYV dissemination in *Ae. aegypti* and *An. quadrimaculatus* and may allow for higher levels of viral transmission than previously expected. Further, these findings suggest that the shortened extrinsic incubation period of arboviruses associated with sequential blood feeding is generalizable across some, if not most, virus-vector pairings.

### 3. Vector competence of human-biting ticks *Ixodes scapularis*, *Amblyomma americanum* and *Dermacentor variabilis* for Powassan virus.

(Doug Brackney, Phil Armstrong, Rohit Sharma, Duncan Cozens)

Powassan virus (POWV; *Flavivirus*) is the sole North American member of the tick-borne encephalitis serocomplex and an increasing public health threat in the United States. Maintained in nature by *Ixodes* spp. ticks, POWV has also been isolated from species of other hard tick genera, yet it is unclear if



these species can serve as vectors. *Dermacentor variabilis* and *Amblyomma americanum* share geographic and ecologic overlap with *Ixodes* spp. ticks and POWV transmission foci raising the possibility that POWV could become established in these tick species leading to range expansion and increased human risk.

Therefore, we assessed the competency of *I. scapularis*, *D. variabilis* and *A. americanum* for POWV lineage II and found that all three species were equally efficient at acquiring the virus and then transmitting it to mice in the subsequent life stage. These findings highlight the potential role of non-*Ixodes* species in the ecology and epidemiology of POWV.

### III. TICK MANAGEMENT AND EPIDEMIOLOGY OF TICK-BORNE DISEASES

#### A. Tick Management

##### 1. Evaluating the Effectiveness of an Integrated Tick Management Approach on Multiple Pathogen Infection in *Ixodes scapularis* Questing Nymphs and Larvae Parasitizing White-footed Mice. (Eliza Little, Scott Williams, Kirby C. Stafford III, Megan Linske, and Goudarz Molaei)

We investigated the effectiveness of integrated tick management (ITM) approaches in reducing the burden of infection with *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum* in *Ixodes scapularis*. We found a 52% reduction in encountering a questing nymph in the *Metarhizium anisopliae* (Met52) and fipronil rodent bait box treatment combination as well as a 51% reduction in the combined white-tailed deer (*Odocoileus virginianus*) removal, Met52, and fipronil rodent bait box treatment compared to the control treatment. The Met52 and fipronil rodent bait box treatment combination reduced the encounter potential with a questing nymph infected with any pathogen by 53%. Compared to the control treatment, the odds of collecting a parasitizing *I. scapularis* infected with any pathogen from a white-footed mouse (*Peromyscus leucopus*) was reduced by 90% in the combined deer removal, Met52, and fipronil rodent bait box treatment and by 93% in the Met52 and fipronil rodent bait box treatment combination. Our study highlights the utility of these ITM measures in reducing both the abundance of juvenile *I. scapularis* and infection with the aforementioned pathogens.

	Control	Deer	Deer Met52 BaitBox	Met52 BaitBox
Unique properties	12	8	5	13
Property visits	241	165	93	239
Area sampled (m <sup>2</sup> )	21,721	15,451	9,517	24,240
Questing nymphs retained	80	55	20	51
Nymphs per 1000 m <sup>2</sup>	3.68	3.56	2.10	2.10
Infected (%)	32 (40%)	26 (47%)	7 (35%)	18 (35%)
Density of infected nymphs (1000 m <sup>2</sup> )	1.47	1.67	0.74	0.74
<i>Borrelia burgdorferi</i> *	24	15	3	12
<i>Babesia microti</i>	9	13	5	8
<i>Anaplasma phagocytophilum</i>	5	1	1	2
<i>B. burgdorferi</i> and <i>B. microti</i>	3	3	2	3
<i>B. burgdorferi</i> and <i>A. phagocytophilum</i>	2	0	0	1
<i>A. phagocytophilum</i> and <i>B. microti</i>	1	0	0	0

By treatment category, the total number of properties, visits, area sampled, questing *Ixodes scapularis* nymphs collected, density of questing nymphs, total infected overall, density of infected nymphs, total infected with *Borrelia burgdorferi*, *Babesia microti*, *Anaplasma phagocytophilum*, and co-infections.

**Impact:** The preponderance of *I. scapularis* and associated diseases, most importantly Lyme disease, babesiosis, and anaplasmosis, and predicted changes in the abundance and diversity of tick species and tick-borne pathogens as results of a warming climate and other environmental changes highlights the importance of utilizing and incorporating a variety of compatible and innovative tools for tick control that could be adjusted under different circumstances. The rather limited number of questing *I. scapularis* nymphs infected/coinfected with *B. microti* and/or *A. phagocytophilum* in our study precludes us from making a conclusion on the effects of treatments on these pathogens. Nonetheless, our study shows the effectiveness of an integrated intervention in controlling nymphal *I. scapularis* and reducing the encounter potential with a questing nymph infected with pathogens.

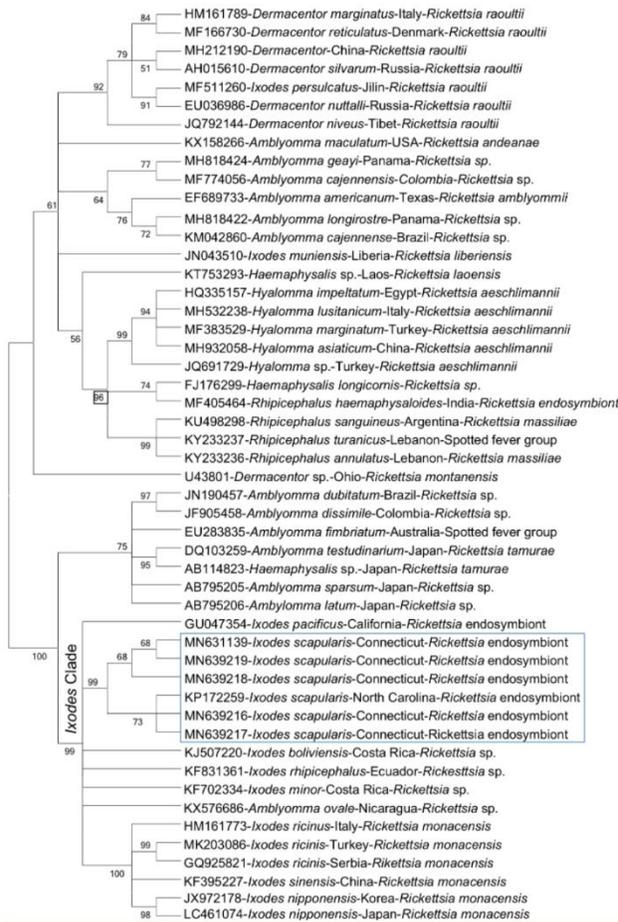
## B. Epidemiology of Tick-Borne Diseases

### 1. Prevalence of Infection and Co-infection and Presence of Rickettsial Endosymbionts In *Ixodes scapularis* (Acari: Ixodidae) in Connecticut, USA.

(Darya Pokutnaya, Goudarz Molaei, Daniel M. Weinberger, Charles R. Vossbrinck, and Alexander J. Diaz)

*Ixodes scapularis* is currently known to transmit seven pathogens responsible for Lyme disease, anaplasmosis, babesiosis, tick-borne relapsing fever, ehrlichiosis, and Powassan encephalitis. *Ixodes*

*scapularis* can also be colonized by endosymbiotic bacteria including those in the genus of Rickettsia. We screened 459 *I. scapularis* ticks submitted to the Connecticut Agricultural Experiment Station Tick Testing Laboratory with the objectives to (1) examine differences in infection prevalence of *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, *Babesia microti*, and *Borrelia miyamotoi*, (2) evaluate whether prevalence of co-infections occur at the same frequency that would be expected based on single infection, and (3) determine the presence of rickettsial endosymbionts in *I. scapularis*. The prevalence of infection in *I. scapularis* was highest with *Bo. burgdorferi* sensu lato (nymph 1/4 45.8%; female 1/4 47.0%), followed by *A. phagocytophilum* (nymph 1/4 4.0%; female 1/4 6.9%), *Ba. microti* (nymph 1/4 5.7%; female 1/4 4.7%), and *Bo. miyamotoi* (nymph 1/4 0%; female 1/4 7.3%). We also identified rickettsial endosymbionts in 93.3% of *I. scapularis*. Nymphs were significantly more likely to be infected with *Bo. burgdorferi* if they were infected with *Ba. microti*, whereas adult females were significantly more likely to be infected with *Bo. burgdorferi* if they were infected with *A. phagocytophilum*. Our study suggests that the infection prevalence of *Bo. burgdorferi* is not independent of other co-circulating pathogens and that there is a substantially higher infection of *Bo. miyamotoi* in *I. scapularis* females compared with nymphs in this study. High prevalence of infection and co-infection with multiple pathogens in *I. scapularis* highlights the public health consequences in Connecticut, a state endemic for Lyme and other tick-borne diseases.

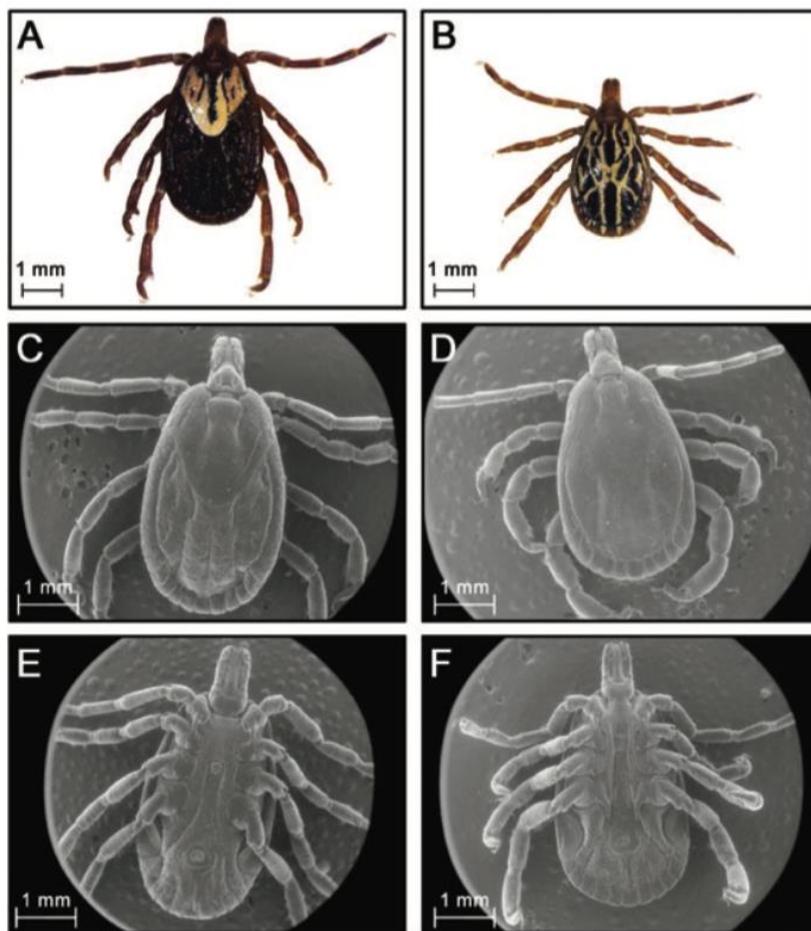


Phylogenetic analysis of partial sequences of the outer member protein A gene of rickettsial endosymbionts in Ixodidae ticks by the Maximum Likelihood method. The evolutionary history was inferred using the Tamura-Nei model, and the tree with the highest likelihood is shown. Fifty nucleotide sequences were used, and 100 bootstrap replicates were run. Bootstrap values are indicated at the nodes.

**Impact:** The steady increases in Lyme disease and other tick-borne disease cases in the Northeastern and upper Midwestern United States over the past 3 decades have become a major public health concern. Given the potential for co-infection in *I. scapularis* and facilitative interactions among different pathogens, humans are at an increased risk of becoming infected with multiple tick-borne pathogens. Overlapping clinical features resulting from co-infections could create challenges in disease diagnosis and treatment if the patient receives a false-negative test result. Further studies on the prevalence of infection and co-infection in *I. scapularis* as well as on underlying mechanisms regulating associations among pathogens are important to better understand how co-circulating organisms in tick microbiomes modulate the host immune response and dynamics of pathogen transmission to humans.

2. Established Population of the Gulf Coast Tick, *Amblyomma maculatum* (Acari: Ixodidae), Infected with *Rickettsia parkeri* (Rickettsiales: Rickettsiaceae), in Connecticut.

(Goudarz Molaei, Eliza A.H. Little, Noelle Khalil, Bryan N. Ayres, William L. Nicholson, and Christopher D. Paddock)



Light microscopy (LM) and scanning electron microscopy (SEM) images of female and male *Amblyomma maculatum* collected in Connecticut. LM images: (A) dorsal aspect of female, (B) dorsal aspect of male; SEM images: (C) dorsal aspect of female, (D) dorsal aspect of male, (E) ventral aspect of female, and (F) ventral aspect of male.

Historically, the recognized distribution of the Gulf Coast tick, *Amblyomma maculatum* Koch, was generally described as within 150-250 km of the United States coastline along the Gulf of Mexico and southern Atlantic, suggesting that warm and humid conditions are necessary for its survival. Starting in the 1950, the cattle industry facilitated the spread and establishment of *A. maculatum* into pasture lands of Kansas and Oklahoma. However, results of a genetic analysis show greatest haplotype diversity of *A. maculatum* population in Kansas with six of seven haplotypes and suggest that the coastal populations of this tick species are likely derived from the Kansas population. More recently, established populations of this tick species have been identified in states well beyond the historically recognized range, including Arkansas, North Carolina, Kentucky, Illinois, and several mid-Atlantic states including Virginia, Maryland, and Delaware. Low genetic variation and high levels of gene flow among expanding populations of *A. maculatum* suggest that these northward migration events are relatively recent. We identified an established population of the Gulf Coast tick infected with *Rickettsia parkeri* in Connecticut, representing the northernmost range limit of this medically relevant tick species. Our finding highlights the importance of tick surveillance and public health challenges posed by geographic expansion of tick vectors and their pathogens.

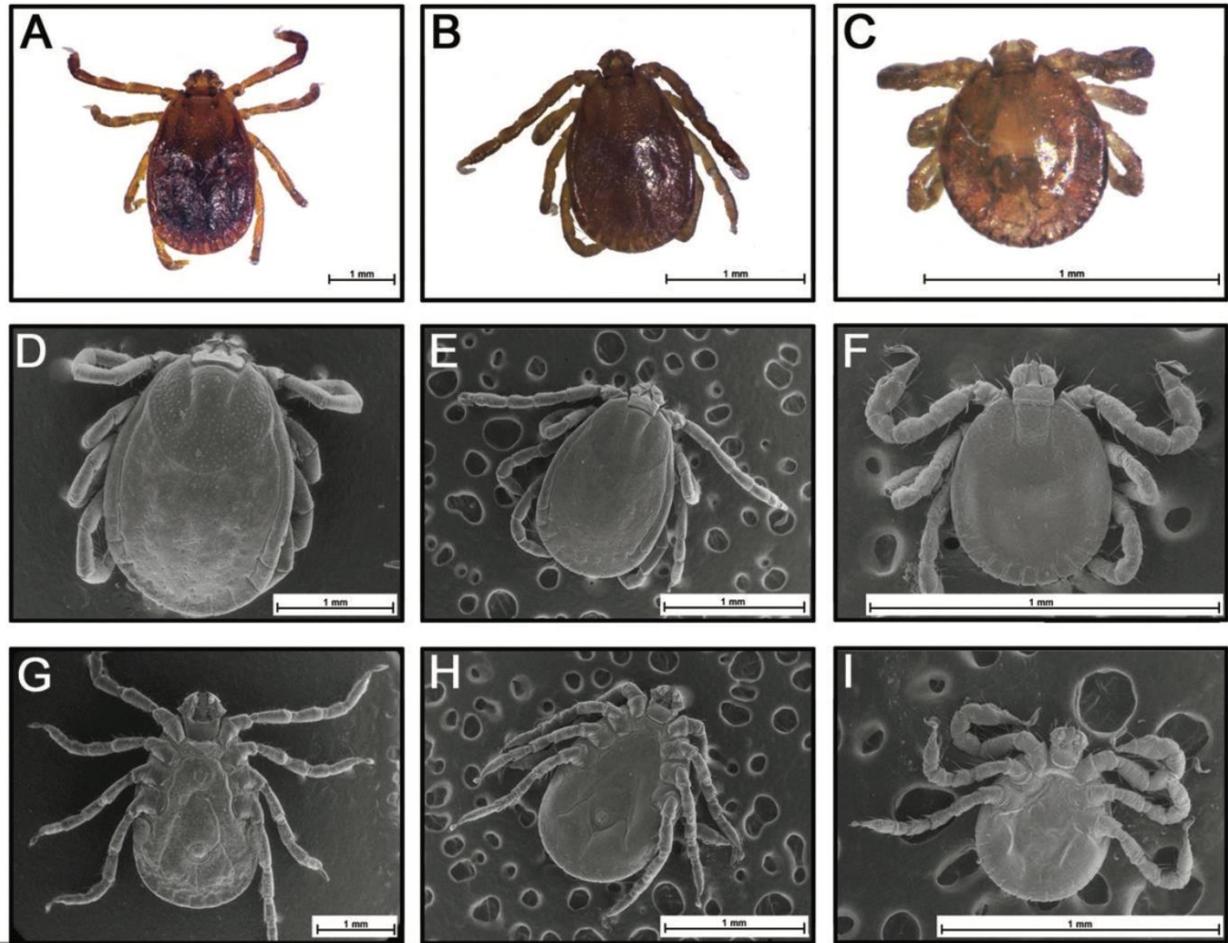


Estimated distribution of *Amblyomma maculatum* in the United States for 2020.

**Impact:** As warming trends continue, it is conceivable that *A. maculatum* could expand northward along the Atlantic coast where it will be met with warm, moist microhabitats similar to those that exist in its historic range. It remains unclear if these findings indicate that newly dispersed populations are more tolerant of cooler, drier environments or whether they are surviving in warmer, more humid microclimates such as along rivers. Identification of established populations of the Gulf Coast tick and documentation of established populations of the lone star tick in New England, highlights increasing public health challenges associated with tick incursion and range expansion in Connecticut and throughout the Northeast.

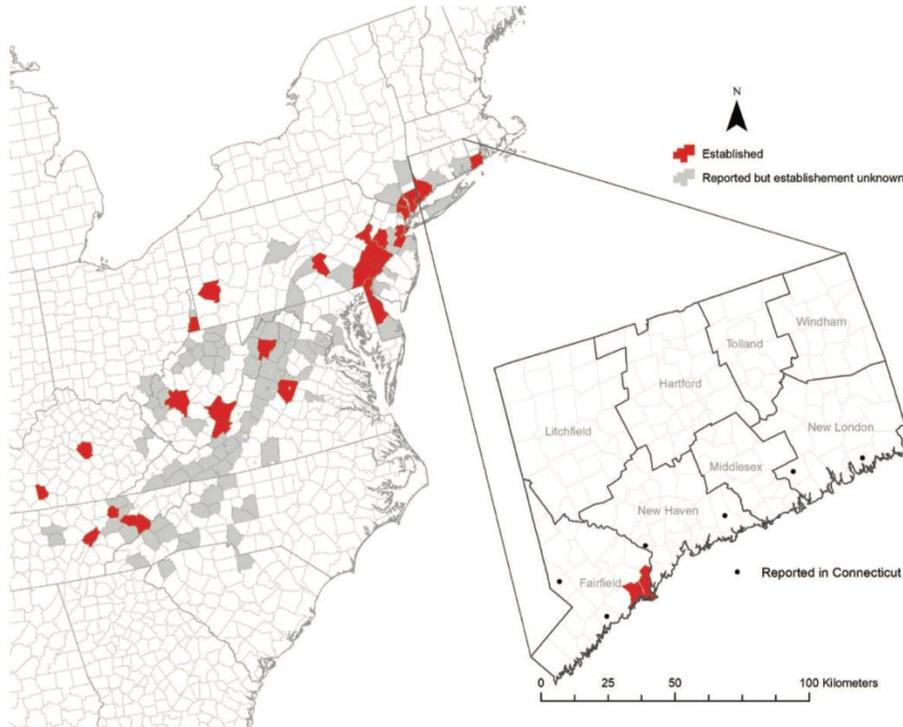
### 3. First Record of Established Populations of the Invasive Pathogen Vector and Ectoparasite *Haemaphysalis longicornis* (Acari: Ixodidae) in Connecticut, United States.

(Goudarz Molaei, Eliza A. H. Little, Scott C. Williams, and Kirby C. Stafford III)



Light microscopy (LM) and scanning electron microscopy (SEM) images of adult, nymphal, and larval *H. longicornis* collected in Connecticut. LM images: (A) dorsal aspect of adult, (B) dorsal aspect of nymph, and (C) dorsal aspect of larva; SEM images: (D) dorsal aspect of adult, (E) dorsal aspect of nymph, (F) dorsal aspect of larva, (G) ventral aspect of adult, (H) ventral aspect of nymph, and (I) ventral aspect of larva.

A number of invasive tick species capable of transmitting pathogens have been accidentally introduced into the U.S. in recent years. The invasion and further range expansion of these exotic ticks have been greatly facilitated by frequent global travel and trade as well as increases in legal and illegal importation of animals. We describe the discovery of the first established populations of *Haemaphysalis longicornis* Neumann and the first fully engorged human parasitizing specimen documented through passive tick surveillance in Fairfield County, Connecticut, U.S. We also report several individual specimens of this invasive arthropod and vector of multiple pathogens of medical and veterinary importance collected through active tick surveillance from three counties (Fairfield, New Haven, and New London).



United States counties east of the Mississippi river with known established populations of *H. longicornis*, confirmed local occurrence with unknown population abundance, and Connecticut towns.

**Impact:** Recent introduction of invasive tick vectors into the northeastern U.S., and their ability to establish populations and expand their geographic range under conducive climatic conditions, are of significant public health and veterinary concern. Expanded tick surveillance programs, implementation of rigorous measures to inspect animals, plants, and other imported materials at ports of entry, proper, accurate identification of exotic ticks and pathogens, as well as the implementation of efficient eradication and capacity to test exotic ticks for native and nonnative pathogens should all be components of a rigorous program in mitigating risks associated with ticks and tick-borne pathogens.

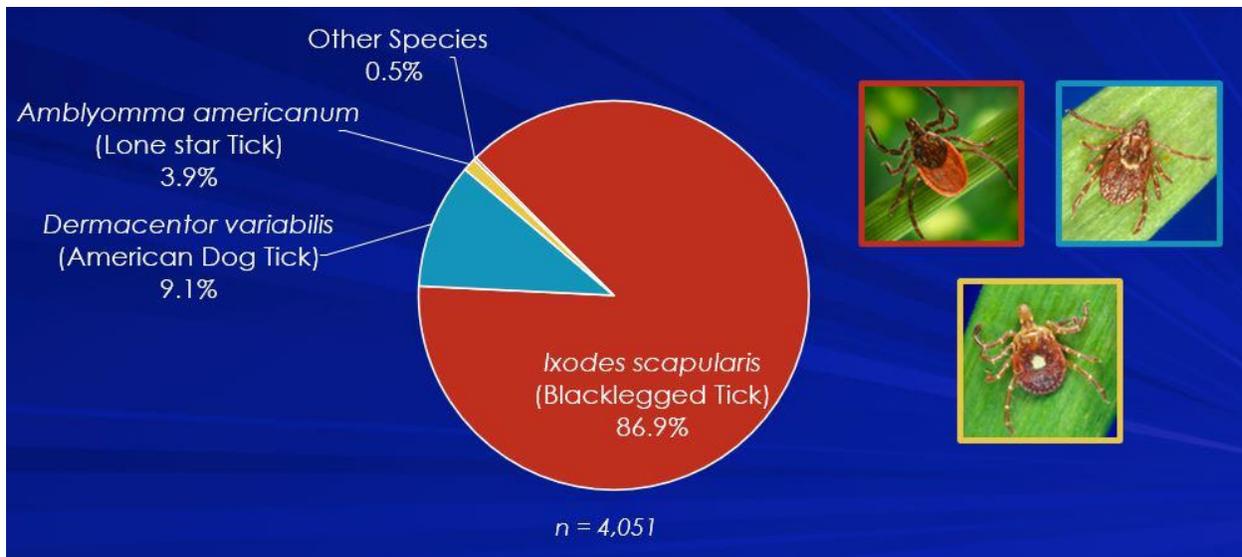
#### **D. Passive Tick Surveillance and Testing Program for Assessing Human Health Risk with Tick-borne Diseases**

(Goudarz Molaei assisted by Noelle Khalil)

Ticks and tick-borne diseases are increasingly becoming a major public health and veterinary concern. In the United States, the number of reported cases of tick-borne diseases has more than doubled between 2004 and 2016, and over 90% of the nearly 60,000 nationally notifiable vector-borne disease cases reported in 2017, were transmitted by ticks.

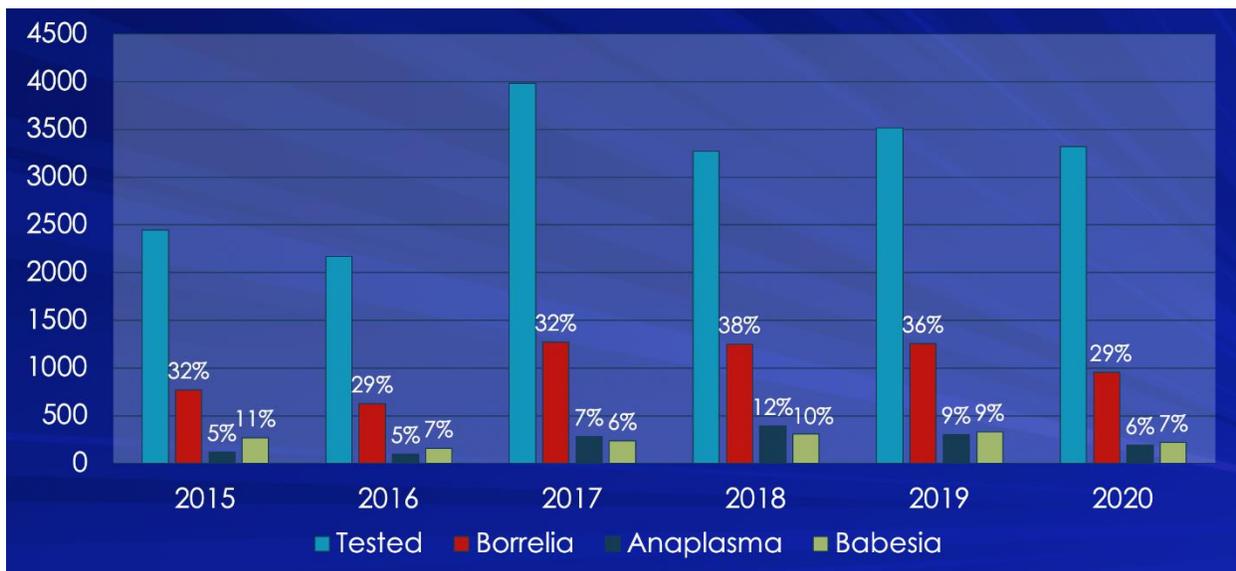


Blacklegged/deer tick, *Ixodes scapularis*, is currently responsible for transmitting seven pathogens to humans, of which the three most common are *Borrelia burgdorferi*, *Babesia microti*, and *Anaplasma phagocytophilum*, causing Lyme disease, babesiosis, and anaplasmosis, respectively. The incidence and geographic range of these three diseases continues to increase in the United States. The preferred hosts for immature *I. scapularis* are the white-footed mouse (*Peromyscus leucopus*) and other small mammals, which serve as the primary reservoir for the three aforementioned pathogens. As adults, *I. scapularis* prefer larger mammalian hosts, primarily the white-tailed deer, *Odocoileus virginianus*. Human infection is incidental, and occurs when humans encroach upon habitat that harbors ticks and their hosts. Given the shared rodent-mammal-tick transmission cycle, these pathogens will occur where *I. scapularis* is or will become established, and with its continued geographic spread co-infections may also increase. Co-infection in ticks could lead to concurrent human infection with *B. burgdorferi* and *B. microti* or *A. phagocytophilum*, which may complicate diagnosis, lead to insufficient treatment, and increase the severity of disease. Monitoring tick populations in Connecticut has historically been conducted by Passive Tick Surveillance and Testing Program by the CAES. This statewide program was established in 1990 and mandated to test blacklegged tick, *Ixodes scapularis*, for *Borrelia burgdorferi*, the causative agent of Lyme disease. In 2015, the program expanded to include testing for *B. microti* and *A. phagocytophilum*, the causative agents for babesiosis and anaplasmosis, respectively. In 2020, a total of 4,051 ticks were submitted by residents, health departments, and physicians' offices to the CAES Tick Testing Laboratory. Of these, 3,519 (86.9%) were identified as *I. scapularis* (blacklegged tick), 367 (9.1%) as *Dermacentor variabilis* (American dog tick), 156 (3.9%) *Amblyomma americanum* (lone star tick), and 9 (0.5%) a few other species.

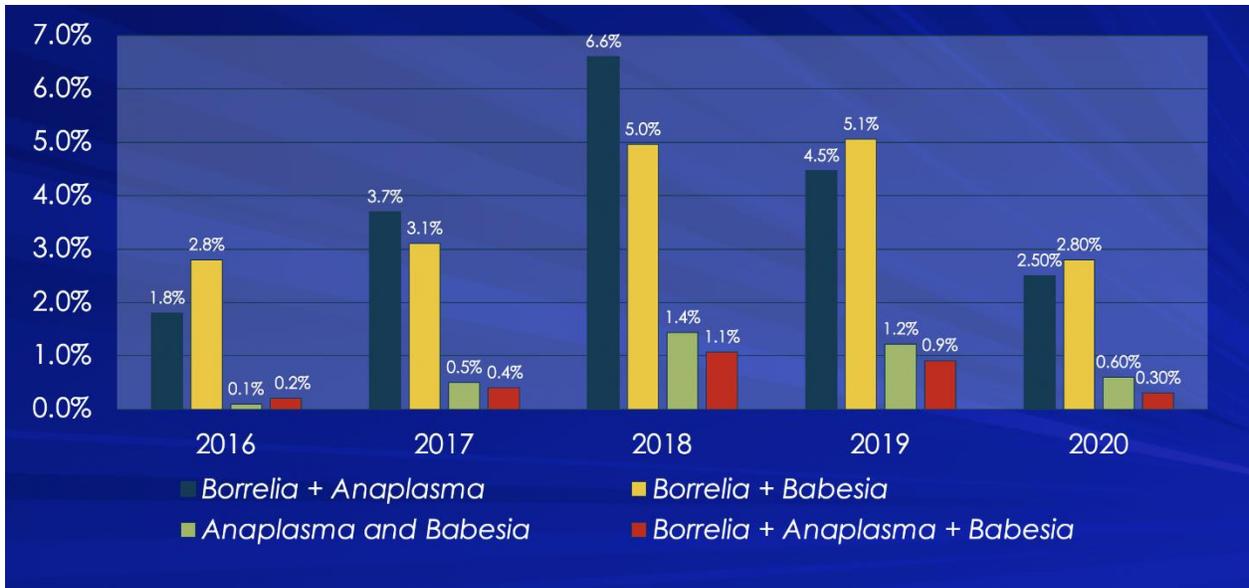


Tick Species Abundance and Composition, Connecticut, 2020.

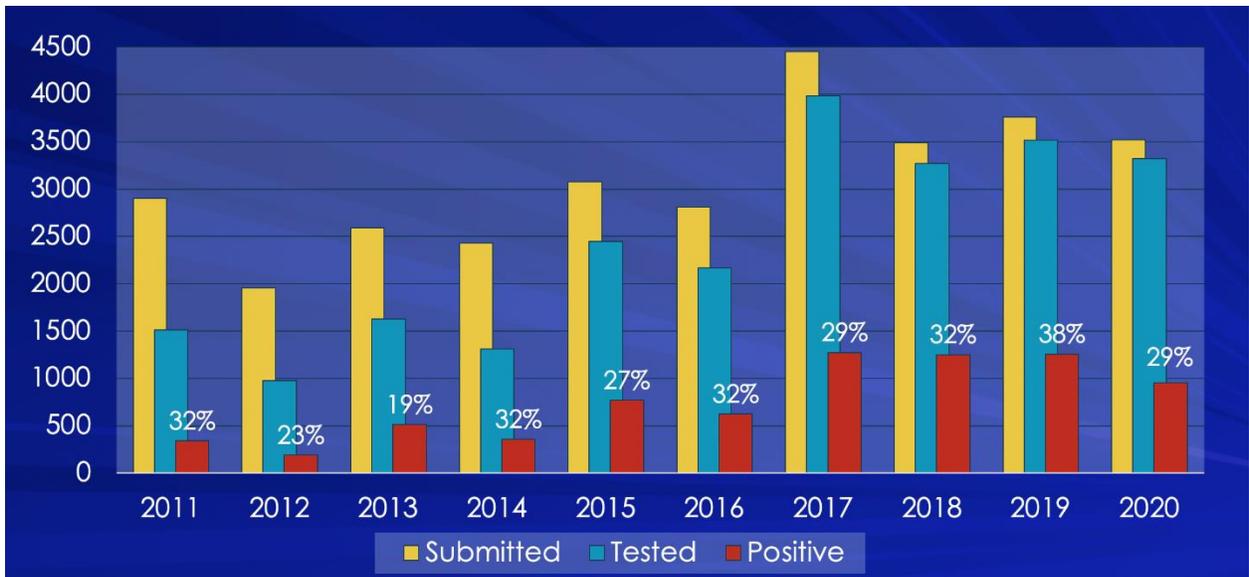
Of the 3,320 engorged nymph and adult *I. scapularis* examined, 955 (28.8%) tested positive for Lyme disease; 219 (6.6%) for babesiosis; and 190 (5.7%) for anaplasmosis. Coinfections with *B. burgdorferi* and *B. microti* were identified in 93 (2.8%); *B. burgdorferi* and *A. phagocytophilum* in 83 (2.5%); *B. microti* and *A. phagocytophilum* in 20 (0.6%); and with all three pathogens/parasites in 11 (0.3%).



Blacklegged Tick Infection Rate with Lyme disease, Anaplasmosis and Babesiosis Agents, Connecticut, 2015-2020.

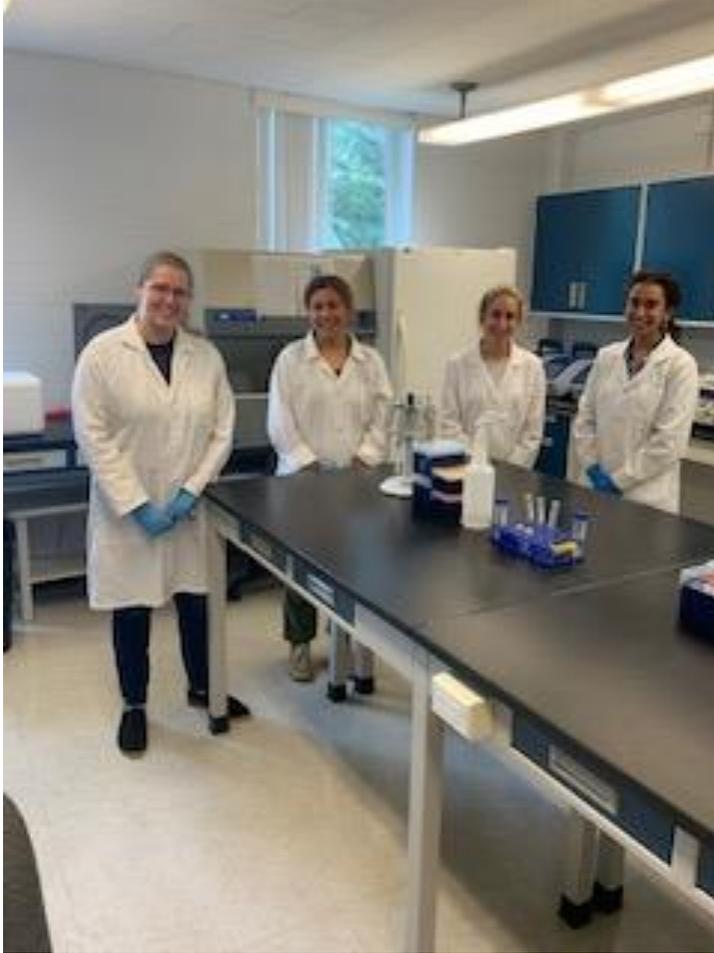


Blacklegged Tick Co-infection with Lyme disease, Anaplasmosis and Babesiosis Agents, Connecticut, 2015-2020.



Blacklegged Tick Infection with Lyme disease Pathogen in Connecticut, 2011-2020.

**Impact:** As the geographic ranges of multiple tick species continue to expand, invasive tick species are being discovered, novel tick-borne pathogens are emerging, and co-infections are surging. Rising global temperatures, ecologic changes, reforestation, and increases in commerce and travel are important underlying factors influencing the rate and extent of range expansion for ticks and associated disease-causing pathogens. It is anticipated that warming temperatures associated with climate change will lead to the continued geographic range expansion and abundance of the native and non-native tick species and tick-borne diseases will be a serious threat to humans, domesticated animals and wildlife health in Connecticut.



**Tick Testing Laboratory Staff.** (Right to left) Noelle Khalil, Alyssa Marini, Julia Elman, and Fiona Quigley.

## E. Active Tick Surveillance Program to Assess Public Health Risk for Tick-borne Pathogens

(Doug Brackney, Kirby Stafford, Scott Williams, Megan Linske, and Duncan Cozens)

The increasing prevalence of Lyme disease (LD) and the emergence of other human tick-associated diseases in the United States have become major public health concerns. To gain a better understanding of the risk associated with these diseases we have initiated a statewide tick surveillance program in order to determine the distribution and abundance of the black-legged tick as well as the prevalence of not only Lyme disease but also babesiosis, anaplasmosis, and Powassan virus encephalitis. Further details on this program are given in the Entomology Department section.

## IV. ENVIRONMENTAL MICROBIOLOGY

### A. Employing Experimental Systems to Characterize Wetland Responses to Disturbance

(Blair Steven)

Our overarching objective is to better understand how interactions between plant community composition and water quality alter freshwater wetland carbon fluxes. Within 20 Connecticut salt marshes (10 without tidal restrictions, 10 tidally restored), we sampled three vegetation zones dominated by *Spartina alterniflora*, *Spartina patens*, and *Phragmites australis* to estimate microbial respiration rates, root zone bacterial communities, and a suite of plant and soil characteristics. Our findings suggest that dominant salt marsh vegetation zones are useful indicators of hydrologic conditions and could be used to estimate microbial respiration rates. This will be important for modeling how these systems will potentially change in the face of climate change.

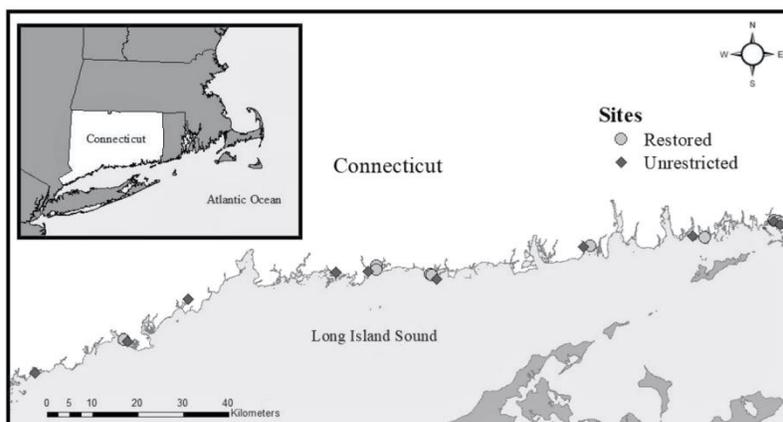


Figure 1. Wetland sampling sites around the state of Connecticut. Sites are marked as tidally restored or unrestored.

### B. Microbiome Engineering for Inhibiting Fire Blight Development in Apple Trees (Blair Steven, Zhouqi Cui, and Quan Zeng)

Fire blight, caused by the bacterial pathogen *Erwinia amylovora*, is one of the most devastating diseases of apples and pears. We are studying how a program of “microbiome engineering” may assist in fighting the development of fire blight. We show that various inoculations did influence the occurrence of fire blight, although the level of disease suppression was dependent upon specific bacterial strains. Furthermore, treatments using different strains or strain mixtures predominantly resulted in increased representation of the inoculated strains, suggesting that disease suppression was due to an alteration of the stigma microbiome

structure. Compared with treatments using single strains, a *Pantoea–Pseudomonas* strain mixture produced a homogeneous microbiome structure with less interflower variability. Findings from this study suggest that the microbiome on the flower stigma can be manipulated through microbial inoculation. (Figure 2).

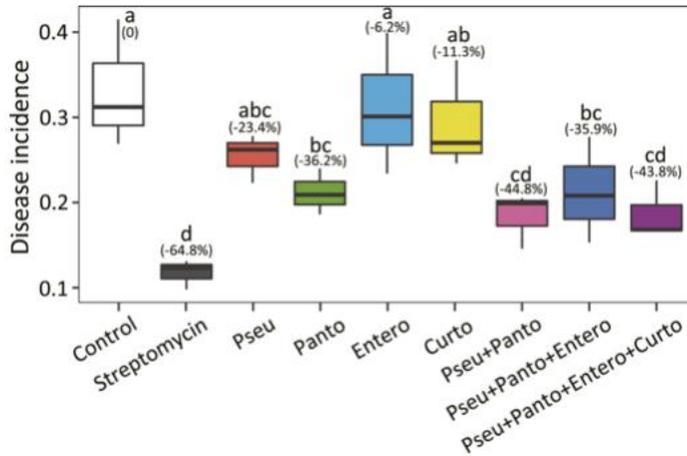


Figure 2. Disease incidence in flowers exposed to various mixtures of microbes isolated from the microbiome of the apple flower. Compared to the standard treatment, spraying the antibiotic streptomycin, a mixture of strains resulted in a statistically similar reduction in disease occurrence. The percent reduction in disease rates is indicated in the brackets.

### C. Introducing Environmental Bacteria to Colony Mosquitoes Alters Host and Microbiome Phenotypes

(Blaire Steven, Doug Brackney)

We have recently developed an axenic (microbe-free) mosquito model, which can be recolonized with bacteria of interest. We investigated the difference between mosquitoes reared with bacteria from the insectary in which they are raised versus from an environmental water source. Mosquitoes colonized with bacteria from the environment digested blood faster, and the bacteria isolated from the environmentally colonized mosquito showed a higher propensity for blood digestion (Figure 3). This suggests that microbiome composition may explain some of the observed differences between colony reared mosquitoes compared to those in the wild.



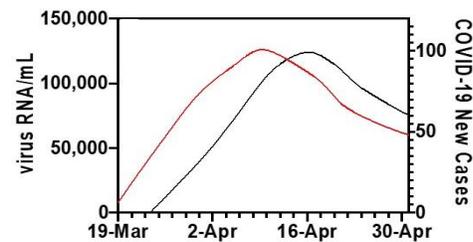
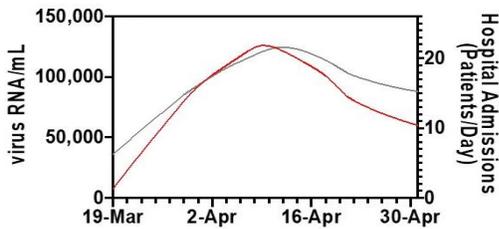
Figure 3. Blood digestion phenotypes of mosquito associated bacteria. Panel A shows a blank blood agar plate. Panel B-E are bacteria isolated from mosquitoes. The bacterium in panel B was isolated from a mosquito colonized by environmental bacteria and demonstrates an increased capability for blood digestion.

## D. Environmental Surveillance of SARS-CoV-2

### 1. Community level surveillance of SARS CoV-2 activity.

(Doug Brackney and Yale Collaborators)

The most common metric followed to track the progression of the COVID-19 epidemic within communities is derived from testing symptomatic cases and evaluating the number of positive tests over time. However, tracking positive tests is a lagging indicator for the epidemic progression. Testing is largely prompted by symptoms, which may take up to five days to present, and individuals can shed virus prior to exhibiting symptoms. There is a pressing need for additional methods for early sentinel surveillance and real-time estimations of community disease burden so that public health authorities may modulate and plan epidemic

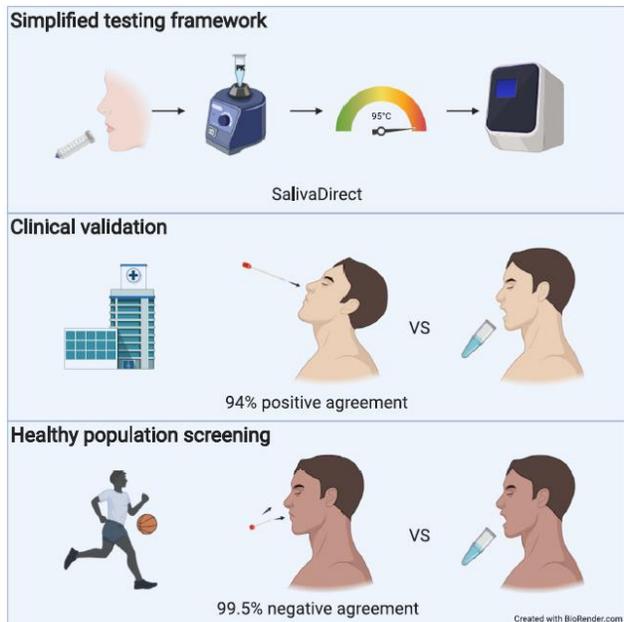


responses accordingly. SARS-CoV-2 RNA is present in the stool of COVID-19 patients and has recently been documented in raw wastewater. Thus, monitoring raw wastewater (sewage) within a community's collection system can potentially provide information on the prevalence and dynamics of infection for entire populations.

To test this, we initiated a surveillance program in New Haven county that monitors SARS-CoV-2 RNA in primary sewage sludge to see if such data was useful as an indicator of community-wide SARS-CoV-2 activity. Thus far, we have found that SARS-CoV-2 RNA concentrations in sewage sludge were a leading indicator of community outbreak dynamics over hospitalization and compiled COVID-19 testing data. SARS-CoV-2 RNA concentrations led hospital admissions by 3 days and COVID-19 cases by 7 days.

### 2. SARS-CoV-2 Diagnostics

(Doug Brackney and Yale Collaborators)



The scale and speed with which SARS-CoV-2 swept across the country left many public health departments scrambling to implement accurate and timely diagnostics protocols. With few FDA approved diagnostic tests and procedures available most diagnostic facilities were forced to adhere to strict protocols with specific reagents and equipment. Consequently, there were and still are shortages for many of these reagents. In addition, the approved sampling method, nasopharyngeal swabs (NP swabs), was moderately invasive and only ~70% accurate in large part due to variation in sampling technique.

To address these problems, researchers at CAES have partnered with scientists at Yale University to develop a more universally acceptable diagnostic protocol combined with a non-invasive and uniform sampling method. Thus far we have found

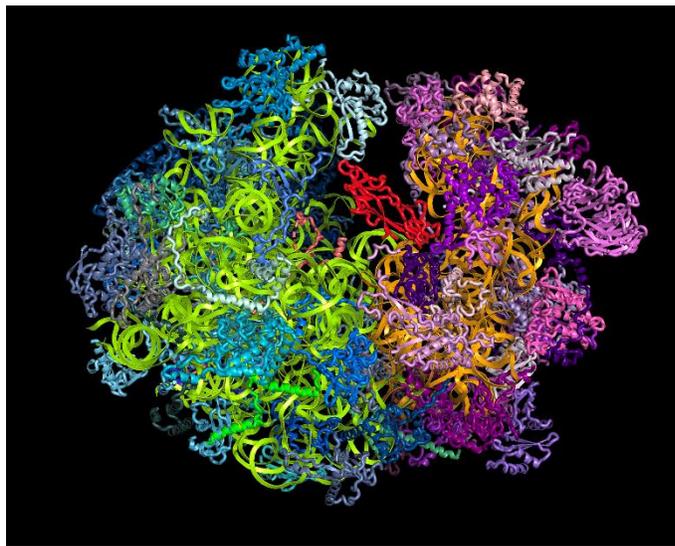
that saliva is just as good or better than NP swabs when it comes to identifying infected individuals. Further, saliva can be used directly with the diagnostic test thereby eliminating the need for reagents and equipment associated with performing RNA extractions, a central step of the initial FDA approved diagnostic strategy. The SalivaDirect test further reduces costs by combining all three of the genetic markers into a single assay reducing assay costs by 66%. Because the initial test was certified for only specific reagents and machines the SalivaDirect protocol has been validated across a number of reagents and machines. If implemented, this will reduce strain on the production of specific reagents resulting in more manufacturers being able to provide needed expertise and resources during the current pandemic. Lastly, we have also been testing the suitability of using the SalivaDirect assay on pooled saliva samples. Such improvements on testing would significantly improve testing capabilities as society and schools begin to re-open. The initial results are promising as we continue to optimize the protocol. The assay is currently being prepared for submission to the FDA for Emergency Use Authorization.

## E. The Microsporidia

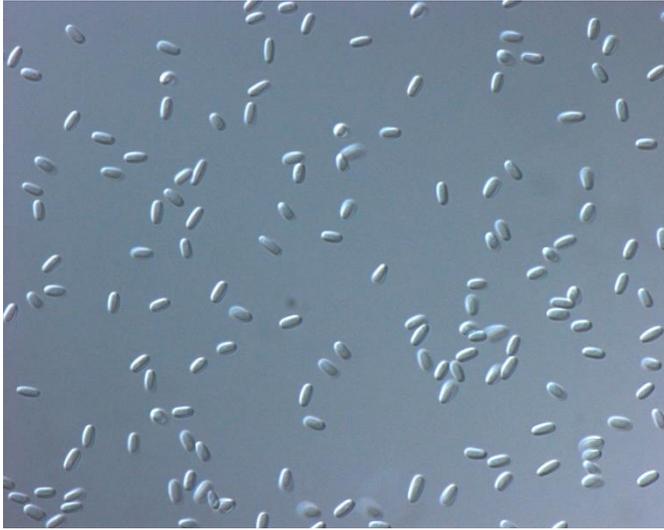
### 1. Three-dimensional structure of the Microsporidial ribosome.

(Charles R. Vossbrinck)

Dr. Vossbrinck, along with Jonas Barandun at the University of Umea, Umea, Sweden, and his colleagues, have published the three-dimensional structure of the ribosome from the microsporidial parasite *Vairimorpha necatrix*. We have discovered a “dormancy” factor that may be shutting down protein synthesis or protecting the ribosome from external factors during its spore stage. Microsporidia are devastating parasites of the world’s two most important domesticated insects, honey bees and silkworms. We have submitted a grant proposal to the USDA in an effort find antibiotic (anti-microsporidial) compounds that can be fed to the bees to allow them to stop this parasite from killing them and thus destroying beehives. We propose to take a two-pronged approach. First to test compounds in the lab to see if they block ribosome function and second to make three-dimensional models of the ribosome using a computer to see if there is a compound that is likely to block the ribosome’s active site and test those compounds. In either case we propose to test the compounds on honey bees in the field.



The three-dimensional structure of the microsporidial ribosome showing the various proteins and RNAs in different colors. The dormancy factor is in the middle of the structure in red.



Spores of *Vairimorpha necatrix*, our model species, a close relative of the highly pathogenic honey bee microsporidian *Vairimorpha ceranae*.

2. A new species of microsporidia infecting the spotted winged fruit fly *Drosophila suzukii*.  
(Charles R. Vossbrinck and colleagues)

Working with a student, Sarah Biganski and scientists from the Institute for Biological Control at the Federal Research Centre for Cultivated Plants at the Julius Kuehn Institute in Darmstadt, Germany, we have discovered and are describing a new species of microsporidia. This species of parasite is of particular interest as a biological control agent because it infects the very harmful fruit fly *Drosophila suzukii*. This small fly has now invaded much of the United States, including all regions of Connecticut and can be found in the fruits of raspberries, blueberries, figs, cherries, blackberries as well as many wild or native fruits such as yew, wineberry, and chokecherry. This recently discovered microsporidial parasite has potential for infecting and controlling this destructive spotted winged fruit fly.

3. The Asian honey bee, *Apis cerana*, in China.  
(Charles R. Vossbrinck and Jinshan Xu)

In cooperation with colleagues in China, we have completed a population analysis of the Asian honey bee, *Apis cerana*, in that country. What we, in Connecticut, refer to as the honey bee, *Apis mellifera*, is a species brought over from Europe by the pioneers. There were no honey bees in North America prior to that time. In Asia, there is a separate species of honey bee, *Apis cerana*, used on honey production in China and elsewhere. We have compared honey bees from various locations and have identified several genes that are responsible for helping the Asian honey bee to adapt to different conditions of temperature and humidity. We are starting to understand the evolutionary adaptations honey bees have evolved to cope with these various conditions at the genomic level.



A comparison of the Asian honey bee, *Apis cerana* (Left) and the European honey bee, *Apis mellifera* (Right), which we culture for honey in Connecticut. The Asian honey bee is smaller, less hairy, slenderer, and faster in flight.

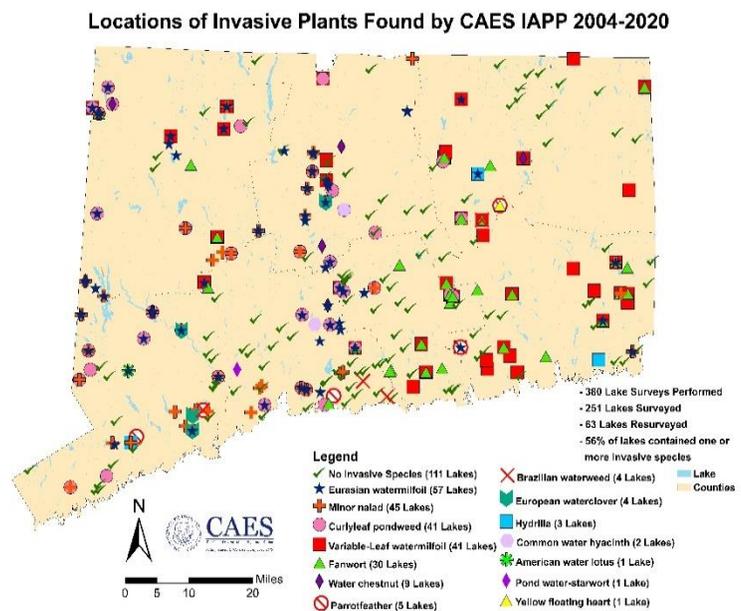
## V. INVASIVE AQUATIC PLANT PROGRAM

(Gregory Bugbee and Summer Stebbins)

We are quantifying the locations of invasive aquatic plants in Connecticut’s lakes and ponds, determining their effects on native plant communities, establishing baseline data to track their spread, and providing information that is critical for management strategies.

### A. Surveillance and Monitoring

Since 2004, the Connecticut Agricultural Experiment Station Invasive Aquatic Plant Program (CAES IAPP) has completed 380 aquatic vegetation surveys of 251 Connecticut lakes and ponds. A total of 63 waterbodies have been resurveyed to determine how invasive plants are changing the quality of lakes and the effectiveness of management practices over time. In fiscal year 2020-2021, Gregory Bugbee and Summer Stebbins mapped the aquatic vegetation in six new and eight previously surveyed waterbodies. Lake Candlewood, Connecticut’s largest lake, was surveyed for the 12th consecutive year to determine the effects of deep and shallow winter drawdown and grass carp (*Ctenopharyngodon idella*) on Eurasian watermilfoil (*Myriophyllum spicatum*), minor naiad (*Najas minor*), and curlyleaf pondweed (*Potamogeton crispus*). Nearby Squantz Pond was also surveyed. We established transects in each waterbody using global positioning systems to quantify changes in native and invasive aquatic species abundance and distribution. We collected water samples and analyzed them for pH, temperature, dissolved oxygen, clarity, alkalinity, conductivity, and phosphorus. These data, along with watershed information, are being used to investigate the factors that influence the susceptibility



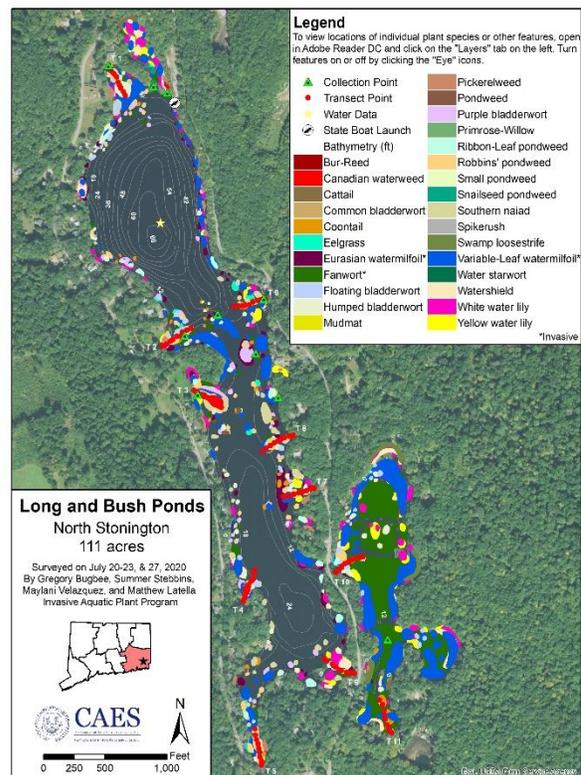
Locations of invasive plants in Connecticut’s lakes and ponds as found in CAES IAPP surveys from 2004-2020.

CAES IAPP Surveys Performed in 2020			
Number	Lake Name	Town	Acres
1	Bashan Lake	East Haddam	273
2	Buckley Pond	Union	25
3	Candlewood Lake	Sherman	5400
5	Diamond Lake	Glastonbury	20
6	Dogwood Lake	Trumbull	3.5
7	Laurel Lake	New Hartford	16
8	Long and Bush Ponds	North Stonington	110
9	Lyman Pond	Middlefield	0.5
10	Middle Bolton Lake	Vernon	121
11	North Farms Reservoir	Wallingford	64
12	Pachaug Pond	Griswold	817
13	Quonnapaug Lake	Guilford	99
14	Squantz Pond	New Fairfield	266
15	Vernal Pond	Guilford	0.3

of waterbodies to individual invasive species. We archived dry specimens of all plant species in the CAES herbarium for future reference. We designed our Invasive Aquatic Plant Program to utilize the latest digital technology to report our findings rapidly and comprehensively to the public. Lake survey maps and other data are published online (<https://www.portal.ct.gov/caes-iapp>). Nearly 60 percent of the waterbodies contained one or more invasive plant species and some lakes contained as many as four invasive plant species.

The most common invasive plants are Eurasian watermilfoil, variable watermilfoil (*Myriophyllum heterophyllum*), minor naiad, curlyleaf pondweed, and fanwort (*Cabomba caroliniana*). Less common are water hyacinth (*Eichhornia crassipes*), water shamrock (*Marsilea quadrifolia*), hydrilla (*Hydrilla verticillata*), and water chestnut (*Trapa natans*). Our 2009 survey of Fence Rock Lake in Guilford discovered Connecticut’s first infestation of Brazilian waterweed (*Egeria densa*) and our resurveys in 2010, 2011, 2012, and 2013 found the population expanding. We have since found Brazilian waterweed in Lower Moodus Reservoir (East Haddam), Staffordville Reservoir (Stafford Springs), Dogwood Lake (Trumbull), and Mono Pond (Coventry). We tested the efficacy of a CT DEEP approved herbicide in Fence Rock Lake and eliminated the plant. We have surveyed Pachaug Pond from 2017 - 2020 to document changes in aquatic vegetation over time. In the early spring of 2018, the level of Pachaug Pond was lowered 1-2 m and then raised to normal by summer. Our surveys found similar occurrence and species richness of aquatic plants between the three years, but the abundance had decreased throughout the center of the lake. These results suggest early spring lake drawdowns may be an alternative to the typical winter drawdowns.

Hydrilla is a destructive invasive aquatic plant in many southern states. Following reports of the plant occurring in the Connecticut River, a task force led by the CAES IAPP was formed. Comprising over 30 experts from throughout the northeast, the task force performed preliminary surveillance of the river from central Vermont to southern Connecticut in 2018. Hydrilla was not found in New Hampshire or Vermont and the first sightings were just north of the Massachusetts/Connecticut border. Traveling south, hydrilla became common, creating large dense stands between Hartford and East Haddam.



Aquatic vegetation survey of Long and Bush Ponds 2020.

The hydrilla found in the river is more robust than seen elsewhere in Connecticut. CAES IAPP in collaboration with the University of Wisconsin-Whitewater, performed genetic tests on the Connecticut River hydrilla and found it to be a different strain than previously found in North America. This could mean the plant has an enhanced ability to spread, harm aquatic ecosystems and resist current control practices. Movement of the CT River hydrilla to lakes and ponds via fragments on trailered boats and wildfowl is of utmost concern. In 2019 CAES IAPP was commissioned to survey the river from Haddam to Long Island Sound and in 2020 from Haddam to the northern most extent in Agawam, MA. Results found 774 acres of hydrilla that often formed monostands that spread out on the surface blocking navigation.



Connecticut River hydrilla investing a tributary with CAES IAPP survey boat in the foreground.

## B. Control Technologies

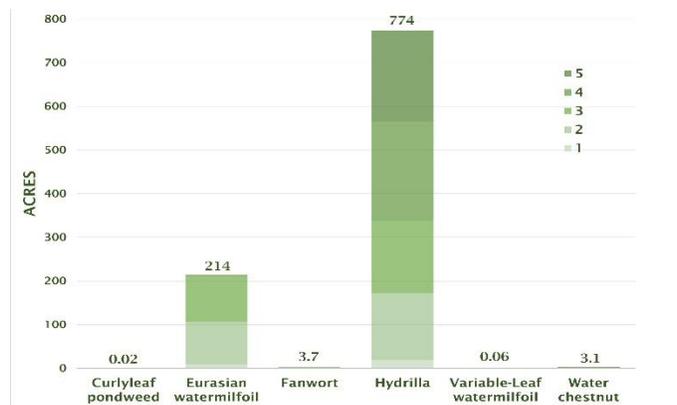
The goals of this objective are 1) to research novel means of control that minimize herbicide usage and protect native vegetation and 2) to investigate non-chemical management options such as winter water level drawdown.

### 1. Herbicides.

Novel methods of chemical control with herbicides can rapidly remove invasive plants and begin to restore native plant communities to aquatic ecosystems.

*Bashan Lake – East Haddam, CT.* We are in the 19th year of research involving the use of spot applications of herbicides to control variable watermilfoil in Bashan Lake. We had largely restored the lake to preinfestation conditions prior to lowering the lake for dam repairs in 2014. Surveys of Bashan Lake in 2018 found a regrowth of variable watermilfoil and several areas where phragmites (*Phragmites australis*) had become established. A new herbicide called ProCellaCOR was registered in 2018 for use on variable watermilfoil. In collaboration with the Bashan Lake Association, the Town of East Haddam, SePro Corp., and Solitude Lake Management Inc., CAES IAPP lead a targeted application of the product that was applied in late September. Control attributed to the ProCellaCOR treatment was excellent in all sites except for the south cove where most of the variable watermilfoil was unaffected. These areas were treated in June 2020. CAES IAPP surveys in late summer 2020 and spring 2021 found no variable watermilfoil.

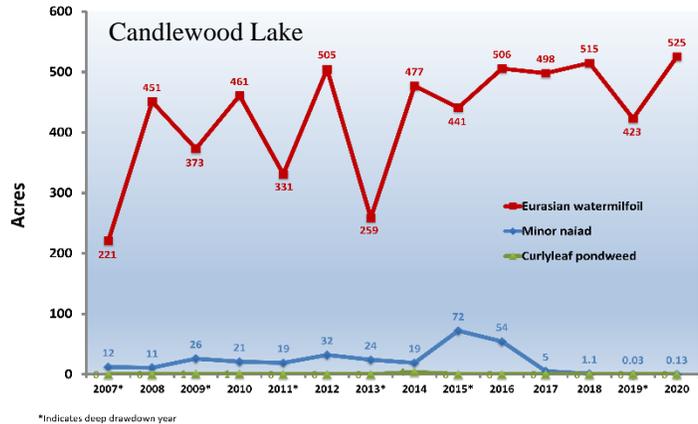
*Connecticut River* – Large scale control of hydrilla may require targeted herbicide applications. Treating a large tidal river with high flow rates and numerous state listed species requires considerable preliminary research. CAES IAPP is leading this aspect and in collaboration with CT DEEP, national hydrilla experts, and other stakeholders hopes to begin trials in 2022.



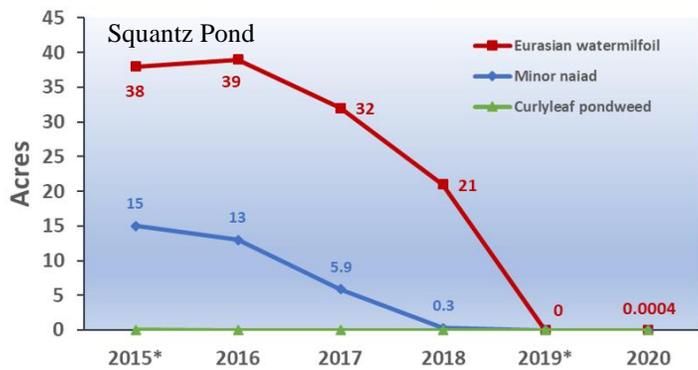
Acreage and abundance (1 = sparse to 5 = dense) of hydrilla and other invasive aquatic plants in the Connecticut River from Agawam, MA to Long Island Sound.

## 2. Winter water level drawdown and grass carp.

*Candlewood Lake - Brookfield, New Fairfield, New Milford, Sherman, CT.* Candlewood Lake’s aquatic plant community is dominated by Eurasian watermilfoil. Winter water level drawdown has been used for decades to manage the plant. In 2015 and 2017, a total of nearly 10,000 sterile plant-eating grass carp were introduced to provide additional control. Using state-of-the-art geospatial technology, we have documented the success of the drawdowns each year since 2007 and have begun to determine the effects of the grass carp. The surface coverage of milfoil shows a negative relationship to drawdown depth. Eurasian watermilfoil reductions attributable to the grass carp appear limited to some shallow coves and minimal in most of the lake. Squantz Pond is attached to Candlewood Lake via a large pipe under a causeway. Virtually all vegetation in Squantz Pond has been eliminated suggesting that some of the grass carp from Candlewood Lake have migrated into the waterbody. CAES IAPP surveillance has found excessive plant reduction is possible if grass carp populations are excessive.



\*Indicates deep drawdown year



\*Indicates deep drawdown years

The effects of winter drawdown depth and grass carp on the acreage of Eurasian watermilfoil in Candlewood Lake (top) and Squantz Pond (bottom).

## 3. Benthic barriers.

*Lake Quonnipaug - Guilford, Bashan Lake - East Haddam, and Lake Beseck - Middlefield.* Benthic barriers are blankets designed to be placed over nuisance vegetation in lakes and ponds. They provide an alternative to herbicides and are thought to control vegetation by blocking the light aquatic plants need to grow. Benthic barriers are not new; they are typically placed over weed beds early in the growing season and removed in the fall. Recently, marketers of benthic barriers have claimed that their products need only be placed over weeds for a few weeks and then moved to another location or removed. To test this practice, we collaborated with the Towns of Guilford and Middlefield and placed benthic barriers at the Lake Quonnipaug and Lake Beseck public beaches. The beaches had problems with Eurasian watermilfoil and other invasive and native aquatic plants. We placed the benthic barriers in April and removed them within two months. The results are promising with little vegetative regrowth throughout the summer. We are also testing the use of benthic barriers to control a pioneer infestation of fanwort in Bashan Lake and hydrilla in the Connecticut River. Further tests are needed to determine why these barriers provide impressive weed control even when they are used for short periods of time.

## C. Outreach

We strive to disseminate all information from our program to the public in a timely fashion and educate stakeholders in the identification, prevention, and management of invasive aquatic species. We make every effort to engage citizens, lake associations, and other stakeholders. CAES IAPP scientists have organized several workshops on the identification of invasive aquatic plants. We also have given presentations to professional organizations such as the Northeast Aquatic Plant Management Society, the North American Invasive Species Management Association, and the Connecticut Invasive Plant Working Group. In addition, CAES IAPP staff members speak to numerous lake associations, town meetings, and student groups such as the Connecticut Envirothon. We have made our information freely and readily available via our website. Included are digitized interactive lake maps, our herbarium, and publications (<https://www.portal.ct.gov/caes-iapp>).

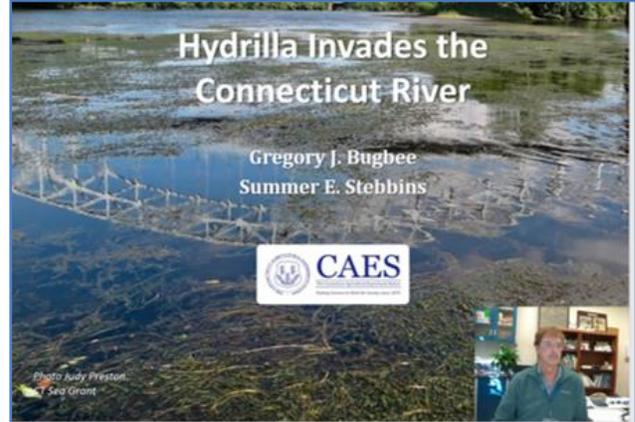
Our invasive aquatic plant control and outreach efforts have resulted in the protection of lakes and provided scientifically proven methods for use by others. CAES IAPP was featured prominently in a video entitled “Invading the Connecticut River – The Spread of Hydrilla” <https://www.youtube.com/watch?v=OZ2baYSgl8Y>. Our workshops have trained hundreds of citizens to recognize and report new infestations to prevent future problems and the associated control expenditures.

## VI. SOIL TESTING LABORATORY

(Gregory Bugbee)

Testing soil samples for fertility and suggesting methods for growing better plants are provided for citizens of Connecticut. At the laboratory in New Haven, 6,951 samples were tested representing one of the highest totals on record. Approximately 1,500 phone calls, emails and in person inquiries were answered.

The soil testing services and recommendations made by the Connecticut Agricultural Experiment Station reduce unnecessary fertilizer treatments to lawns and nursery stock throughout the state. This provides direct economic and environmental benefit to the suburban community by reducing nitrogen runoff into soil and water.



Invasive aquatic plant talk via teleconference for the Connecticut Invasive Plant Working Group Conference.



Talk on improving soil fertility presented for the Connecticut Masters Gardeners Association Virtual Symposium.

## DEPARTMENT OF FORESTRY AND HORTICULTURE

Connecticut's landscape is a quilt of forests, farms, towns, and cities. Scientists in the Department of Forestry and Horticulture are studying the factors that influence both forest and farm productivity, including how trees respond to novel pests and a changing climate, innovative forest management practices, the effect of the growing deer population on natural and managed landscapes, and novel specialty crops.

The value of the forest to Connecticut is much more than the timber and other forest products. First and foremost, forests protect watersheds, aquifers and groundwater supplies that provide the bulk of our clean drinking water. Trees also provide air pollution control, acting as giant filters to remove dust, particulates, and some airborne chemicals. In addition, trees cool our environment in the summer by recycling water and reflecting sunlight. Forests contribute to the character of Connecticut and add to our enjoyment throughout the year.



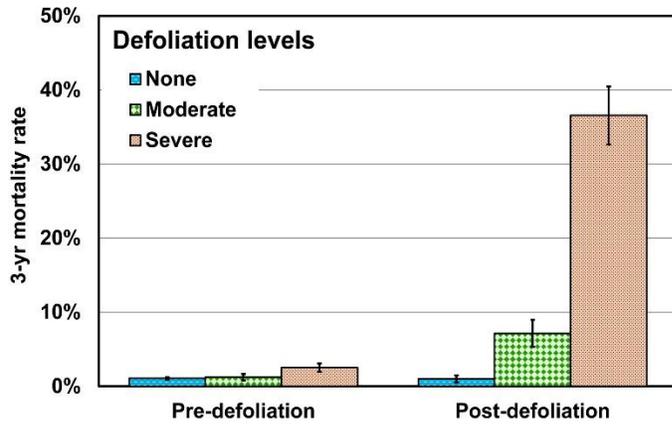
**Mature forest in Sharon completely defoliated in early summer 2021.**

### **Multiyear defoliations in southern New England increases oak mortality**

(Dr. Jeffrey S. Ward assisted by Mr. Joseph P. Barsky)

In 2021, tens of thousands of acres of Connecticut forest were again severely impacted by gypsy moth defoliations. Understanding the impact of these outbreaks on forest health is essential for natural resource managers. Repeated episodes of multi-year defoliations of oak-hickory forests in southern New England during the 1960s-1980s caused widespread regional oak mortality. Populations of the primary defoliator, European gypsy moth (*Lymantria dispar* L.), collapsed with the unanticipated appearance of gypsy moth fungus (*Entomophaga maimaiga*) in 1989 and multi-year defoliations did not occur for decades. The lack of widespread multiyear outbreaks between 1989-2015 lulled many natural resource managers into believing that multi-year defoliations would no longer occur. However, the fungus did not activate during the exceptionally dry late springs from 2015-2018 and gypsy moth populations exploded.

To assess the impact of the return of multiyear defoliations, we examined 3095 oaks on 29 permanent study areas in Connecticut and Rhode Island that were established at least eleven years before the latest outbreaks. Pre-defoliation stand level oak mortality averaged 2% (three-year basis). Post-defoliation mortality did not differ between managed and unmanaged stands, but was much higher in severely defoliated stands (36%)

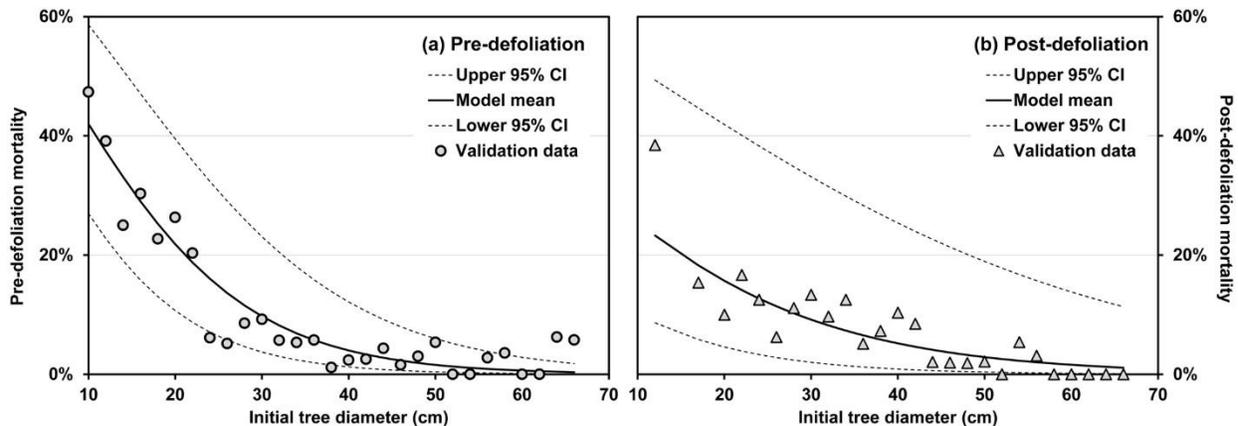


**Oak mortality increased with defoliation intensity.**

than in stands with moderate (7%) or low-no defoliation (1%). Individual tree post-defoliation mortality of northern red oak (9%) and chestnut oak (14%) differed from black oak (27%) which differed from white oak (34%).

While speculative, the study suggests that tree age accounts for some of the differences in the relative importance of various tree and stand characteristics for predicting mortality between previous and more recent multiyear defoliation episodes. With a few exceptions, the oaks we measured were survivors of the multiyear defoliations in the 1960s and later. Hence, they were thirty-five years older and

had grown larger since the last major outbreak in 1981. The mixed oak forests in eastern Connecticut were highly resistant to defoliation when the stands were less than fifty years old in the mid-1940s. However, many stands in eastern Connecticut were among those most heavily defoliated in the most recent outbreaks and experienced heavy mortality. The difference? Trees in these stands included in this study were eighty years older than in the 1940s and were thirty-five years older than when they survived during the last widespread multiyear outbreak. Anecdotally, we observed little or no mortality of oaks in 10 and 40-year-old stands adjacent to mature stands that experienced heavy oak mortality.



**On stands that experienced moderate defoliation intensity, pre- and post-defoliation mortality were similar and were lower for larger trees.**

In summary, our study found that post-defoliation mortality differed by defoliation severity, differed among species, and often but not consistently, varied with stand oak basal area. Consistent with previous studies, high levels of defoliation across multiple years greatly increased mortality. This study confirmed that mortality patterns are species specific, as northern red oak had lower mortality than white and black oak across all defoliation levels. However, comparison with other studies demonstrates that species susceptibility to LDD mortality can vary across time and space, so managers cannot assume that the species with the highest mortality in previous events will have the highest mortality in future defoliations. Effects of stand oak basal area and density, tree diameter, and management were much less consistent, suggesting the importance of site-specific factors. Despite some indication of higher mortality in managed sites, forgoing management to reduce potential mortality is not recommended due to the difficulty in predicting

outbreaks, potential loss of income, and the increased risk of hazard trees following severe defoliation in unmanaged stands. Natural resource managers should not assume that oaks that survived earlier multiyear defoliations episodes will survive future multiyear outbreaks, possibly because trees are older.

**Impact:** Natural resource managers should not assume that oaks that survived earlier multiyear defoliations episodes will survive future multiyear outbreaks, possibly because trees are older. While speculative, this research suggests that some of the differences between earlier and recent defoliation episodes in the relative importance of various tree and stand characteristics for predicting mortality is tree age. With a few exceptions, the oaks we measured were survivors of the defoliations in the 1960s and later. Hence, they were older and larger than the last major multiyear outbreaks.

### **Effectiveness of slash walls to enhance regeneration**

(Dr. Jeffrey S. Ward assisted by Mr. Joseph P. Barsky in collaboration with Cornell University, Metropolitan District Commission, South Central Connecticut Regional Water Authority, and Massachusetts Department of Conservation and Recreation)

Obtaining adequate quality regeneration, especially oak regeneration, can be problematic in area with high deer densities. Our earlier study found that it is unlikely to obtain sufficient oak unless there is both a low level of deer browse damage and high levels of sunlight. High levels of sunlight can be obtained by appropriate management prescriptions (i.e., more intense harvesting). Reducing browse damage by restricting deer access is necessary in forests where hunting is restricted by deed, regulation, or social pressure.

The traditional method of restricting deer access has been construction of 8-ft tall woven wire fences. However, these fences are expensive to construct, approximately \$4 per linear foot, often require maintenance after severe weather, and may incur an additional expense if they have to be removed when regeneration has been established. Peter Smallidge and Brett Chedzoy at Cornell University have developed a lower cost alternative – slash wall – using the tops of harvested trees and low value poletimber and culls. These materials are piled into a continuous wall 10-ft tall (to allow for settling) at a cost of ~\$2 per linear foot. The fences also have the advantages of becoming taller if a tree falls on them and now requiring removal.

We have initiated a study replicated at four sites in southern New England and several sites in at the Cornell University Arnot Forest in upstate New York. Both inside and outside of the slash walls, all regeneration taller than 140 cm was tallied on 231 10-m<sup>2</sup> sample points along with 30-140 cm tall regeneration on 4-m<sup>2</sup> points. Additionally, we identified and geo-referenced 1740 trees scheduled to be harvested. We will compare growth and survival of sprouts developing from these trees after they are harvested.

**Completed slash wall in Oakham, MA (left) and arial view of slash wall cut in North Madison, CT (right).**





**Areas with high deer densities often are dominated by dense ferns with a distinct lack wildflowers, shrubs, and tree regeneration.**

### **Deer Herbivory Exclosure Study**

(Drs. Scott C. Williams, Megan Linske, and Jeffrey Ward assisted by Mr. Michael R. Short and Joseph P. Barsky)

Another method to study the impact of deer on natural ecosystems is to compare growth rates and species diversity of vegetation protected from white-tailed deer (*Odocoileus virginianus*) herbivory using 8-ft tall woven wire fences to unprotected plots. In 2018, CAES staff began collecting vegetation data within deer exclosures and adjacent control plots in collaboration with the Metropolitan District Commission (MDC) and the Wildlife Division of the Connecticut Department of Energy and Environmental Protection (DEEP). Deer exclosures prevent deer from accessing vegetation within. Growth rates and species

diversity of enclosed vegetation are compared with that of an adjacent control plot, where deer have access to vegetation. Plots have been sampled for woody and herbaceous plants for the past several years. Preliminary data analyses indicate that herbaceous cover within exclosures is greater than control plots. Density of tree seedlings at least two feet tall is twice as high within exclosures compared to control plots. All locations were sampled again in 2019 and 2020. An additional deer fence was erected on Nepaug Reservoir to investigate impacts to different silvicultural treatments in the presence and absence of deer browsing. Results from this study will reveal plant species composition and growth rates in the absence of browsing deer.

**Impact:** Overabundant herds of white-tailed deer negatively affect forest regeneration by repeated herbivory. This in turn will negatively affect the future of the timber industry and other wildlife populations in Connecticut. CT DEEP and MDC are using these data to scientifically justify and document the results of their deer management program to limit over browsing of vegetation by white-tailed deer to ensure forest regeneration to protect the drinking water supply of greater Hartford. The Metropolitan District Commission will use these data to monitor similar impacts by overabundant deer but as it relates to water quality in terms of minimizing erosion and siltation into surface drinking water bodies.

### **Precommercial crop tree release of white oak saplings**

(Dr. Jeffrey S. Ward assisted by Mr. Joseph P. Barsky in collaboration with the Forest Stewards Guild, South Central Connecticut Regional Water Authority, and Massachusetts Department of Conservation and Recreation)

While oaks are the predominant canopy tree species over much of southern New England, obtaining oak regeneration is often unsuccessful through the region, especially white oak (*Quercus alba*) regeneration. Earlier research by Dr. Ward demonstrated that precommercial crop tree release of northern red, black, and scarlet oaks saplings increases both diameter growth and persistence in an upper canopy position. However, there have been no scientific studies examining whether early release also benefits white oak. Our objective was to determine whether early release of white oak saplings increases survival, proportion remaining in a free-to-grow or better canopy position, diameter growth, and height growth.

As part of a USDA Forest Service grant to enhance regional oak resiliency, we established three demonstration research study areas to examine this question – two sites in Massachusetts and one site in Connecticut. One difficulty we quickly encountered was find sapling stands with sufficient white oak saplings that were 2-m tall or taller. We needed at least 90 potential crop trees (PoCT) to have adequate sample sizes – hence two of the study areas were in Massachusetts. The minimum height was to ensure that stems were above typical deer browse height. The following measurements were taken prior to treatment assignment and implementation: PoCT diameter (mm) at a permanently marked position 1.4 m aboveground, PoCT height (dm) of top and bottom of live crown with a telescoping pole, and PoCT canopy position (suppressed, gap, upper canopy). We also recorded the species, diameter, and height of up to the four nearest neighboring trees interfering with PoCT growth. Each tree was permanent identified with a numbered tag attached with a wire loop. Stems were painted pink to permit quick field identification.

After initial measurements, each of the 402 PoCTs were randomly assigned to one of two initial treatments: control/no release or complete release. No competing/interfering neighboring trees removed for the control treatment. For release treatments, all competing/interfering neighboring trees with crowns within an inverted 45-degree cone of the middle of the PoCT live crown were cut. PoCT diameter and crown class will be measured annually during the dormant season. Top and bottom of live crown will be measured at five-year intervals.

**Impact:** Although white oak is the state tree of Connecticut (also Illinois and Maryland), our earlier surveys found less than five percent of young stands had more than few white oak saplings in a competitive position that would allow them to grow into mature trees. It is likely that white oaks will become a rare sight in future years without proactive management practices such as precommercial crop tree release. Natural resource managers will be able to maintain viable populations of this charismatic species if we find white oak has the same positive response to release as was observed in earlier studies of the red oak group.

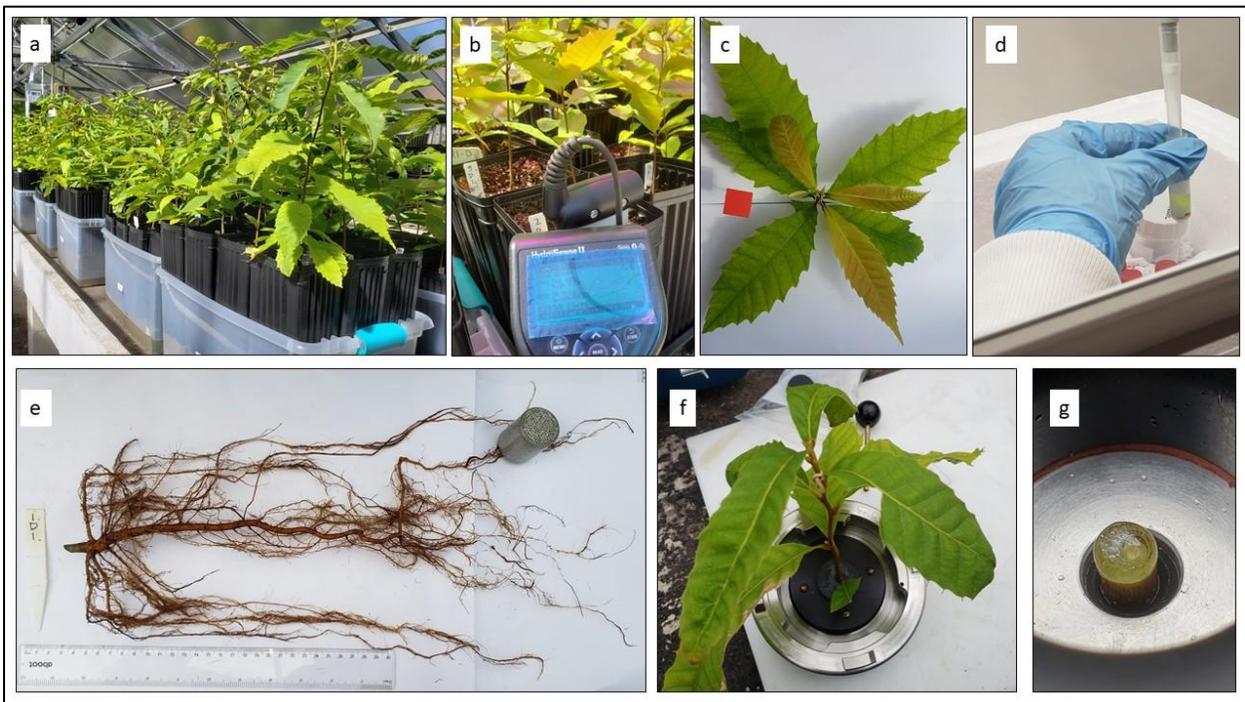


## Impact of genetic heritage on drought stress in trees – Chestnuts as a model system

(Dr. Susanna Keriö with Drs. Nubia Zuverza-Mena, Blaire Steven, Washington da Silva (CAES), and Dr. Jared Westbrook (The American Chestnut Foundation))

Understanding how trees respond to abiotic and biotic stress is key to developing effective management strategies and tools to maintain a healthy forest canopy cover. Climate change is predicted to amplify the abiotic and biotic tree stress, thus resulting in increased mortality. Severe stress events caused by droughts, invasive pathogens, and invasive pests can cause permanent losses of genetic variation in tree populations. The loss of genetic variation will reduce the ability of forests to adapt to the amplifying impacts of climate change.

An example of a native tree that has become functionally extinct due to an invasive pathogen is the American chestnut. The fungus causing chestnut blight (*Cryphonectria parasitica*) was introduced to North America in the early 1900s. Chestnut blight has made natural regeneration of American chestnut largely impossible. Work on germplasm conservation and introgressive hybridization by scientists at the CAES, The American Chestnut Foundation, and several universities in the US has resulted in a selection of backcross hybrids with relatively high blight resistance. However, with the increasing impact of drought on tree health in rural and urban areas in North America, it is of interest to test how the progenies from the chestnut breeding population perform under drought stress.



Tree drought responses were studied in chestnut hybrid seedlings to investigate the mechanisms involved in drought stress responses in *Castanea*. a) A total of 300 chestnut hybrid seedlings were included in the experiment and maintained in drought tubs in a greenhouse. b) Soil water levels were monitored with a soil water content sensor. c-g: Impact of drought on tree growth were estimated by leaf area measurements (c), chlorophyll extractions (d), shoot and root biomass measurements (e), and stem water potential measurements (f-g).

As part of the urban tree stress research program in the Dpt. of Forestry and Horticulture, Dr. Susanna Keriö initiated a project that studies the drought stress responses of chestnut hybrid seedlings. The greenhouse experiments were completed in July 2021, and analysis of biomass, growth responses, leaf chlorophyll levels and shoot water potentials (Figure 1) is pending. Dr. Keriö's research was supported by a Career Award from the Experiment Station Associates, and with a subaward from the American Chestnut Foundation. The results will provide insights into how the genetic heritage of chestnut hybrids affects abiotic stress tolerance in chestnuts. Additionally, in collaboration with Dr. Nubia Zuverza-Mena in the Dpt. of Analytical chemistry, the project studied the impact of foliar application of copper oxide nanoparticles on drought stress in chestnuts. The results from the study will support the efforts to restore the American chestnut into the hardwood forest ecosystems of North America, and will provide insights into the mechanism underlying abiotic stress tolerance in *Castanea* and *Fagaceae*. The information has potential to improve tree drought tolerance in silvicultural and arboricultural settings.

### **New Crops Program**

(Dr. Abigail A. Maynard)

Investigation of new crops is essential to provide new opportunities for farmers during a time of changing agriculture in Connecticut. Today, about 11,000 acres on 733 farms in Connecticut are devoted to vegetable production with a cash value of 30.2 million dollars. This compares to 19.1 million dollars from 582 farms in 2002. Seventy-nine percent of these farms are less than 100 acres in size; sixty-three percent are less than 50 acres in size. With numerous small farms, there is a need for growers to find a diversity of high value niche crops. In addition, small farm sizes in Connecticut have resulted in marketing shifts from wholesale contracts with local supermarkets to direct retail sales. Approximately 560 farms offer direct sales through roadside stands and sales rooms, where a variety of fruit, vegetables, nursery stock, and Christmas trees are offered. About 16 of these are open all year. Nearly 20% of these farms offer pick-your-own fruit and vegetables to reduce the cost of harvest labor. These savings are passed on to the consumer.

The development of a network of farmers' markets in Connecticut's major urban centers and densely populated suburbs is an important segment of direct sales of vegetables to consumers. All produce sold at farmers' markets must be "Connecticut Grown." Farm fresh produce is offered at reasonable prices to urbanites who cannot travel to the farms. Niche crops valued by diverse ethnic groups are generally sold at these markets. According to the Connecticut Department of Agriculture, there were 120 farmers' markets in 2019, attended by over 300 farmers compared to 87 markets in 2007, a 38% increase.

As the popularity of farmers' markets in Connecticut have surged, so too has the need for growers to find a diversity of high value niche crops. Consumers used to a wide variety of fruits and vegetables in large supermarkets are seeking a greater diversity of ethnic and specialty crops at farmers' markets and roadside stands. A recent survey of vegetable growers by The Connecticut Agricultural Experiment Station showed that over 70 vegetable crops are currently being grown in Connecticut. The Connecticut Agricultural Experiment Station has been investigating specialty crops to provide new opportunities for Connecticut's farmers since 1982. Over 50 fruits and vegetables have been studied resulting in over 50 publications. Results have been, and continue to be, communicated to growers at meetings and farm visits. Some of the crops studied in the New Crops Program include globe artichoke, Belgian endive, radicchio, heirloom tomatoes, sweet potatoes, specialty melons, okra, and tomatillos. Research included cultivar trials and experiments to determine the best cultural methods for growing each specific crop in Connecticut. Crops that were chosen have a high market value and an existing or expanding market that would readily accommodate these commodities



**Heirloom tomato trials.** In 2012, tomatoes were the most popular vegetable crop grown in Connecticut with 631 farms growing the fruit. According to an Experiment Station survey, 78% tomato growers grow heirloom tomatoes. A strong market for heirloom tomatoes has developed because home gardeners and consumers seek tomatoes with excellent flavor in a variety of colors, shapes, and sizes. Consumers perceive that heirlooms taste better and have thinner skins than hybridized tomatoes. In addition, heirloom tomatoes demand a higher price on the marketplace. Heirloom tomatoes provide an excellent opportunity for local growers, despite several production problems. Most heirloom tomatoes have little disease

resistance. In addition, because their skin is tender, heirloom varieties may crack easily. Earlier variety trials were conducted on heirloom tomatoes 2004–2006 and 2007–2009 in which a total of 57 varieties were evaluated. A 2018 catalog from Totally Tomatoes lists 138 different heirlooms. In 2020, Dr. Maynard evaluated the yield, quality, and disease resistance of 11 (previously not tested at CAES) heirloom tomato varieties at Lockwood Farm and at Windsor.

**Impact:** Combining both sites, Artisan Orange Jazz had the highest yields (28.5 lbs/plant) followed by Trucker’s Favorite (27.0 lbs/plant), Marianna’s Peace (25.8 lbs/plant), and Trophy (25.7 lbs/plant). Amish Gold Slicer, Old Brooks, and Trophy had consistently the best quality fruit with little cracking. Cultivar selection can dramatically increase yields and grower profits. By growing Artisan Orange Jazz (28.5 lbs/plant) instead of Amish Gold Slicer (20.0 lbs/plant), the grower can produce 8.5 more pounds for each heirloom tomato plant. At a retail price of \$3.49/pound, the grower can gross almost \$30 more per plant by growing Artisan Orange Jazz instead of Amish Gold Slicer. Comparing heirloom tomatoes with conventional tomatoes, the average total yield of the two research plots (165 plants/plot) was 3,993 lbs or a retail value of \$13,936. The same yield of the same number of conventional tomatoes would have a retail value of \$8,026 (\$2.01/pound). The long-term benefits of growing heirloom tomatoes include providing a product that has growing consumer demand and additional revenue for growers who attend farmers’ markets or have their own roadside stands.

**Pawpaw Trials:** Pawpaws are shrubby trees that are native to the temperate woodlands of the eastern United States. The American Indian is credited with spreading pawpaws across the eastern U.S. to eastern Kansas and Texas, and from the Great Lakes almost to the Gulf. They are woodland understory plants that need shade to protect the seedlings but once established prefer full sun. They produce maroon, upside-down flowers which are self-incompatible, requiring cross pollination from another unrelated pawpaw tree. They are not pollinated by bees but by flies and beetles. The pawpaw is the largest edible fruit native to America. Individual fruits weigh 5 to 16 ounces and are 3 to 6 inches in length. The tasty fruit has a smooth, custard texture. In this trial, 4 cultivars of pawpaws were planted in 2002. Since 2013, annual yields have been recorded from each tree.



**Impact:** Thus far, the cultivars Rebecca's Gold and Overleese have averaged the highest yields (77 and 58 fruit/tree, respectively) with Sunflower producing the largest fruit (8.3 oz/fruit). Pawpaws are an ideal fruit for Connecticut growers who attend farmers' markets or have their own roadside stands as they are very delicate and difficult to ship long distances. The long-term benefits of growing pawpaws include an additional unique product and revenue for growers.



**Onion Trials** Onions are one of a few crops which can be marketed for several months after harvest. In this way, growers can sell onions in the fall and winter when most other vegetables are not available. In addition, onions are a good CSA crop in that they can be included in the farm offering every week. There are currently 76 CSAs in Connecticut. Twenty-five years ago, Experiment Station trials evaluated 35 varieties of Spanish and storage onions for yield, quality, and storage longevity. Only 3 of those varieties are still available. In 2020, Dr. Maynard evaluated the yield, quality, and disease resistance of 10 (previously not tested at CAES) storage onions varieties at Lockwood Farm and at Windsor. In addition, onions from each variety were placed in storage after harvest and evaluated monthly for seven months for their storage longevity.

**Impact:** Ailsa Craig and Patterson (10 lbs/10 ft row) averaged the highest yields with Blush (8 lbs/10 ft row) averaging the highest yields of the red varieties. Cultivar selection can dramatically increase yields and grower profits. By growing either Ailsa Craig or Patterson (10 lbs/10 ft row) instead of another yellow cultivar Expression (3 lbs/10 ft row), the grower can triple the yields, producing over 23,000 more pounds per acre of yellow onions. At a retail price of \$0.75/pound, the grower can gross over \$17,000 more per acre by growing either Ailsa Craig or Patterson. For red onions, by growing Blush (8 lbs/10 ft row) instead of Cabernet (4 lbs/10 ft row), the grower can double the yields, producing almost 12,000 more pounds per acre of red onions. At a retail price of \$0.75/pound, the grower can gross almost \$9,000 more per acre by growing Blush. For white onions, Sierra Blanca (7 lbs/10 feet) averaged the highest yields. In terms of storage longevity, Patterson was the best cultivar with 96% still sound after 7 months. Cabernet and Yankee averaged greater than 90% after 6 months. Cultivars that stored well for 4 months were Bridger, Expression, Scout, and Zoey. Cultivars that only stored for at most 2-3 months were Ailsa Craig, Sierra Blanca, and Desert Sunrise. The long-term benefit of growing onions includes additional revenue for growers who attend farmers' markets or have their own roadside stands especially important product in the fall, winter, and spring when other vegetables are not available.

## DEPARTMENT OF PLANT PATHOLOGY AND ECOLOGY

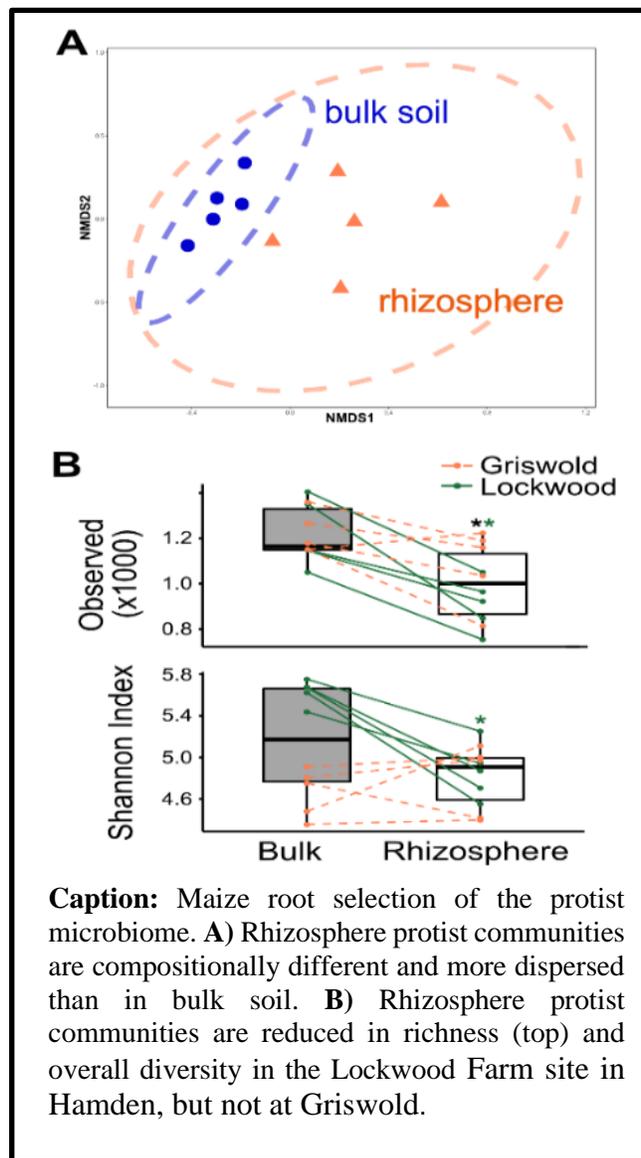
The Department of Plant Pathology and Ecology is led by Vice Director and Chief Scientist, Dr. Wade Elmer and has seven research scientists who are supported by one full-time technician. The Plant Disease Information Office serves as the Department Flag Ship serving the citizenry and agricultural industries of Connecticut and provides vital support to other Connecticut state agencies and CAES departments. The department maintains active cutting-edge research programs that address important disease problems caused by bacterial, fungal, nematode, and viral pathogens of crops and trees important to Connecticut while also addressing national and international issues.

### RESEARCH ACTIVITIES

#### The Roles of Protists in Shaping Microbiomes and Plant Health.

Dr. Lindsay Triplett and Dr. Blaire Steven, along with collaborators at the University of Connecticut, initiated a USDA-funded project in 2019 to understand the functional roles of protists in shaping bacterial communities of plant roots. Protists are single-celled organisms that feed on bacteria in the soil, and some protists can greatly enhance plant growth by releasing nitrogen or feeding on harmful bacteria. In the first two years of the project, we have developed improved methods to profile the protist communities on plants, built an isolate collection of protists from the maize rhizosphere, and profiled the communities on the same roots to identify common and plant-enriched clades. Furthermore, we identified patterns of protist community assembly in the roots and leaves of different nightshade species. In the coming year, these resources will be used to profile the complex food webs occurring at the plant-soil interface and understand how certain protists affect crop health.

**Impact:** Plant-associated microbes have a strong influence on the sustainability of crops and ecosystems, and the market for beneficial microbial products has surpassed \$4 billion. However, the roles of protists among these microbes are still poorly understood. This study will help us understand which protists are most beneficial to plants and why, which could lead to new protist-based strategies for crop enhancement.



**Caption:** Maize root selection of the protist microbiome. **A)** Rhizosphere protist communities are compositionally different and more dispersed than in bulk soil. **B)** Rhizosphere protist communities are reduced in richness (top) and overall diversity in the Lockwood Farm site in Hamden, but not at Griswold.

## Characterization of stress-tolerant physiological states of plant pathogenic bacteria.

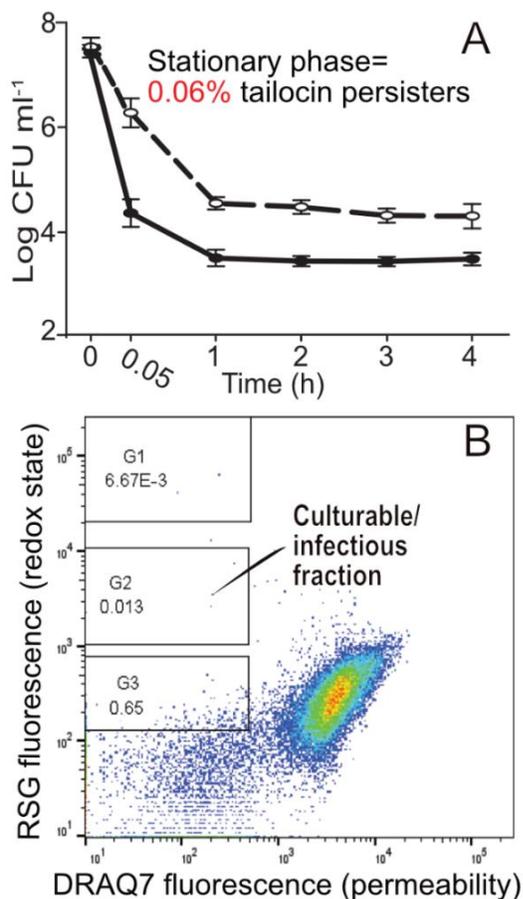
Antimicrobial treatments often leave behind a small population of survivor bacteria, and this is hypothesized to arise from a portion of the population that is in a state of dormancy. Dr. Lindsay Triplett, along with collaborators at the Pennsylvania State University, initiated a USDA-funded project in 2019 to understand the physiological and genetic basis of this survival state, and to determine whether it impacts the effectiveness of biological control treatments. The work in previous years demonstrated that biocontrol peptides and antibiotics leave different populations of survivors, and therefore can eradicate pathogens when applied in combination. In this year, work led by postdoctoral researcher Dr. Ravikumar Patel found that antibiotics trigger most pathogen cells to enter a noninfectious active state, but only dormant cells survived. He also found evidence that bacteria have common strategies to survive very different types of pore-forming antimicrobials used in agriculture. These discoveries can help us understand how bacteria can survive control treatments and point us to new combination strategies for disease control.

**Impact:** Antibiotic and biological control treatments are important tools to fight crop disease, but a small proportion of cells survive treatment for unknown reasons. These survivors can undermine disease control

efforts because they lead to new infection and antibiotic resistance. Understanding why some bacteria survive exposure to these treatments can help us design ways to make disease control methods more effective at a lower cost.

### The contribution of toxin-antitoxin systems to bacterial plant disease.

Toxin-antitoxin systems are genetic modules that are thought to help human bacterial pathogens survive antibiotic treatments. With collaborators at Penn State, Drs. Lindsay Triplett and Ravikumar Patel recently helped discover a single gene that helps confer stress survival to the bean pathogen *Pseudomonas syringae* pv. *phaseolicola*. In the past year, we have confirmed that the toxin slows growth of the pathogen and causes cell elongation. We are currently working to determine its mechanism of action in the cell, and understand how it works to affect stress tolerance in the plant.



**Figure Caption.** *Pseudomonas* maintains active survivors to the peptide tailocin. **A)** Tailocin kills most cells in a few minutes, but 0.06% survive long-term exposure. **B)** By sorting the active and intact fraction, we can separate out the survivors to study their properties. Adapted from Patel et al., 2021.

**Impact:** Toxin-antitoxin systems are thought to play a major role in bacterial survival of antibiotics and survival in the host, making it difficult to eradicate disease in an area. Discovering which ones are important will tell us which ones to target for disease control strategies, and which ones could be used to improve biocontrol strains for improved survival.

### **Manipulation of the apple stigma microbiome reduces the occurrence of fire blight disease**

Flowers are important reproductive organs of Angiosperms. Flowers secrete nutrient rich exudates that support the growth of an assemblage of microorganisms, including both beneficial and pathogenic members, most of which belong to the phylum Proteobacteria. Given the potential role of the microbiome in plant health, manipulating the microbiome to promote growth of beneficial members holds promise in controlling plant diseases. In this study we inoculated four different bacterial strains that were originally isolated from flowers, alone or in mixtures of increasing complexity, onto apple flowers during bloom. We tested if such treatments would influence fire blight occurrence, a disease caused by a bacterium *Erwinia amylovora*, and if we could detect a shift in the structure of the microbiome due to the treatments. We show that various inoculations did influence the occurrence of fire blight, although the level of disease suppression was dependent upon specific bacterial strains. Furthermore, treatments using different strains or strain mixtures resulted in largely unique microbiome structures, with increased representation of the inoculated strains. These data support that disease suppression was due to an alteration of the stigma microbiome structure. Compared to treatments with single strains, a *Pantoea-Pseudomonas* strain mixture produced a homogeneous microbiome structure and better disease control.

### **Metabolic interactions of *Erwinia amylovora* and Apple in the establishment of Fire blight**

Dr. Schultes is studying metabolic requirements of *Erwinia amylovora* to establish disease. *E. amylovora* is the causal agent of a devastating disease of apples and pears called fire blight. Fire blight can cause large losses in apple and pear production and is a major disease for commercial farmers. Understanding the metabolic requirements for virulence by *E. amylovora* will allow for development of new disease control methods. *E. amylovora* grows on different plant tissues as part of the disease process. In springtime, infected cankers generate ooze with overwintered *E. amylovora* that serves as inoculum for blossom infection. Different floral parts serve as bacterial propagation locals during disease establishment. As part of an epiphytic phase *E. amylovora* is deposited on stigmatic surfaces, amplifies and then is introduced into the nectary after a wetting event. Thereafter, bacterial growth occurs in the developing fruit with eventual invasion into the vascular system and subsequent dispersal in the plant. Successful infection by *E. amylovora* relies upon virulence factors to evade and suppress host recognition and defense strategies and then on acquiring adequate nutrition to proliferate and establish disease. Importantly, colonized plant tissues present the bacterium with distinct nutrient environments requiring the bacterial to be metabolically nimble.

The amino acids asparagine and aspartate serve as major nitrogen transport molecules in apples. During springtime asparagine and aspartate are transported from the roots to actively growing tissues including young leaves and flower buds. The peak of asparagine and aspartate concentrations in xylem sap coincides with the development of flower clusters. Infection of flowers by *E. amylovora* initiates as flowers open soon thereafter as the bacteria deposit and propagate on stigmatic surfaces. In addition, asparagine and aspartate are the main nitrogen containing compounds of stigma exudate. Our research investigates the requirement of asparagine biosynthesis and transport by *E. amylovora* for successful disease establishment.

The research project is to identify and biochemically characterize the asparagine synthase genes in *E. amylovora* and then to mutate these loci and test if virulence on apple fruitlets is compromised.

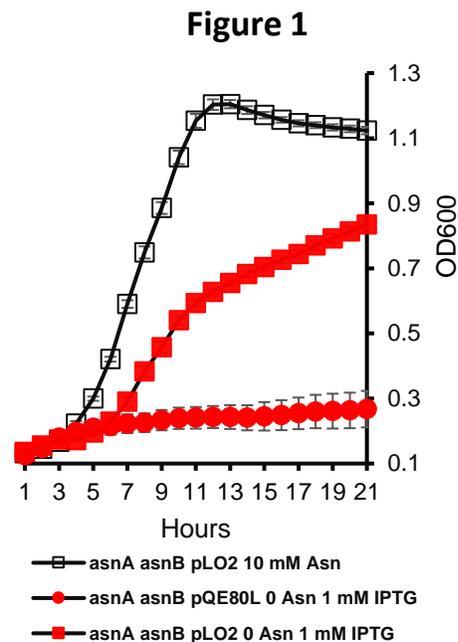


Figure. The *EaAsnB1* gene (in pLO2) complements the deficiency of the *E. coli* auxotrophy upon induction (red squares) and allows for growth in minimal media with no added asparagine.

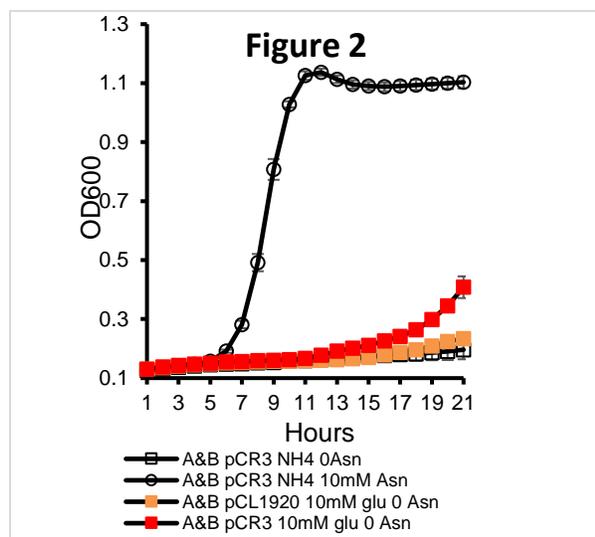
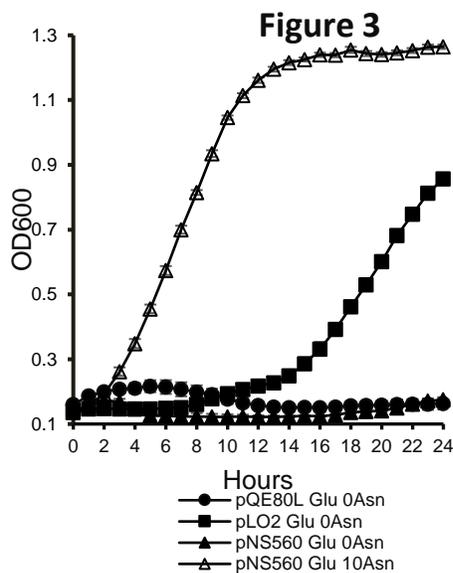


Figure. The *EaAsnB2* gene complements the asparagine auxotrophy in *E. coli*, but only when glutamine is utilized as a substrate (red square).

The next step in our research is to generate an *E. amylovora* strain that is deficient in both *EaAsnB1* and *EaAsnB2*. This strain will be used in functional complementation experiments and in fruit virulence assays. The *EaAsnB1* locus was mutated using the lambda red system resulting in a  $\Delta EaasnB1::CamR$  allele and the *EaAsnB2* locus was disrupted using a targeted pKNOCK-KanR insertion disruption. A growth complementation assay with glutamine as the substrate has yet to be undertaken.

*Escherichia coli* contains two distinct asparagine synthase (AS) genes encoding for EcAsA and EcAsB enzymes. A bioinformatic search of the *E. amylovora* genome indicates no gene encoding for a AsA-type enzyme but two genes encoding for AsB-type enzymes. Our first set of experiments is to determine if the (*E. amylovora* AsB) *EaAsB1* and *EaAsB2* genes encode for actual asparagine synthase enzymes. The coding regions of *EaAsB1* and *EaAsB2* were cloned into includible bacterial expression vector, pQE80L generating plasmids pLO2 and pNS560, respectively, and constructs encompassing the 5'- open reading frame and 3' regulatory regions were cloning into a low copy plasmid pCL1920 as constructs pCR1 and pCR3, respectively.

These plasmids were used in a heterologous complementation study using an *E. coli* strain that has no functioning *EcAsA* or *EcAsB* genes. We constructed an *E. coli* strain that carries a deletion/insertion disruption of *EcAsA* and *EcAsB* loci using the lambda red recombination system. Plasmids containing the *E. amylovora* *EaAsnB1* & 2 genes were moved into the *E. coli*  $\Delta asnA \Delta asnB$  strain and tested for the ability to grow on minimal media without exogenous asparagine. As shown in Figure 1 the *EaAsnB1* gene (in pLO2) complements the deficiency of the *E. coli* auxotrophy upon induction (red squares) and allows for growth in minimal media with no added asparagine.



We have isolated the *E. amylovora* asparagine permease gene, *EaAsnP*, and cloned it into expression vector. In addition, we have generated an *E. coli* and *E. amylovora* strain that are deficient in the endogenous *AsnP* loci. In the future, these strains will be used in a similar manner as described above for functional complementation studies and virulence assays in apple fruits.

Figure. Expression of the *EaAsnB1* locus from plasmid pLO2 complements the asparagine deficiency when NH<sub>4</sub> is the substrate (solid square) while *EaAsnB2* in plasmid pNS560 does not complement the asparagine deficiency under the same conditions (solid triangle) (Figure 3).

**Impact:** Comprehending how *Erwinia amylovora* utilizes the asparagine in disease establishment will contribute to devising new strategies for fire blight control.

## Forest Health Monitoring

### Oak Wilt

Due to the proximity of occurrences of oak wilt in New York state – on Long Island, Brooklyn – Dr. Marra has assumed responsibility for monitoring for oak wilt in the state of Connecticut, a devastating vascular wilt disease caused by the ascomycete fungus, *Bretziella fagacearum*. Symptoms of the disease can be easily confused with other biotic and abiotic factors that also result in crown dieback, and therefore proper and complete diagnosis of oak wilt must be completed in the laboratory, using both traditional culturing methods as well as DNA extraction and PCR. This devastating disease typically kills oaks in the red oak group (red oak, scarlet oak, black oak, pin oak, bear oak, in Connecticut) within a single season, and spreads rapidly via root grafts as well as vectoring by native sap beetles. To gain a more thorough understanding of the disease and its diagnosis, in August 2019, Dr. Marra attended and participated in a diagnostics workshop hosted in Minnesota by the US Forest Service and the University of Minnesota.



Figure 1. Clockwise from top left: a red oak, infected with oak wilt, in a forest in a Minneapolis suburb (R. Marra, August 2019); a black oak in Branford with symptoms strongly suggestive of oak wilt; a twig from the Branford black oak with vascular streaking suggestive of oak wilt; foliage from the black oak with characteristic oak wilt symptoms (R. Marra, July 2020).

Given the proximity of recent oak wilt findings in New York state, Dr. Marra continues to educate the public on symptoms to be on the lookout for, through presentations to, and interactions with, landscape and tree-care professionals, as well as to Master Gardener classes.

In early July 2020, an arborist contacted Dr. Marra regarding a black oak on residential property in Branford that experienced sudden and rapid dieback. Dr. Marra visited the oak and collected samples and photographs (Figure 1). After consultation with USFS oak-wilt expert Dr. Jennifer Juzwik, samples were shipped to her lab at the University of Minnesota, while simultaneously processing samples at CAES for DNA analysis and fungal culturing. Results from CAES matched those from USFS: while there was no evidence of *Br. fagacearum*, the vascular streaking appeared to be the result of infection by *Botryosphaeria dothidea*, a saprophyte that can become an aggressive pathogen in trees under stress.

**Impact:** Oak wilt is a devastating disease that threatens Connecticut’s abundant red oak stock, including red oak, black oak, pin oak, scarlet oak, and bear oak. Based on the trajectory of outbreaks in neighboring

New York state, the disease is most likely to turn up in residential areas, which makes scouting and surveys futile. We are therefore dependent on the informed vigilance of tree-care professionals, which includes arborists, tree wardens, and other landscape managers. Also essential is the ability of the CAES staff to act quickly in diagnosing and confirming the presence of *Br. fagacearum*, and communicating this to the state's DEEP, which will be responsible for developing a response protocol.

### ***Forest Health Monitoring***

#### ***Beech Leaf Disease***

Beech leaf disease (BLD), caused by the foliar nematode, *Litylenchus crenatae mccannii* (*Lcm*), was first identified in 2012 in Ohio, and subsequently in western regions of PA and NY, as well as in Ontario, Canada. BLD can kill young trees within seven years of detection. BLD was first found in Connecticut in 2019 by Drs. Li, Smith, and Marra, on American beech (*Fagus grandifolia*) in lower Fairfield County. There were no other reports of BLD outside of Fairfield County in 2019. In the summer and fall of 2020, with USFS R9E Emerging Pest funding, Dr. Marra and seasonal research assistant Cora Ottaviani conducted distribution surveys throughout the state. By September 2020, 42 state forests, state parks, preserves, and water-company properties distributed throughout the state had been inspected for BLD, with the disease confirmed in 19 of the sites (Figure 2). BLD was confirmed and found sporadically abundant in additional parts of Fairfield County, as well as in New Haven, Middlesex, and New London Counties; BLD was more sparsely distributed in the lower portions of Litchfield, Tolland, and Windham Counties. Dr. Marra also confirmed BLD in RI and on European beech (*F. sylvatica*) in eastern MA using a PCR-based diagnostic assay developed by Dr. Marra. The R9E grant also funded the installation of 11 long-term BLD monitoring plots throughout the state (Figure 2). Data for the USFS are being collected from these plots this year, in 2021, and will be revisited for data collection annually henceforth.

This year, 2021, saw an explosion of BLD throughout the state, especially in the lower four counties (Fairfield, New Haven, Middlesex, and New London). BLD symptoms this year are exacerbated by last year's record heat and drought, compounded by the unusually dry 2021 spring, manifesting in premature leaf drop and branch dieback, eliciting an outpouring of public inquiries and concerns. Dr. Marra was interviewed by various local media, which helped to educate the public about BLD.

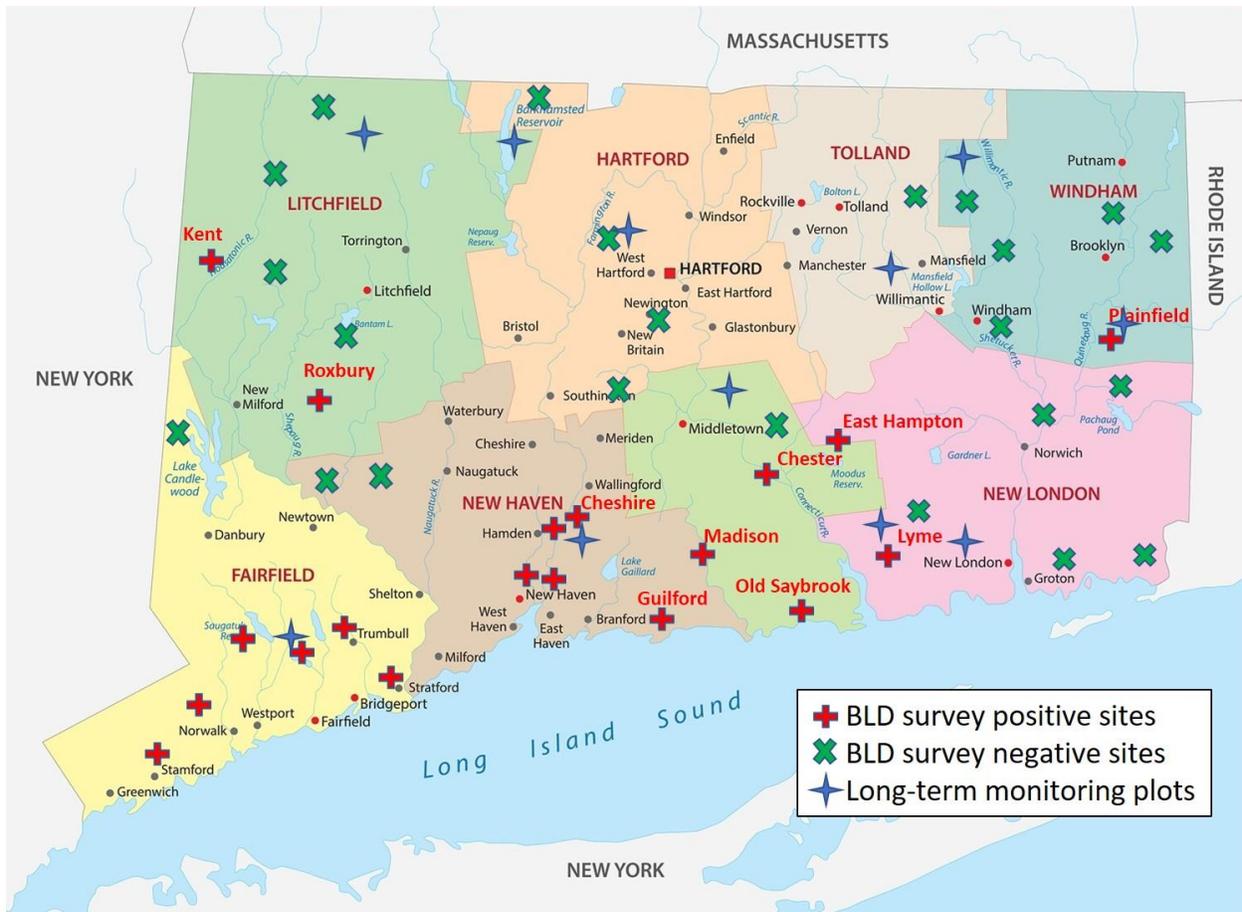


Figure 2. Long-term BLD monitoring plots, and 2020 survey sites, indicating where BLD was found and not found.

The characteristic foliar symptoms of BLD (Figure 3), darkening and hypertrophy in interveinal bands of leaves, appear immediately upon leaf-out. However, at this stage in early spring, and until late June or early July, juvenile and adult nematodes are rarely found; presumably, only nematode eggs are present in symptomatic tissue. To permit early-season confirmation of the presence of the nematode, Dr. Marra developed a rapid PCR diagnostic test that targets a 682 bp portion of the mitochondrial cytochrome oxidase subunit 1 gene (CO-I), permitting confirmation of the presence of *Lcm* using DNA extracted from <20 mg of leaf tissue (approximately one hole-punch leaf disc). Dr. Marra used this method to reveal the random and patchy distribution of the nematode (eggs, presumably) within symptomatic interveinal bands. This marker system is also being used to develop a real-time PCR discrimination assay that will allow us to distinguish between *Lcm* and the Japanese subspecies, *L. crenatae crenatae* (*Lcc*); this tool will be essential for determining if *Lcm* originated in Asia.



Figure 3. Beech leaf disease is characterized by a darkening of interveinal bands, best seen by viewing foliage from below with lighting from above.

As a member of the Beech Leaf Disease Working Group, comprising researchers in OH, NY, the USDA-ARS, and Ontario, Canada, Dr. Marra is developing a molecular genetic fingerprinting system for *Lcm*, consisting of a suite of microsatellite loci that will be used in population genetic studies aimed at testing hypotheses on paths of movement of the nematode, to gain insights into how the disease spreads at both local and regional scales. To this end, Dr. Marra generated a whole-genome sequence of *Lcm*, which has proven highly valuable to several other research programs in the BLDWG, including microbiome studies. Eighteen microsatellite loci have been identified and are currently being tested for the presence of multiple alleles among nematodes at varying levels: within and among leaves, trees, sites, and states.

### ***Forest Health Monitoring***

#### ***Forest Ecosystem Monitoring Cooperative***

In 2019, Dr. Marra joined Dr. Ward in exploring the feasibility of Connecticut’s participation in the multi-state Forest Ecosystem Monitoring Cooperative, a regional partnership of forest-health cooperators and scientists from New England and New York that provides a framework for collaborative sharing of research and observations.

In 2020-2021, Drs. Marra and Ward are the Connecticut State Coordinators for the formation of the Connecticut State Partnership Committee (CT-SParC), and share a seat on the FEMC Steering Committee, which develops FEMC strategic planning, proposal reviews, region-wide work plans, and Connecticut-specific “Sprint” projects.

## **Genetic Variation and Dispersal Dynamics in *Fusarium palustre*, associated with Sudden Vegetation Dieback in salt marshes of eastern United States**

Dr. Marra's research on *Fusarium palustre*, the fungal pathogen of *Spartina alterniflora* (described previously by Drs. Elmer and Marra) made progress despite the attention given to beech leaf disease and oak wilt. Because of the unique nature of *F. palustre* distribution (i.e., in isolated patches in discontinuous salt marshes), Dr. Marra is testing hypotheses about the introduction and spread of the pathogen, and relatedness among populations. A key component of wetland dieback syndrome, *F. palustre* has been shown in Dr. Marra's lab to have a surprisingly high degree of genetic diversity both within and among populations sampled from various marshes ranging from Louisiana to Maine. Amplified Fragment Length Polymorphisms (AFLP), used in an earlier study, showed a significant amount of genetic variability among a group of approximately 100 *F. palustre* isolates from North America as well as several from China, a surprising result, given the absence of an observed sexual state, and therefore no obvious mechanism for generating the observed levels of genotypic diversity. Based on this finding, and in order to study relatedness (or lack thereof) of disjunct populations, Southern Connecticut State University graduate student Alysha Auslender developed a suite of 47 microsatellite markers for *F. palustre*, all of which showed remarkably high genetic diversity among 32 isolates representing the currently known distribution of the fungus along the Eastern Seaboard, ranging from Louisiana to Nova Scotia, as well as China.

A subset of 20 of these microsatellite markers were used to study population differentiation among three populations of *F. palustre*, collected by Dr. Wade Elmer from salt marshes in Connecticut: (1) 50 isolates from West River in Guilford, collected in 2007 (WR07); (2) 22 isolates from West River, CT (same site as in "1"), collected in 2008 (WR08); and (3) 24 isolates from Hammonasset Beach State Park, Madison, CT, collected in 2008 (HAM). All isolates were confirmed to be *F. palustre* based on morphology as well as partial sequence of the translation elongation factor 1-alpha (*tef1*) gene. Comparisons between populations "1" and "2" will facilitate a test for genetic differentiation between temporally disjunct populations collected from the same site, an important consideration given seasonal and tidal fluctuations that are characteristic of salt marshes. Comparisons between populations "2" and "3" will allow a test for genetic differentiation between two spatially disjunct populations that were collected in the same year.

This research is ongoing. All three populations have been genotyped at the 20 microsatellite loci, all of which are polymorphic both within and among the three populations (Table 1). Using these data, hypotheses will be tested on both geospatial and temporal population differentiation.

Table 1. Twenty microsatellite loci segregating among three Connecticut populations of *F. palustre*.

LOCUS	# ALLELES
aac1	12
aaga1	7
atc1	5
atg2	7
cat1	10
cat2	7
cat3	8
ctc1	5
gca1	7
gta1	9
gtt1	12
gtt2	11
gtt3	12
tcc1	5
tct2s	9
tga1	8
tgagg1	8
tgc1	8
ttc1	16
ttg1	5

The amount of genetic variability in populations of *F. palustre* was unexpected, given that no sexual state has been observed for this fungus (like many *Fusarium* species). Therefore, we conducted a search for the presence of the canonical ascomycete mating-type locus and alleles, *MAT1-1* and *MAT1-2*, by doing a local BLAST search against the whole-genome sequence (WGS) using publicly available *MAT1-1* and *MAT1-2* sequences of relatively closely related ascomycetes. After identifying an intact *MAT1-2* allele in the WGS, primers were designed to flank the locus, thus facilitating the identification of the *MAT1-1* allele in a number of other *F. palustre* isolates. Once complete sequences were obtained for both alleles, a real-time PCR assay was developed to allow rapid assignment of mating-type to *F. palustre* isolates. In all three populations, as well as the screening population, the ratio of *MAT1-1*:*MAT1-2* was not significantly different than 0.33:0.66, according to Chi-square analysis (Table 2). The significance of this ratio is currently under investigation.

Table 2. *MAT1-1*:*MAT1-2* allele segregation in the *F. palustre* screening population and the three Connecticut populations HAM, WR07, and WR08. Numbers in parentheses are the expected number of alleles under a null hypothesis ratio of 0.33:0.66; the Chi-square test confirms the null hypothesis.

	<i>MAT1-1</i>	<i>MAT1-2</i>	$X^2$
HAM	11 (8)	13 (16)	0.192633
WR07	16 (16)	33 (33)	0.923449
WR08	6 (7)	16 (15)	0.548602
SCRN	11 (11)	21 (21)	0.897332
ALL	44 (42)	83 (85)	0.747622

**Impact:** Nothing is known about the means of dispersal of *F. palustre* from one salt marsh to the next. This is particularly intriguing given that salt marshes are typically disjunct in their distribution, and experience tidal inundation on a daily basis, suggesting the possibility that dispersal is by means of water. We currently

do not know the means by which *F. palustre* generates these high levels of genetic and genotypic diversity among the sampled isolates, a conundrum given the absence of a known sexual state. Research into the epidemiology and dispersal dynamics of this fungus is critical, given the importance of salt marches as buffers against the impacts of climate change and associated sea-level rise on coastal ecology.

### **Perennial Canker caused by *Neonectria ditissima***

Perennial target canker (also known as *Neonectria* canker) continues to be researched by Dr. Marra. This research focuses on the ecology and genetics of the causal agent of perennial target canker, the fungal pathogen, *Neonectria ditissima*. The goal of this research is to gain a fuller understanding of the life history, evolution, and population dynamics of *N. ditissima*, particularly with respect to its principal hosts, black and yellow birch (*Betula lenta* and *B. alleghaniensis*) (Figure 4). Fundamental knowledge of the natural history of *N. ditissima* is lacking, yet is an essential component to effective management strategies. Dr. Marra has developed the field techniques and laboratory tools necessary to the study of this fungus and the disease it causes, and has used these tools and methods to examine the relationship between mating system and genetic structure.

Previously, Dr. Marra developed and used a set of 13 polymorphic microsatellite markers to study mating and genetic differentiation in *N. ditissima* from two nearly adjacent sites at West Rock Ridge State Park in New Haven, CT. This study revealed a paradoxical juxtaposition of high levels of genetic diversity alongside high levels of selfing and biparental inbreeding. The results confirm an earlier hypothesis that *N. ditissima* has a “mixed mating system” (selfing and outcrossing occurring in the same population). All observations of selfing were confirmed through the use of AFLPs.

Having previously identified the two alleles (idiomorphs), *MATI-1* and *MATI-2*, of the mating-type locus (*MATI*) in collaboration with a graduate student, Matthew Stauder, at West Virginia University, Dr. Marra, assisted by a 2019 USDA Plant Health Fellow, Olivia Rianhard (Eastern Connecticut State University), screened a collection of isolates obtained from cankered trees in Connecticut, using a Taqman-based real-time PCR assay to allow for quick and efficient screening of large numbers of isolates. Using this protocol, Ms. Rianhard screened numerous sets of sexual (ascospore) progeny that have previously been shown to be the result of self-fertilization by analysis at 13 microsatellite loci. Preliminary results suggested that the *MATI* idiomorphs segregate even among ascospore progeny that appear otherwise to be the result of self-fertilization, despite the occurrence of only one or the other idiomorph in the parental genome. In order to confirm this observation, Dr. Marra, assisted by student interns from the University of New Haven, reisolated DNA from new cultures of these progeny arrays, taking utmost precautions in avoiding contamination during extraction, confirming the observation that these progeny arrays, presumably the result of self-fertilization due to the absence of segregation at any microsatellite loci, do indeed segregate at the MAT locus. The genetics underlying this heretofore undescribed phenomenon are currently under investigation.

**Impact:** Due to its increasing abundance in Connecticut, black birch is a tree of growing importance and concern. Although trees infected with perennial canker can persist for decades, the extensive scarring caused by the cankers renders them of little value for lumber or veneer. Our efforts to more fully understand the biology and natural history of *N. ditissima* is an important contribution in the fields of mycology and evolutionary biology, and will contribute to the identification and utilization of control strategies. An important result of this research is that it provides empirical support for theoretical models that posit the importance of biparental inbreeding to the evolutionary stability of mixed mating.



Figure 4. Black birch (*Betula lenta*), with multiple *Neonectria ditissima* cankers distributed along stem. Because cankers typically only form on stems younger than ~15 years of age, lower cankers were likely initiated many years before those higher up the stem.

### Survey for grapevine leafroll-associated viruses in Connecticut

Washington da Silva (PI), Gale Ridge (Co-PI), and Francis Ferrandino (Co-PI)

Dr. da Silva is leading a three-year statewide survey of the viruses that cause grapevine leafroll disease (GLD) to develop efficient management strategies to control this devastating disease in Connecticut (CT) vineyards. GLD is the most detrimental and widespread viral disease of grapes worldwide (Figure 1). It can cause up to \$40,000 loss per hectare during a single growing season. There is no cure for GLD. The only management options are to plant healthy grape seedlings and to eliminate infected plants from vineyards, because of vectors that can spread the viruses from infected to healthy plants. The problem is that GLD can take up to five years to develop visual symptoms and many common grape cultivars do not show GLD symptoms when infected. In this project, we joined experts in plant virology, entomology, and epidemiology in a collaborative effort to identify the extent of the viruses' spread and the insect vectors (hemipterans) capable of transmitting these viruses in CT. With this information, we will then be able to raise awareness among grape growers, vineyard managers, and vintners on the detrimental effects of this devastating virus disease in grape production and quality. CAES is partnering with the Connecticut Department of Agriculture in knowledge dissemination and outreach. The long-term goal is to develop a statewide management plan that is mechanistically and economically feasible, which might then be adopted by all growers throughout the northeastern region of the United States.

**Impact:** With the first two years' survey results in hand, we are assisting growers on decision-making processes. We have visited 25 vineyards and, overall, 54% of the samples tested were positive for at least one of the viruses that cause leafroll disease (Figure 2). We are providing real-time data to growers of the percentage of their vineyards that is infected with leafroll disease, and the plants that tested positive for the

viruses so that growers can remove infected plants to reduce the viruses' spread (Figure 3). Our new virology lab at CAES is up and running - the only plant virology lab in the New England region. It is set up with all the equipment and resources needed to provide services to growers so that samples can be tested before planting to avoid introduction of grapevine virus diseases in CT vineyards. Growing grapes is an expensive venture and having information on the presence of grapevine viruses in the state, the right identification of the virus species, the presence of vectors, and percentage of virus incidence statewide will help to maximize resources and mitigate losses. We are already able to advise growers on when to remove plants and to spray pesticides to reduce vector populations in order to reduce risks of virus spread in the vineyards. And, in worst-case scenarios, we will provide guidance as to when it is economically practical to remove all plants and start the vineyard fresh.

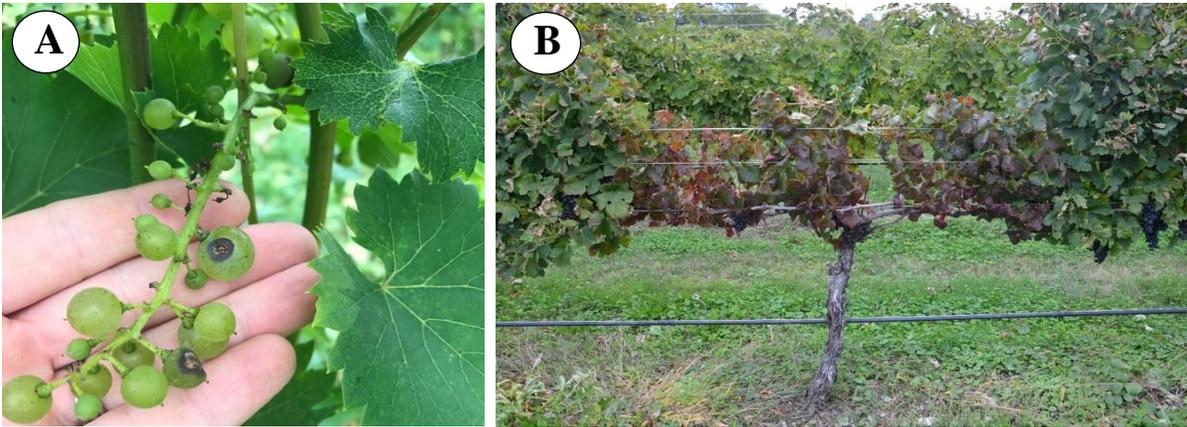


Figure 1. Mosaic-like symptoms on leaves and small berry malformation (A) and development of redness on grapevine young shoots and old leaves (B) resembling leafroll diseases.

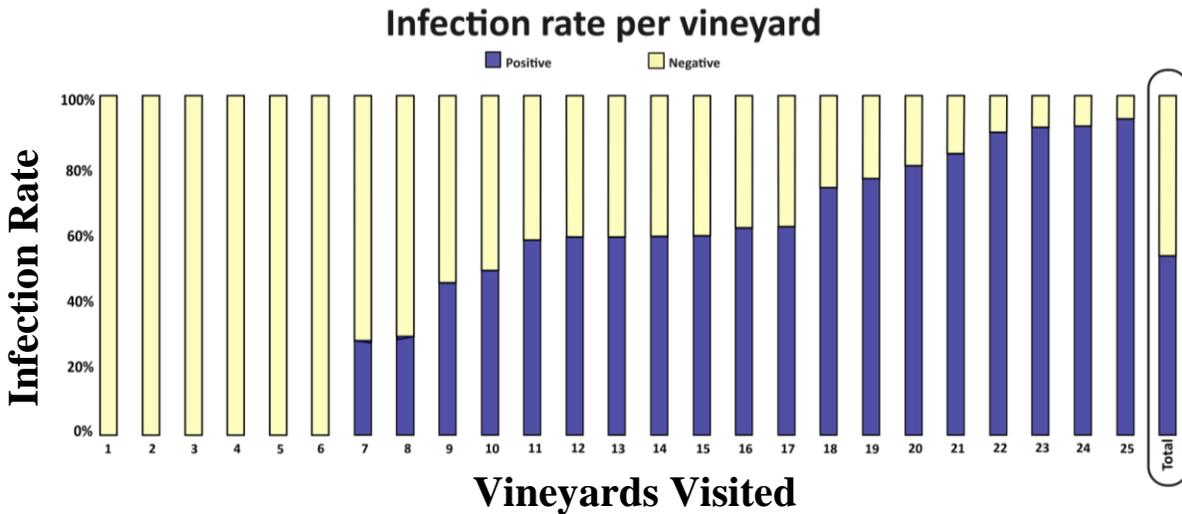


Figure 2. Twenty-five vineyards were analyzed for their incidence of GLRaV-1, -2, -3, and -4, as well as GFLV, ToRSV, and TRSV utilizing DAS-ELISA. Six vineyards tested negative for all seven viruses, whereas the remaining vineyards 7-25 had levels of overall virus infection ranging from 30% to 93%. A bar representing the total infection incidence in this study, according to DAS-ELISA, is circled at the far right with an incidence of 54%.



Figure 3. A grape plantation, Cabernet Franc variety, from a Connecticut vineyard. Half of the grape plot tested positive for grapevine leafroll virus 1 and 3 (see enlarged photo for typical leafroll disease symptoms). The other half tested negative and we can visually see the difference between infected (right side of the plot) and non-infected plants (left side of the plot). The grower was advised to remove the entire left side of the plot to mitigate further spread of the viruses to other sections of the vineyard by insect vectors.

## Using nanoparticles to deliver dsRNA for controlling destructive plant viruses

The achievement of virus resistance in plants by the application of exogenous double-stranded RNA (dsRNA) is well documented. Essentially, dsRNA is recruited by the plant RNA silencing machinery to guide the cleavage of complementary virus RNA by a sequence-specific manner, resulting in virus infection suppression. The trouble is that the application of naked dsRNA on plant leaves provides a short-lived protection window (~ five days) against target viruses - it is quickly assimilated by the plant regulatory mechanisms and also degraded by environmental factors. However, just recently nanoparticles have emerged as a promising dsRNA delivering system that protects and gradually delivers dsRNA in plants. Drs. da Silva and Zuverza-Mena are working around the clock to establish this technology at CAES with the long-term goal of helping the development of innovative ways to control plant virus infections. Their three specific objectives are: 1) to characterize and screen dsRNAs from tobacco plants infected with potato virus Y (PVY), 2) to evaluate commercially available nanoparticles and to synthesize and characterize nanoparticles as potential dsRNA delivering systems, and 3) to use nanoparticles to sustainably deliver those dsRNA molecules to protect tobacco plants against this devastating virus.

**Impact:** Tobacco is a valuable crop in Connecticut (CT) with an annual farm-gate value of ~\$41M, which is planted primarily for cigar wrapping and no blemishes are acceptable on the leaves. Potato virus Y (PVY) is associated with deformities on leaves of several solanaceous species, including tobacco (Figure 1), and it has become an endemic disease in CT and neighboring states. In 2009 alone, losses in tobacco linked to PVY infections were greater than \$10M in CT and contributed to 45% of the crop being discarded - the loss was 100% in some farms, causing growers to cease all production. The results from this research have the potential to change the way we protect plants and to create sustainable plant virus disease control strategies that will help to mitigate crop losses due to virus diseases in CT tobacco farms. We have identified regions in the PVY genome (Figure 2), by Illumina high-throughput sequencing, likely to be efficiently targeted by RNAi silencing machinery and successfully designed dsRNA molecules (Figure 3) that protect tobacco plants against PVY infections for up to five days (Figure 4). We are now designing, synthesized, and testing different nanoparticles to act as nanocarriers for a sustainable delivery of dsRNAs to suppress PVY infections in tobacco plants (Figure 5). An overview of the experiments being conducted is highlighted in Figure 6.



Figure 1. Mosaic, chlorosis, and necrosis on tobacco leaves caused by PVY.

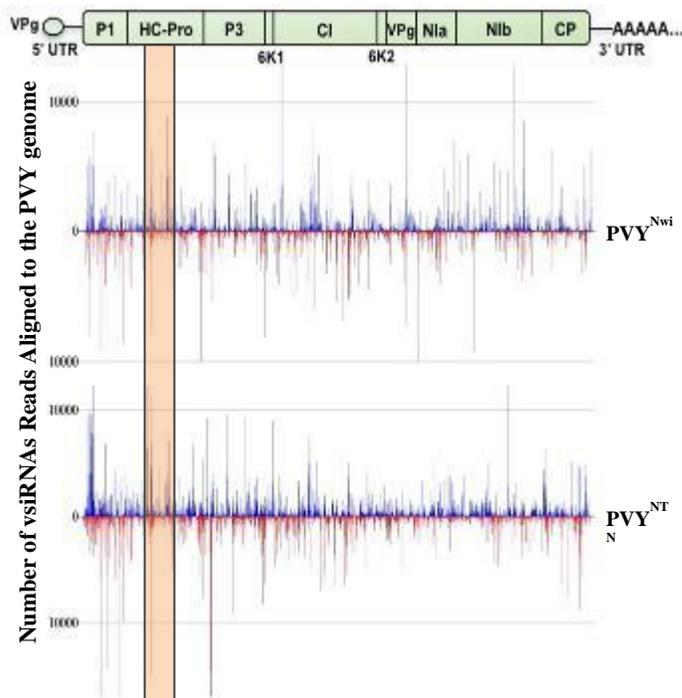


Figure 2. Graphical representation of total sense (blue bars) and antisense (red bars) vsRNA reads aligned to PVY<sup>Nwi</sup> and PVY<sup>NTN</sup> genomes. The horizontal green schematic representation on top denotes the PVY genome. The orange vertical box depicts a vsRNA hotspot region, common on both PVY strains (Nwi and NTN) genomes, detected on the helper-component (HC-Pro) cistron that was used for dsRNA synthesis.

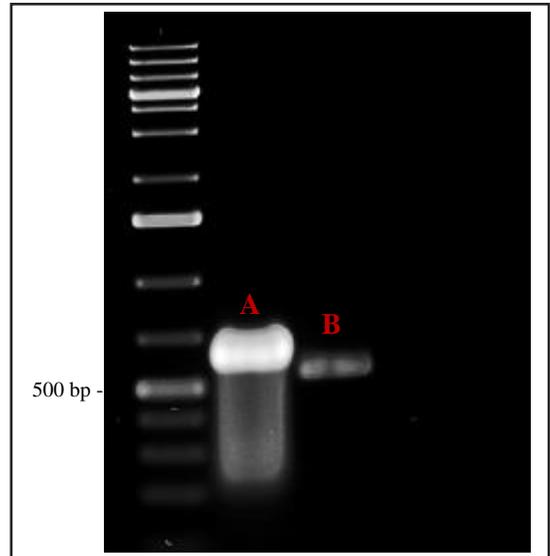


Figure 3. DsRNA synthesized from the helper-component (HC-Pro) region of PVY genome. **A**, dsRNA. **B**, PCR product (HC-Pro region) used as template for dsRNA synthesis.

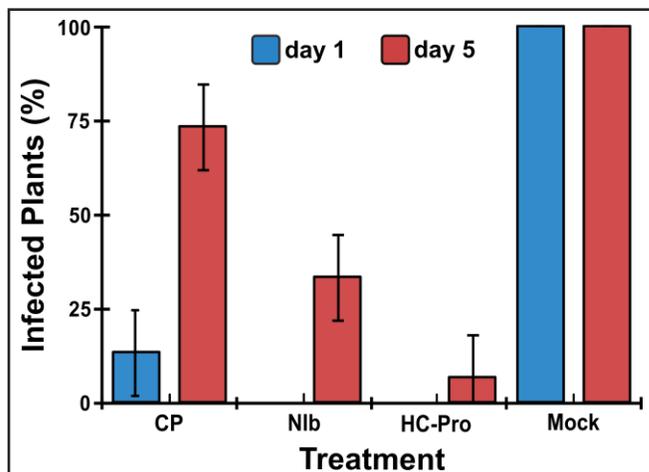


Figure 4. Percentage of infected plants (n=5) post treatment with dsRNA (from 3 different cistrons) followed by PVY<sup>Nwi</sup> inoculation 1 or 5 days post dsRNA application. Three independent experiments were performed.

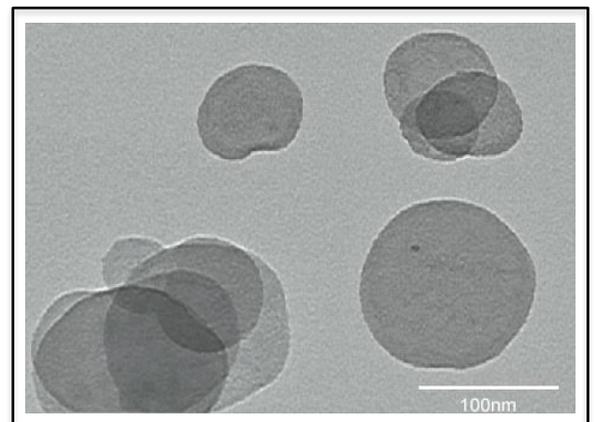


Figure 5. TEM image of chitosan-tripolyphosphate(TPP)-dsRNA complex synthesized in our preliminary studies by Dr. Shidore.

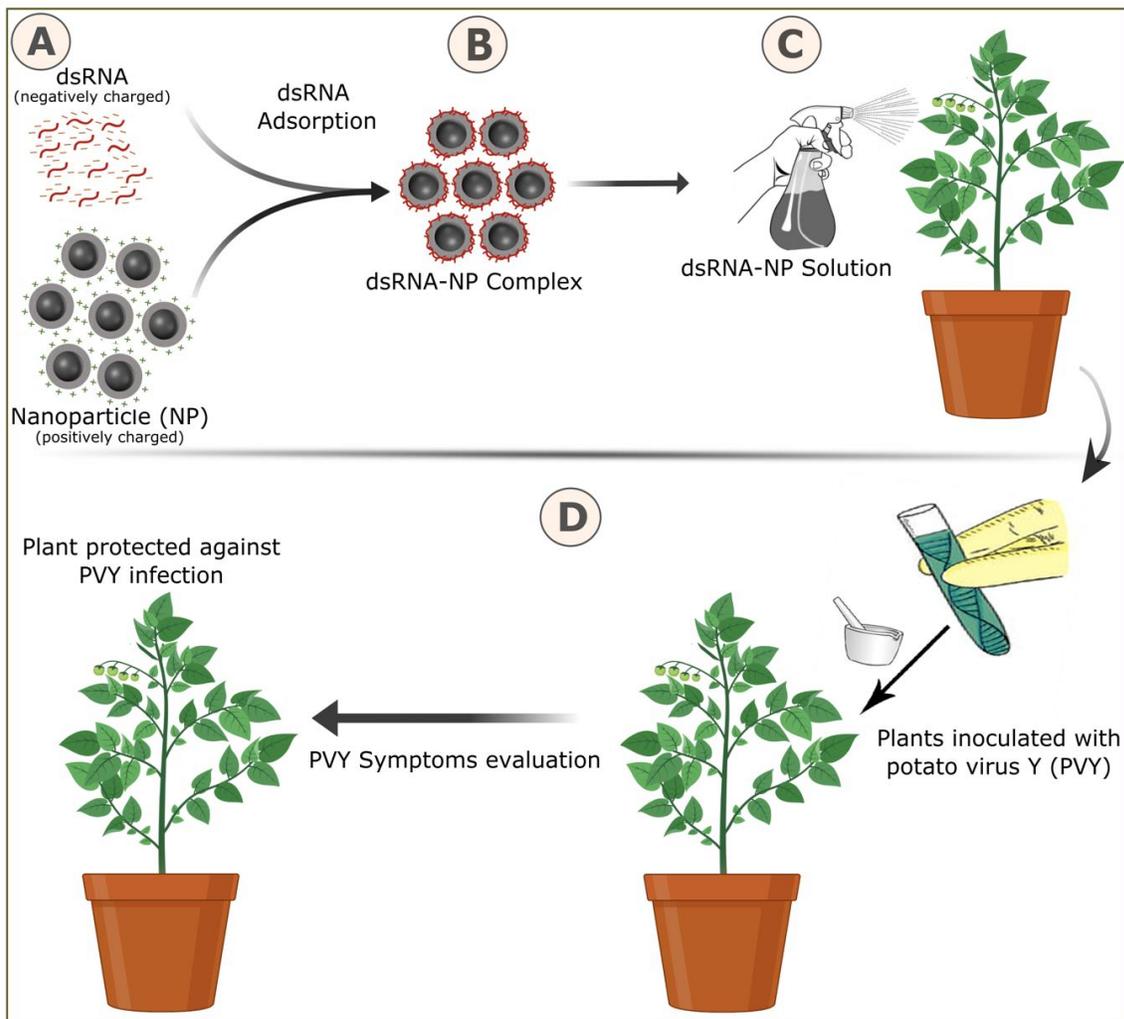


Figure 6. Overview of the research proposed. **A)** synthesis of dsRNA and chitosan, carbon dots (CDs), or silica-based nanoparticles (NP). **B)** dsRNA molecules adsorbed onto surface of positively charged chitosan, CDs, or silica-based nanoparticles (forming a dsRNA-NP complex) for slow release of dsRNA into plant leaves. **C)** dsRNA-Silica NP complex will be encapsulated by a layer of silica for slow-release. **D)** Virus inoculation post application of dsRNA-NP complexes formulations to determine which design will provide the best protection for potato plants against PVY infection. **E)** The best dsRNA-NP complex formulation will be used for treating potato plants in the field against PVY infections.

## Using Nanoparticles of Cu to Enhance Plant Health

Nanoparticles (NP) of Cu (CuO and CuPO<sub>3</sub>) have shown to be effective promoters of plant health when applied foliarly. Dr. Elmer along with Dr. White (Analytical Chemistry) have partnered with the NSF-funded Center for Sustainable Nanotechnology (CSN) to advance the use of NP of Cu in plant health management. Host defense mechanisms are activated by Cu-containing enzymes like polyphenol oxidase, which contains four atoms of Cu per molecule. This enzyme catalyzes the oxidation of *o*-diphenols to produce antifungal *o*-quinones. These and other defense products are increased by NP of Cu. Numerous greenhouse and field trials on many vegetable and ornamental plants have been conducted. NP of Cu frequently outperform the NP of other micronutrients like B, Mn, and Zn and provide season-long protection following a single application.

The most recent success was in using NPs of CuO to suppress Fusarium wilt of chrysanthemum, a potted ornamental that generates considerable income for Connecticut growers. The role of nanoparticles of CuO in ornamental crop management was studied over a three-year period. In 2017, 2018, and 2020, nanoparticles of CuO, Mn<sub>2</sub>O<sub>3</sub>, or ZnO were foliarly applied at 500 µg/mL (0.6 mg/plant) to chrysanthemum transplants and planted in potting soil noninfested or infested with *Fusarium oxysporum* f. sp. *chrysanthemi*. An untreated control and a commercial fungicide, fludioxonil, were also included. Chrysanthemums treated with nanoscale CuO had a 55, 30, and 32% reduction in disease severity ratings compared to untreated plants in 2017, 2018, and 2020, respectively (Figure 1). Specifically, the averaged dry biomass for the 3 years was reduced 22% by disease, but treatment with nanoscale CuO led to a 23% increase when compared to controls. Horticultural quality was improved 28% with nano CuO and was equal to the fungicide. These findings agree with past reports on food crops where single applications of nanoscale CuO improved plant health, growth, and yield.



Figure 1. Chrysanthemums treated with nanoscale CuO, MnO, ZnO, or fungicides with and without *Fusarium oxysporum* f. sp. *chrysanthemi*.

The ornamental industry is an ideal venue for implementing nanotechnology since ornamentals can avoid negative perceptions that consumers have between nanotechnology and food safety. Since nanoscale CuO is acting as a nano fertilizer, it could be quickly registered and avoid potential hurdles that emerge with fungicide regulation. It is also worth noting that the industry is largely based on transplant production, which could provide an early-season window for nanoscale CuO application before being transported to production sites. There is no reason to expect that the 20-40% decreases in disease development cannot be enhanced by a tuning of nano Cu chemistry as demonstrated on other crops. Additional work can also focus on the simultaneous delivery of multiple nanoscale micronutrients as part of a more complex dosing regimen to stimulate different disease and stress response pathways in a coordinated and time-dependent fashion. In conclusion, we believe that nanotechnology can readily be applied to achieve the higher

standards of quality for the ornamental plant industry, while simultaneously reducing the need for expensive and potentially toxic synthetic fungicide treatments.

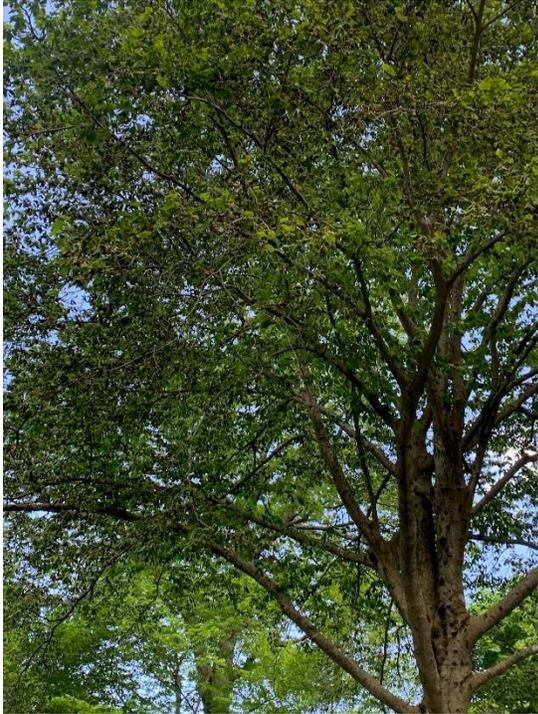
**Impact:** These studies revealed that applications of NP of Cu offer an improved delivery system for applying CuO to susceptible tissues. Nanoparticles offer great promise in increasing food and fiber production without additional chemical inputs and may be the new weapon in plant disease management by enhancing plant health for nominal costs and without the cultivation of new land or application of chemicals.

### ***Disease Survey***

In the summer of 2020, a long period of dry and hot weather conditions resulted in severe heat and drought stress on trees and shrubs. Cool and wet weather in early spring favored fungal and bacterial foliar diseases on woody ornamentals, fruit trees, and bushes. Dr. Yonghao Li, assisted by Ms. Katherine Dugas, diagnosed a wide range of fungal, bacterial, viral, nematode, and abiotic diseases on trees, shrubs, herbaceous ornamentals, lawn grasses, fruits, and vegetables during the year.

#### **Herbaceous and Woody Ornamentals:**

Since beech leaf disease was first detected in Connecticut in 2019, it has been found in all counties of the state. Compared to the last two years, more severe damage with distorted and leathery leaves was observed on infected trees in the spring of 2021. Anthracnose also contributed to necrosis of leaves on affected beech trees. Numerous reports of arborvitae trees dying were received in fall 2020 and spring 2021, which was contributed by drought and heat stress in summer 2020. Phytophthora root rot and poor root conditions also contributed to declining of arborvitae. Pestalotiopsis needle blight was prevalent in arborvitae, which might be associated with winter injury and environmental stress on the trees. Boxwood blight was found occasionally in landscapes and nurseries. Severe dieback of boxwood plants in landscapes were contributed by winter injury, Volutella blight/canker, and Macrophoma leaf spot. Colletotrichum dieback was first detected in Connecticut in 2020. Gymnosporangium rust diseases were prevalent on crabapple, pear, quince, serviceberry, hawthorn, and cedar trees. Exobasidium leaf gall was widely reported on azalea and rhododendron in early summer. Botryosphaeria canker was found on apple, arborvitae, beech, cedar, hornbeam, and rhododendron. Powdery mildew was found on dogwood, pear, maple, lilac, magnolia, and oak. Alternaria leaf spot resulted in severe early defoliation on privet in early summer. Rhizosphaera needlecast and Stigmata needlecast remained two major foliar diseases on spruce, including blue spruce and Norway spruce. Fungal leaf spot remained a major disease on mountain laurel.



Beech leaf disease



Dying of established arborvitae trees



Colletotrichum dieback of boxwood

Rust diseases were found on goldenrod in flower gardens. Powdery mildew was problematic on begonia, heuchera, peony, beebalm, rudbeckia, and zinnia. Botrytis blight was found on phlox, hosta, and impatiens. Thielaviopsis root rot was found on columbine. Bacterial leaf spot and Alternaria leaf spot were problematic on zinnia. Bacterial leaf spot was found on greenhouse-grown salvia, lavender, poinsettia, chrysanthemum, begonia, and heuchera.



Bacterial leaf spot of salvia



Bacterial blight of begonia

Vegetables and crops:

Fusarium wilt became prevalent in tomato both in greenhouses and home gardens. Septoria leaf spot, blossom-end rot, anthracnose, and bacterial leaf spot remained major diseases in garden- and field-grown tomatoes. Herbicide injury was frequently found in home vegetable gardens, especially on tomato plants. On peppers, bacterial leaf spot and Phytophthora blight were problematic. Powdery mildew, anthracnose, bacterial wilt, and bacterial angular leaf spot were major disease problems on cucurbits. Bacterial black rot and Alternaria leaf spot were found on broccoli and Brussels sprout. Sclerotinia bulb rot of onion and garlic was found. Powdery mildew damage was found on hemp.



Alternaria leaf spot on broccoli



Powdery mildew of hemp

Tree and Small Fruits:

Plum pocket disease was found in a home orchard. Black knot was prevalent on cherry, peach, and plum trees and caused significant diebacks. Cedar-apple rust, scab, fire blight, frog-eye leaf spot, and black rot were prevalent on apple trees. On pear trees, rust and Fabraea leaf spot were found. Leaf curl, scab, and brown rot continued to be major diseases on peach. Black rot, powdery mildew, downy mildew, and anthracnose were commonly found on grapevines. Phomopsis canker, Botryosphaeria canker, and mummy berry were major diseases on blueberry.



Plum pocket



Black knot of plum

Turf:

Sudden onset of cold temperatures in early November resulted in chilling injury on turfgrasses. Snow mold resulted in browning of lawn grasses in spring 2021. Brown patch, summer patch, red thread, anthracnose,

powdery mildew, and rust were common diseases of lawn grasses. Many cases of Pythium blight and Bipolaris leaf spot were found in lawns.



Snow mold of turfgrass

Weeds:

Numerous reports of the invasive plant lesser celandine were received in spring 2021. Poison ivy, Oriental bittersweet, Japanese knotweed, Asiatic dayflower, Virginia creeper, horsetail, garlic mustard, mugwort, nightshade, pigweed, spurge, Japanese stiltgrass, thistle, and sumac remained significant problems in residential properties and gardens. Running bamboo continued to be a topic of increasing public concern because it causes problems between neighbors. Crabgrass, annual bluegrass, bittercress, creeping bentgrass, common chickweed, clover, ground ivy, mouse-ear chickweed, yellow nutsedge, purslane, red sorrel, roughstalk bluegrass, wild garlic, and wild violet were major weed problems in turfgrasses.



Lesser celandine

**Impact:** Information from disease surveys in Connecticut landscapes, greenhouses, nurseries, vegetable fields, orchards, natural woodlots, forests, and home properties each year helps to monitor and assess the impact of these problems on the overall health of plants in the state. This information also assists in detecting new diseases or in identifying potentially important emerging diseases on specific plants, which can then be monitored in the years that follow.

## **SERVICE ACTIVITIES**

Members of the Department of Plant Pathology and Ecology are involved in a wide range of service and public outreach activities. Some of these services involve presentations, publications, displays at meetings and other outreach events, tours of facilities, and interviews, in addition to being conducted in cooperation with other state agencies.

### **Seed Testing: In Cooperation with the Connecticut Department of Agriculture, Bureau of Regulation and Inspection**

Every year, official samples of vegetable, crop, and lawn grass seeds are collected by inspectors from the Bureau of Regulation and Inspection of the Connecticut Department of Agriculture and submitted to The Connecticut Agricultural Experiment Station, an official seed testing laboratory for Connecticut.

In 2020, 329 vegetable, two lawn, and two crop seed samples were tested for germination rates and purity that are required for compliance with Connecticut Seed Law Regulations and the Federal Seed Act by following strict protocols designated by the Association of Official Seed Analysts. In 329 vegetable seed samples, only 303 samples were tested for seed germination rates because the other nine samples did not have enough seeds for the test. Among the tested vegetable seed samples, two hundred seventy-five samples passed the germination test, but the other 28 samples did not meet their label claims and the Federal standard. Lawn seeds are tested for both germination and purity. A total of two lawn grass seed mix samples were tested for purity and germination rates. The results of the tests showed that germination rates of both samples higher than the claims or passed the claims with tolerance. For the purity test, both samples passed the claims except total fescue in the Conservation Seed Mix did not meet the claim and creeping red fescue in the URI #2 Improved Seed Mix was passed the purity test within tolerance. Both crop samples, Fall Rye Seed VNS and Buckwheat VNS, passed both purity and germination tests.

**Impact:** Results of seed tests conducted by Station staff are reported to the Seed Control Official of the CT Department of Agriculture who has the authority to stop the sale of products that do not meet label claims or contain noxious weeds. In the short term, this program protects state residents from purchasing inferior seed and ensures that seeds comply with the Connecticut Seed Law Regulations and the Federal Seed Act. The long-term benefit of the seed testing program is to minimize the unintentional introduction of noxious weed seeds that could potentially impact crops of economic importance and the state's ecosystem.

### **Samples for Analytical Chemistry and the Connecticut Department of Consumer Protection**

During the year, Dr. Li examined 10 samples from the Connecticut Department of Consumer Protection at the request of the Department of Analytical Chemistry at the Experiment Station.

## **Citizen Inquiries**

### **Plant Disease Information Office**

Dr. Li answered 3,251 inquiries about plant health from Connecticut citizens. Although the majority of inquiries were on ornamentals, trees, and shrubs (72%), other categories, such as food crops (12%) and turf grasses (4%), were also well represented. A moderate percentage of inquiries fell into the miscellaneous category (12%), which included identification of various plants, weeds, and mushrooms, and information about pesticides and their relationships to health and environmental concerns. Most inquiries were from commercial growers and plant care professionals (35%) and Connecticut homeowners (61%). One percent of inquiries were from cooperative extension and 3% were from health departments, news, agricultural personnel, and others. A further breakdown of inquiries showed that 28% of the questions came in by phone, 21% came in by mail, 27% came as email, and 24% were brought in person. To respond inquiries, 1,848

letters and email messages with attached files of fact sheets were sent from the PDIO. Many citizens opted to download fact sheets posted on the CAES website in lieu of letters since this gave them instant access to the information of concern.

## VALLEY LABORATORY

Scientists at the Valley Laboratory conduct research on insects, diseases, mycology, integrated pest management, soil nutrition, and weeds of concern to commercial agriculture and homeowners in Connecticut. The Valley Laboratory, located in Windsor, was originally established in 1921 to conduct tobacco research and has conducted a century of research and service to the State of Connecticut. While research on tobacco continues today, the research mission has expanded to reflect the diverse agriculture present in the state. Scientists and staff also diagnose insect and plant health problems, test soils for fertility, conduct outreach to growers and homeowners by speaking to professional and community groups, host informational meetings, and assist municipalities, state agencies, and students.



**The Tobacco Experiment Station in the 1920s.**

### **Activities on the Farm**

There were a total of 34 experimental plots at the Valley Laboratory Research Farm during the past year. Five Windsor-based scientists had 30 of these plots; three New Haven-based scientists were using 4 plots. Additional plots were maintained by the Farm Manager as rotation crops or for seed collection. Valley Laboratory scientists also conducted experiments in many plots off site, such as in growers' fields, the CAES Lockwood and Griswold farms, and in state forests. Valley Laboratory Farm Manager James Preste kept the farm and equipment ready and in excellent shape. He expertly maintained the many field plots and addressed the specific needs of each scientist. He and his summer research assistants did an outstanding job maintaining the extensive ornamental garden in cooperation with the Connecticut Nursery & Landscape Association. Mr. Preste and Dr. LaMondia coordinated the Valley Laboratory effort to comply with EPA Worker Protection Standards for Agricultural Pesticides and organized and conducted safety and pesticide training sessions for the staff.

## RESEARCH ACTIVITIES

### Hemlock Woolly Adelgid Research

Eastern hemlock, *Tsuga canadensis*, is the sixth most common tree species in Connecticut forests, and the second most abundant conifer. Hemlocks are an important component of watershed forests that capture, filter, store, and protect Connecticut's northern drinking water reservoirs. Eastern hemlocks are long-lived, and are considered a foundation species as they provide critical shelter, forage, and habitat for many wildlife species. The unique cool shade provided by hemlocks provides essential thermoregulation for native trout streams and is integral to many recreational areas in state lands, land trust, bird sanctuaries, and public preserves.

The most serious threats to eastern hemlock are the invasive non-native pests from Asia: the hemlock woolly adelgid, *Adelges tsugae* (HWA) and the elongate hemlock scale, *Fiorinia externa* (EHS). Both pests periodically infest and cause serious damage to Connecticut hemlocks. Biological control with the introduced ladybeetle HWA predator, *Sasajiscymnus tsugae*, has been Connecticut's major strategy to mitigate HWA damage in our hemlock forests since 1995 and remains the only biological control agent for HWA readily available to the public due to the suitability of this ladybeetle for large-scale commercial laboratory rearing. The only company successfully rearing *S. tsugae* for the public is Tree-Savers from Pennsylvania. The rearing methods for *S. tsugae* are a direct amplification of the original research on the biology and life cycle of this species and the rearing methods developed by Dr. Cheah at the Valley Laboratory and are an example of technology transfer from original research to the commercial sector. Connecticut's experience using *S. tsugae* as the sole biological control agent for 26 years has helped sustain the state's hemlock resource. After the initial hemlock decline and mortality during the spread of HWA in the 1990s, hemlocks have persisted in many Connecticut forests where *S. tsugae* was released in mass numbers (>162,000) from 1995-2001. These findings indicate the utility of biological control with *S. tsugae* as a tool to mitigate HWA damage in hemlock forests. Public interest and endorsement of biological control and rejection of chemical control are increasing, especially due to non-target pollinator concerns. A new Connecticut collaborative program for biological control of HWA, launched by Dr. Cheah in 2020, was further expanded in 2021 to publicize and educate the public on the availability of this control strategy, including training on HWA scouting and implementation of *S. tsugae*.

While HWA populations can be greatly reduced by severe winters in the Northeast, warm, mild winters conversely result in high survival resulting in HWA rebound and reinvasion from other regions. The lack of polar vortex events in recent winters led to patchy outbreaks of HWA in 2020 and continued spread in 2021 after a second successive warm winter. Dr. Cheah scouted for HWA outbreaks during the winter and spring 2021 and field-checked reports from state foresters and the public to pinpoint suitable release sites. Many areas east of the Connecticut River had recent outbreaks of HWA. Infestations were also identified in northwestern Connecticut. Drought impacts from 2020 on mature hemlocks were evident in more cases of hemlock borer attacks resulting in tree mortality, especially in upland areas.



Resurgence of hemlock woolly adelgid and elongate hemlock scale in late winter 2021.

To mitigate further HWA spread and damage to hemlocks weakened by another severe drought in 2020, small-scale augmentative releases of *S. tsugae* were implemented to target these outbreaks. This cooperative HWA biological control program was expanded beyond state lands by Dr. Cheah to more land trust preserves, town open space and other preserves, through a system of purchases and donations to protect important and popular hemlock sites. Initiating small-scale implementations of *S. tsugae* were facilitated via partnerships between Dr. Cheah and Tree-Savers, CT DEEP foresters, Metropolitan District Commission foresters, land trust managers, town conservation commissions, private preserves and community organizations, and other volunteer groups in 2021.

In 2021, >5,000 *S. tsugae* were generously donated to Dr. Cheah for the Connecticut biological control program from Tree-Savers and released in 13 new state land locations (including 2 popular state campgrounds) in 11 towns with the participation of CT DEEP foresters and park managers. The towns in which *S. tsugae* were released on state lands in 2021 are Barkhamsted (People's and American Legion State Forests), Canton (Nepaug State Forest), Colchester (Salmon River State Forest), Coventry (Nathan Hale State Forest), Eastford (Natchaug State Forest), East Haddam (Devil's Hopyard State Park), Hartland (Tunxis State Forest), Killingly (Old Furnace State Park), Plymouth (Mattatuck State Forest), Thomaston (Black Rock State Park), and Torrington (Burr Pond State Park).



Tree-Savers' shipments of *S. tsugae* to Connecticut for HWA biological control releases.



Releasing *S. tsugae* at the Nepaug State Forest, Old Furnace State Park, and the People's State Forest with members of FALPS (Friends of American Legion and People's State Forests).



CT DEEP foresters releasing *S. tsugae* at Black Rock State Park and Tunxis State Forest.

Purchases and donated releases of *S. tsugae* were also implemented in diverse hemlock stands in 7 other towns by town conservation commissions, land trusts, and other community organizations. Dr. Cheah guided and assisted in releases made by the Wyndham Land Trust in Pomfret and Thompson, at the Pomfret Audubon through a generous donation of *S. tsugae*. The Towns of Woodbury and New Hartford, through their Conservation Commissions and land trust members, purchased *S. tsugae* for release on hemlock

preserves popular with the public for hiking and recreation. Both preserves had substantial HWA infestations and some hemlock decline. Releases of *S. tsugae* were also made to protect and conserve hemlocks at a popular rock-climbing preserve, Ragged Mountain Foundation, in Southington, which is adjacent to the Metacomet Trail (part of the New England Scenic Trail) with the land manager and members from New York State.



Ragged Mountain Foundation, Southington.

Other communities in Ashford and Storrs also implemented *S. tsugae* to control HWA in residential settings where chemical control is not favored. Homeowners are increasingly investing in biological control with *S. tsugae* where appropriate to protect their hemlock trees without chemicals. A grant in June 2021 was also awarded to Dr. Cheah from the Farmington River Coordinating Committee to address mitigation of HWA damage and spread in the upper watershed forest of the Farmington River, Connecticut's only National Wild and Scenic River. This grant enabled more augmentation releases of *S. tsugae* along popular hiking trails in the People's State Forest and the American Legion State Forest campground, which have been recently heavily infested with HWA, with the help of volunteers from the Friends of the American Legion and People's State Forests (FALPS). The Metropolitan District Commission also invested in further releases of *S. tsugae* in 2021 to control HWA in hemlock forests along the headwaters of important feeder brooks for the Barkhamsted Reservoir, which is the primary water supply for the city of Hartford and its surrounding area. Chemicals cannot be used in reservoir watershed forests to control pests and disease and biological control is an important and safe alternative strategy to mitigate pest damage and tree mortality.



Hemlock and white pine in watershed forests of the Barkhamsted Reservoir.

As of June 30, 2021, this collaborative program has released 13,124 *S. tsugae* in 2021 in 22 additional hemlock sites throughout Connecticut, of which 6,474 (49.3%) were generous donations by Tree-Savers. The total number of *S. tsugae* officially released in Connecticut is 198,104 in 60 sites since 1995. The total number is actually higher due to private property and homeowner releases.

### **Impacts:**

- Development of this new collaborative Connecticut biological control program for HWA is very successful and is rapidly gaining popularity amongst the public. This is another example of technology transfer from the research findings of Dr. Cheah that biological control with *S. tsugae* can be a useful tool for all communities, state, private and municipal partners for managing HWA at a landscape level and in sensitive riparian environments without the use of chemicals for restoring and conserving eastern hemlock forests.
- Biological control also offers a safe and attractive alternative to homeowners seeking to protect landscape hemlocks on private properties. This strategy minimizes the need and application of annual prophylactic chemical treatments for HWA.
- Mature hemlock forests can be protected as increasingly important carbon dioxide sinks in a warming world and biological control with *S. tsugae* is an important tool.
- Connecticut has the longest running HWA biological control program in the USA at 26 years since 1995. Long-term impacts of HWA biological control in Connecticut show that eastern hemlocks are a resilient tree species which can recover from biotic and abiotic stressors, which is important to the multiple and diverse avian, amphibian, fish, and mammal species that are dependent on the hemlock ecosystem.
- The equivalent monetary investment of the sum total of biological control releases with *S. tsugae* in Connecticut far exceeds \$495,260 in terms of costs per beetle as the intangible benefits in hemlock ecosystem services protected are many magnitudes more, in terms of mitigating tree mortality, protecting watershed forests, preserving popular hiking and recreation areas and trails, wildlife and avian habitat, and conservation of hemlock forests as carbon sinks.

### **Insect Management**

Efforts continue to assist Christmas tree growers to find effective strategies to manage armored scale pests. Reliance on dinotefuran, a systemic neonicotinoid, apparently is incompatible with a critically important biocontrol agent for cryptomeria scale. Growers using dinotefuran to manage armored scales exacerbate this problem, whereas growers not spraying for scales only have significant populations of elongate hemlock scale present, which is less damaging. Dr. Cowles initiated a test of selective insecticide alternatives to dinotefuran and demonstrated acetamiprid to be more effective than dinotefuran, but it too is a neonicotinoid. Pyriproxyfen, an insect growth regulator, and afidopyropen, which affects chordotonal receptors, were as effective as dinotefuran to selectively target scales when applied in a two-spray program targeting scale crawler activity. Prospecting for insect pathogenic fungi to test for their potential to be used as biopesticides is being discontinued, as any practical use of these fungi would require U.S. EPA registration, infections are probably limited during seasons with low rainfall, and a new team in West Virginia is taking up the challenge of working in this subject area. Insecticide trials in 2021 will evaluate the effectiveness of pyriproxyfen, afidopyropen, and spirotetramat applied alone or combined with horticultural oil as a single spray for managing elongate hemlock scales.

### **Honey Bee Health**

Dr. Cowles is collaborating with Mr. William Hesbach, President of the Connecticut Beekeepers Association, to test the effectiveness of Aluen CAP for managing late-season infestation of varroa mites in bee hives. This oxalic acid product is manufactured by a beekeeper's cooperative in Argentina, and has many favorable properties, including exemption from residue tolerance, it is organically acceptable, and can be present in the hive during nectar flow and when honey supers are on the hive. Another aspect of improving honey bee health is to enhance the quantity and quality of bee forage. Efforts continue to grow and evaluate bee forage in replicated plots at Lockwood Farm and at Humming Grove Farm in Broad Brook.

Collaboration with Dr. Jatinder Aulakh continues to determine the most effective herbicides to use in initial establishment of these plants, including replicated field tests at Lockwood Farm in 2021.

### **Christmas Tree Disease Management**

Application of sulfur to reduce soil pH to 4 enhances the establishment and growth of firs native to the eastern U.S. grown as Christmas trees, and may delay infection of susceptible trees to *Phytophthora* organisms that cause root rot. One hypothesis for improved tree growth with more acid soil is that *Phytophthora* spp. are less tolerant of acid soils than are the fir tree hosts, allowing the trees to grow quickly enough to compensate for some loss of roots to disease, but alternative hypotheses need to be tested. In collaboration with Dr. Blaire Steven, we investigated the rhizosphere soil microbiome for trees in adjacent plots with soil pH ~5 vs. 6 and found that the microbial community greatly differed with respect to pH. Bacteria antagonistic to the growth of *Phytophthora* spp. were found from both soil pH conditions, and these interactions were highly species specific (both for bacteria and *Phytophthora*). Although there are trials being conducted with potted Fraser fir to see whether these antagonistic bacteria can provide practical levels of protection from *Phytophthora* infection. In order to be practically useful, such bacteria would have to undergo U.S. EPA registration. Therefore, tests are now being conducted with commercially available biocontrol bacteria and fungi to determine whether they can provide a practical benefit for preventing *Phytophthora* root rot in susceptible fir transplants.

A grant supported by the Christmas Tree Promotion Board in 2019 determined that bare-root transplants significantly benefit from the addition of controlled-release fertilizer incorporated into soil around the roots at the time of planting. A follow-up experiment in 2021 supported by the CT Christmas Tree Growers' Association investigates which components of complete nursery fertilizers are necessary to observe these benefits for improved color and growth. This experiment is being conducted at two sites (CT and VT) with eight different sources (seven species) of trees.

#### **Impacts:**

- The Connecticut Queen Breeders' Association has locally selected queen bees that they can share or sell to interested beekeepers.
- Christmas tree growers are implementing use of sulfur to improve the health of their true firs.

### **Weed Science**

#### **Effect of Reflective Anti-Transpirant, Elemental Sulfur, and Herbicides on Christmas Tree Growth and Establishment**

The ability to produce Christmas trees in Connecticut, especially fir trees, is threatened over the long-term by changes in our climate. Each year, growers experience an average loss of 5 to 30% of young trees – likely to the combined adverse effects of drought, heat stress, weed interference, and herbicide injury. Dr. Aulakh is conducting several field research trials to evaluate the role of anti-transpirant, sulfur application, and herbicides in improving Christmas tree survival, growth, and weed control. Christmas tree growers will be able to minimize losses of young trees to drought, heat stress, and reduce the risk of herbicide injury. Herbicide research trials in 2020-2021 revealed excellent tolerance of tested Christmas trees to preemergence (PRE) application of a pre-packaged mixture of atrazine + mesotrione + s-metolachlor (Lumax EZ at 4 lb./a), and to postemergence (POST) application of topramezone (Frequency at 8 fl. oz./a) alone and as a tank-mixture with clopyralid (Stinger at 8 fl. oz./a).



Christmas tree research trials at Kogut's Tree Farm in Enfield, CT. Pictures: nontreated control (left) Lumax EZ (4 lb./a) applied before budbreak.

***Impact:***

- Christmas tree growers have safer, effective, and economical herbicides for PRE and POST control of several annual grasses and broadleaf weeds.

**Preventing Freeze Injury in Peaches and Nectarines**

Peaches and nectarines are very susceptible to freeze injury during the late winter and early spring months as the buds begin to swell and mature into blossoms. Field research is in progress since 2018 at peach and nectarine farms in Ellington and Windsor, CT. Research aims at investigating the potential of exogenous applications of phyto-hormones at early-bud swell, late-bud swell, and green tip stages for preventing freeze injury via artificially prolonged fruit bud dormancy.

Data are being recorded on various response variables. Results from this research would improve peach and nectarine growers' practices for preventing/reducing freeze damage and sustaining optimum peach production.



A peach research site at the Valley Laboratory in Windsor, CT.

### **Evaluation of fall applied herbicides and application rates for Oriental bittersweet control**

Oriental bittersweet, a non-native woody vine, is becoming increasingly invasive in natural ecosystems and managed habitats. An experiment has been initiated in 2020 at the Valley Laboratory in Windsor to evaluate various herbicides and their application rates for the Oriental bittersweet control. Excellent control of young Oriental bittersweet vines was achieved with a single fall application of triclopyr (Garlon 3A at 2 qts./a) or triclopyr (Garlon 3A at 1 qt./a) plus glyphosate (Maddog at 2 qt./a). With glyphosate (2 qts./a) alone, control of Oriental bittersweet was not satisfactory.

#### ***Impact:***

- This research will provide vegetation managers with effective herbicides and their application rates for managing Oriental bittersweet in natural areas, landscapes, and plantation crops such as Christmas trees.



Oriental bittersweet research plots at the Valley Laboratory 2020-2021. Pictures: nontreated control (left), glyphosate 2 qt./a (center), triclopyr 2 qt./a (right).

## Mycology Research

Dr. DeWei Li conducts research on fungal taxonomy, indoor molds of human health concern, fungal succession on water-damaged building materials, and infiltration of fungi from outdoors into residences.

### Intercropping Wine Cap Mushrooms in Christmas Trees

This three-year project started in January 2019 to develop a new intercrop, wine cap mushroom for Christmas tree farms using woodchip mulch. The project has dual purposes: 1) develop a new cash crop, wine cap mushroom for Christmas tree farms; 2) the woodchip mulch will improve root health by controlling weeds and thus preventing damage from herbicides, maintaining cool, moist soil conditions, suppressing injurious root pathogenic nematodes, and adding organic matter into the soils. The cultivation was conducted at the Valley Laboratory, Humming Grove Farm, and Jones Family Farm. The wine cap mushrooms have been successfully cultivated at all field plots in the three locations from early fall 2019 to spring 2021. The cultivation produces mushrooms in both spring and fall. Woodchip mulch suppressed weeds effectively.



Wine cap mushrooms.

#### **Impact:**

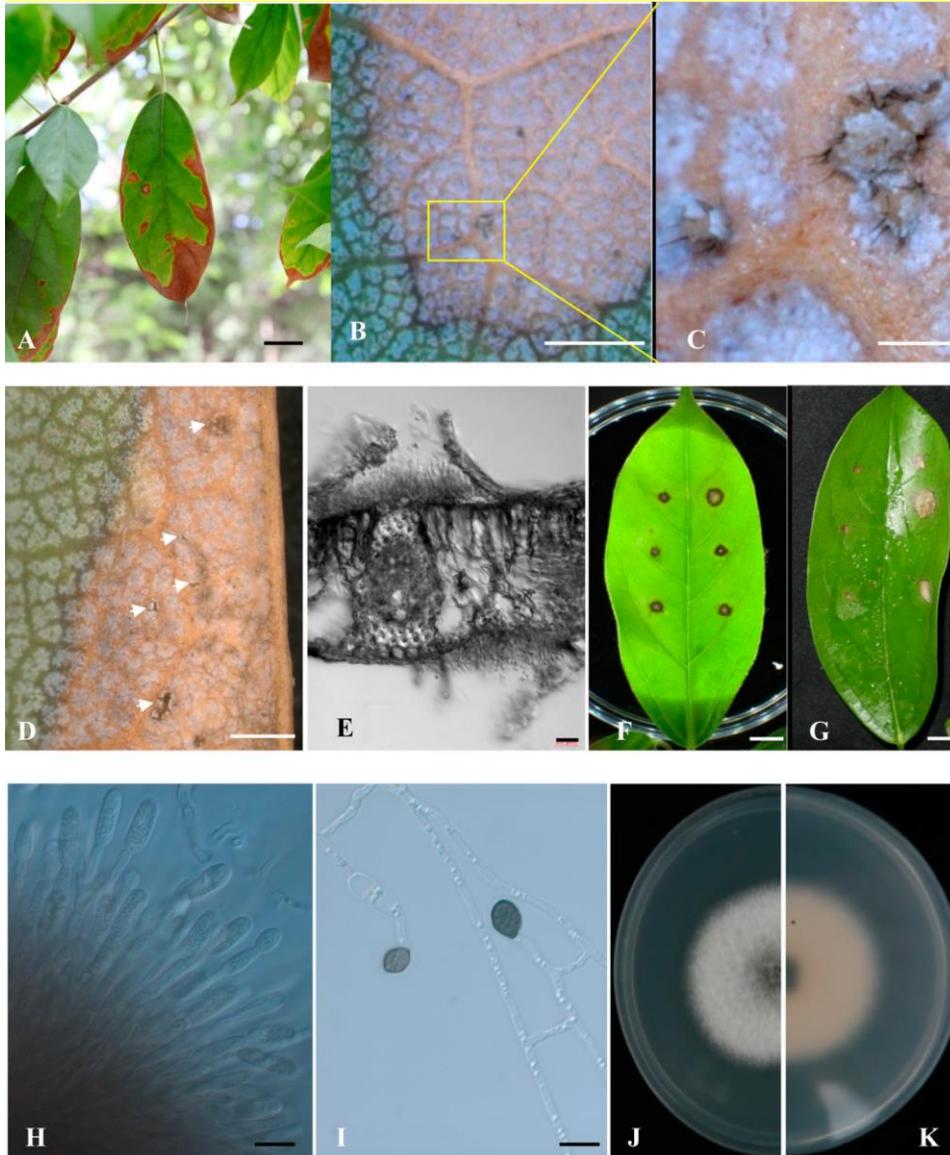
- Wine cap mushroom (*Stropharia rugoso-annulata*) is an edible gourmet mushroom. This study helps Christmas tree farmers develop a new produce-wine cap mushroom, which can be marketed as fresh or dried produce. Fresh wine cap mushrooms have been sold at \$5.00/lb. Grocery stores and farmers' markets are potential venues for this produce. The new crop will increase their profits in the future. Woodchip mulch also suppressed the weeds.

#### **Study of New Plant Diseases**

A number of newly emerged diseases are being studied: *Diaporthe fusicola* causing leaf blotch of *Osmanthus fragrans*, *Alternaria alternata* causing leaf spots of *Liriodendron chinense* × *tulipifera*, leaf blotch of *Salix babylonica* caused by *Botryosphaeria dothidea*, and leaf blotch of *Aesculus chinensis* caused by *Colletotrichum gloeosporioides* and *Colletotrichum fructicola*. These studies are a collaboration with several plant pathologists/scientists at CAES and in China.

**Impact:**

- These new diseases of ornamental plants are causing severe damage to ornamental plants and the landscape. Determination and characterization of these pathogens is imperative for disease management and future studies to fully understand the diseases for finding solutions to these diseases.



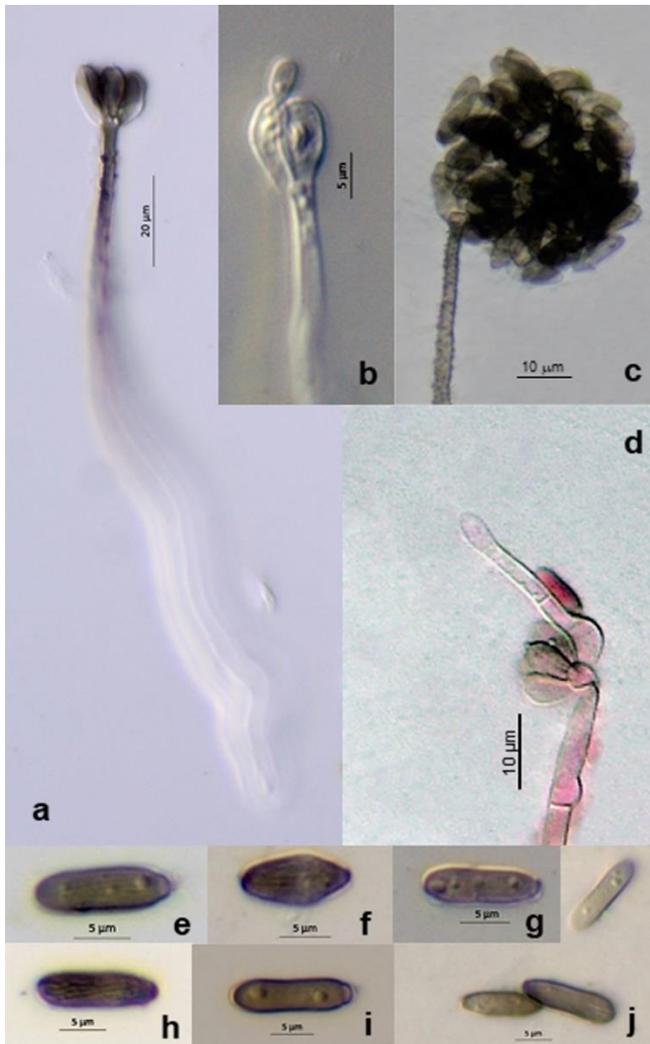
Symptoms of leaf blotch disease on *Acer coriaceifolium* and morphological characters of conidiophores, conidia, appressoria, and colony of QS2-1-1. **A.** Diseased leaves in nature, bar = 2 cm. **B-C.** Conidial masses and setae on the lesion of an infected leaf developed in nature; bar of B = 1 mm, bar of C = 100  $\mu$ m. **D.** Conidial masses and setae on a lesion on the edge of an infected leaf in nature (arrows indicate conidial masses), bar = 0.5 mm. **E.** Acervuli on the adaxial and abaxial surfaces of an infected leaf developed in nature, bar = 20  $\mu$ m. **F-G.** Symptoms on leaf of *A. coriaceifolium* 5 days after being inoculated with mycelial plugs and spore suspension of QS2-1-1, bars = 1 cm. **H.** Conidiophores and conidia of QS2-1-1, bar = 10  $\mu$ m. **I.** Appressoria of QS2-1-1, bar = 10  $\mu$ m. **J-K.** Culture of QS2-1-1 on PDA from above and below 5 days after plating.

## Fungal Taxonomic Study

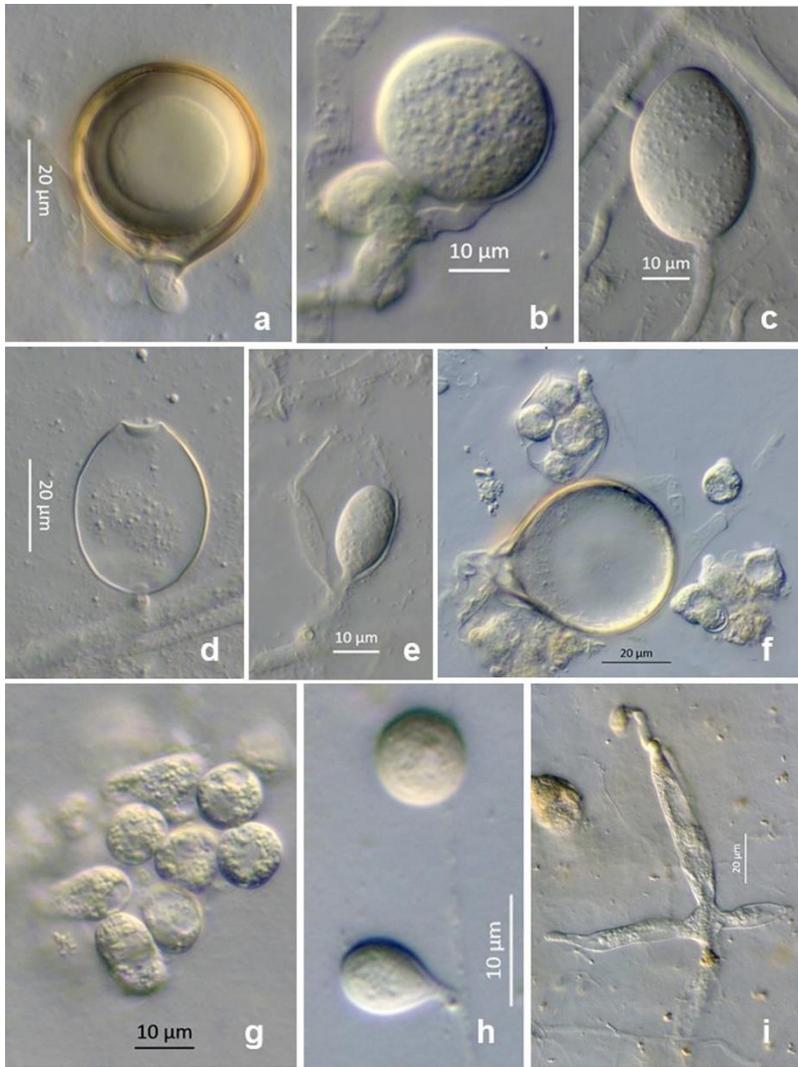
This collaborative study with James LaMondia, Neil Schultes, Robert Marra, and mycologists from several countries: Brazil, Canada, China, Cuba, Mexico, has led to the discovery of two new fungal species, *Striatibotrys neoecylindrosporus* and *Diaporthe humulicola* and two new genera, *Distobactrodesmium* and *Mirohelminthosporium*. These new species and genera have been published in four papers. *Diaporthe humulicola* is a new disease on hops.

### Impact:

- Discovering and describing new fungal species provide very important information to fungal diversity in the world and for the studies, such as plant disease management, biological resources, fungal ecology and fungal biology. Determination and identification of phytopathogen, which causes significant loss of farmers, is an important service to local economy, agriculture, and CT farmers. These studies are imperative for identifying fungi and determine the causal agents. The newly described species supplement new information to fungal diversity, resources and conservation and utilization.



*Striatibotrys neoecylindrosporus* (ex-type). **a.** Conidiophore and phialides. **b.** Phialides and immature conidium. **c.** Conidial mass. **d.** Proliferating from a phialide. **e–j.** Conidia. **e, f.** Conidium with striations.



*Phytophthora abietivora*. **a.** Oogonium and oospore. **b.** Immature oogonium and antheridium. **c.** Sporangium. **d.** Empty sporangium. **e.** Nesting sporangium. **f.** Zoospores, sporangium, and oogonium. **g.** Zoospores. **h.** Chlamydospores. **i.** Irregular coralloid hyphal swellings.

## Plant Disease Research

### Tobacco Disease Research

The Connecticut Agricultural Experiment Station Valley Laboratory was established in 1921 as the Tobacco Substation to combat tobacco problems and diseases such as wildfire, a devastating disease caused by a bacterial plant pathogen. Wildfire was eventually eliminated by incorporating plant resistance to this pathogen. Ever since, tobacco breeding to incorporate genetic plant resistance to plant pathogens has been used to successfully manage diseases with minimal environmental impact. Plant resistance is the most economical, environmentally responsible, and often most effective way to control diseases. The development of plant resistance to tobacco mosaic virus (TMV) in the 1950s, tolerance to ozone damage (weather fleck) in the 1960s, resistance to black shank in the 1970s, and Fusarium wilt in the 1980s and early 1990s effectively controlled serious diseases that each threatened to seriously impact or even wipe out cigar wrapper tobacco production in the Connecticut River Valley.

There are currently a number of pathogens that still threaten the crop. Dr. LaMondia conducts an ongoing breeding program to develop resistance to: *Fusarium oxysporum* (causing Fusarium wilt); *Globodera tabacum* (the tobacco cyst nematode); tobacco mosaic virus, and *Peronospora tabacina* (blue mold) for both shade and broadleaf types. An inbred line, C9, was initially released in 1991 and is still being produced as a wilt- and TMV-resistant cultivar. A new hybrid with similar resistance profiles and increased uniformity was released as B1 and is in production. In 2011, a male-sterile F1 hybrid ‘B2’ highly resistant to Fusarium wilt, TMV, and the TCN and with moderate resistance to blue mold and black root rot was released and subsequently licensed.

Black shank, caused by *Phytophthora nicotianae*, has re-emerged as a serious pathogen in Connecticut and we are working to develop a hybrid line with significant resistance to the pathogen. Our first candidate line, B3, was evaluated under field conditions in 2014 and 2015 and, while resistant, was found to be lacking in sufficient wrapper leaf quality. Additional crosses have been made and an inbred with very high levels of resistance is being used to produce hybrids that are being commercially evaluated. Black root rot, caused by the fungus *Thielaviopsis basicola*, has been damaging and increasing in impact in recent years with cool wet springs. We obtained sources of dark wrapper tobacco with high levels of black root rot resistance from cooperating scientists in Kentucky. A back-cross program was used to transfer resistance to CT broadleaf, and resistant plants were selected for broadleaf characteristics. Inbreds have been developed and have been used to develop hybrid lines with resistance to multiple pathogens. A number of these lines are being evaluated under commercial conditions and two (D1 and D2) have now been licensed with a company for commercial seed production. The hybrid cultivars that have been released have been developed as Low Converter (LC) cultivars to reduce the levels of nicotine conversion to nornicotine during the curing process. Nornicotine is an alkaloid that is responsible for adverse health effects. Brown spot, caused by *Alternaria* fungi, can cause significant losses when ripe tobacco cannot be harvested on time due to rain. We have identified a source of resistance and are evaluating breeding lines under field conditions. We have also initiated breeding for resistance to target spot and tomato spotted wilt.



Fusarium wilt susceptible (left) and resistant (right) cultivars. TMV infected leaves.

**Impacts:**

- C9 and B1 broadleaf tobacco carry resistance to Fusarium wilt and TMV. C9 has been widely grown since its release (>80% of acreage) and has prevented more than \$5 million in losses each year since 1992. B1 is more uniform and is replacing C9 over time.
- The development of a male-sterile hybrid broadleaf cigar wrapper tobacco with resistance to most of the major pathogens, including Fusarium wilt, TMV, the TCN and blue mold, will allow sustainable production with reduced disease and much reduced pesticide inputs. Growing B2 eliminates the need for nematode management at over \$500 per acre per year. New varieties in development are resistant to black root rot, for which there are no current management options.
- B1, B2, D1, and D2 have been released as new cultivars and licensed to a local seed company. Proceeds will help support further research on plant resistance. Adding resistance to black root rot and brown spot will further reduce plant losses to disease.

Tobacco blue mold, caused by *Peronospora tabacina*, can quickly devastate cigar wrapper tobacco crops and must be managed with protectant fungicides. Dr. LaMondia conducted experiments in field-grown broadleaf wrapper and shade-grown Connecticut wrapper tobacco types to evaluate efficacy against blue mold and resulting fungicide residues in cured leaves. Fungicides were applied as weekly season-long programs versus front-loaded schedules where the same total amount of fungicide was applied but with higher rates early in the season. Efficacy against disease was evaluated and leaves were harvested and cured. Fungicide residues were determined by Dr. Eitzer using the QuEChERS method. Blue mold was severe in the first year. Front-loading fungicides reduced disease and fungicide residues in broadleaf and shade tobacco. Blue mold did not occur in broadleaf in the second year but front-loading fungicides and reducing rates again reduced fungicide residues in cured leaves. Blue mold only occurred in the second half of shade tobacco harvests and disease severity was greater for front-loaded treatments, which coincided with reduced fungicide residues from those harvested leaves. Models were developed to describe the decline of dimethomorph, azoxystrobin, and mandipropamid to predict the time required since the last application to achieve target ppm residues in cured leaves. Target residues were achieved for broadleaf tobacco but not for shade-grown tobacco in these experiments.



Tobacco blue mold symptoms and sporulation.

Dr. LaMondia conducted experiments to examine disease management strategies and resulting fungicide residue levels in cured shade-grown Connecticut cigar wrapper tobacco under field conditions over three years. Fungicides were applied as weekly season-long programs. Leaves were harvested weekly over six weeks and leaves from the second and fifth harvests were cured and evaluated for fungicide residues. Residues were determined by Dr. Eitzer using the QuEChERS method and by a commercial laboratory.

Fungicide residue data were used to independently validate models that were developed in previous years. The models accurately predicted fungicide residues in cured leaves. The dimethomorph model predicted that more than 5.5 weeks would be needed to achieve the target GRL of 2 ppm in cured leaves after full rate application of Forum. The azoxystrobin model predicted that 4 weeks would be required after a full rate application of Quadris to achieve the GRL of 16 ppm in cured leaves. There are currently no GRL standards for mandipropamid, but the model predictions for achieving less than 10 ppm or less than 2 ppm after half-rate applications of Revus would be 4 or 5 weeks, respectively. Fluopicolide residues were only below 10 ppm when Presidio was applied at a full rate six or more weeks prior to harvest. Oxathiapiprolin residues were below 10 ppm when Orondis Ultra was applied three weeks before harvest. All fungicide programs were effective in managing blue mold in 2017, the only year that the disease occurred. These data will help growers determine the time between fungicide application and harvest required to maintain fungicide residues below desired levels.

### Hop Research

Hop (*Humulus lupulus*) cultivation in the Northeastern United States dates to the first settlers but disappeared for a century because of disease pressure and the enactment of Prohibition. Subsequently, it was established in the Pacific Northwest, which is currently the largest production area worldwide (53,282 acres; IHGC - 2017 Statistical Report).



New York State has the largest production area in the Northeast (400 acres, IHGC-2017 Statistical Report) followed by Vermont and Massachusetts and Maine. Commercial hop production has just started in Connecticut (30 acres) and New Jersey. The increasing popularity of the microbrew culture, local brewpubs, home brewing, and the growing demand for regional products have created a niche market for high quality hops in the Northeast.

Yellow Lupulin glands of female hop cones contain resins, acids, and essential oils, which are responsible for aroma, flavor, and bitterness in beer.

### New and Emerging Diseases of Hops in Connecticut

Drs. Kodati and LaMondia continually monitor for diseases and insects on hops and provide IPM information to the hop growers in Connecticut. The most common diseases and pests were downy mildew, two-spotted spider mites, and potato leaf hopper. Intensive scouting and timely application of pesticides is required for the control of diseases and pests. Previously, a new pathogen, *Diaporthe humulicola* was identified causing the disease on hop leaves and cones grown at the Valley Laboratory hopyard. They noticed *Diaporthe* spp. infected stems of hop plants in the growing season of 2020. Molecular and morphological tools are being employed to confirm the species identity of the isolates that were collected from hop stems. They are conducting studies to understand the diversity and epidemiology of *D. humulicola*. They are also conducting several crosses between wild hop types and commercial cultivars to develop hybrids that are resistant and with high quality cone production.

#### Impact:

- Understanding the diversity and epidemiology of disease helps in development of management practices.
- The breeding work will be helpful in identifying the useful traits (for the quality of hops and disease resistance) and development of the hybrid lines.

## **Boxwood Blight**

Boxwood blight is a new, introduced disease in Connecticut. The fungus that causes boxwood blight, *Calonectria pseudonaviculata* (*C.ps*), forms leaf spot and stem lesions resulting in defoliation and dieback. The impact of the disease has been very high; boxwood losses in nurseries were estimated at over \$5.5 million in Connecticut in the first two years since October 2011. While production nurseries have not experienced problems in Connecticut, boxwood blight has been widespread and damaging in landscapes in years with wet conditions conducive to disease.

### **Movement of *C. pseudonaviculata* Through a Landscape**

Boxwoods are an important component of established landscapes, especially historical plantings in which they are highly valued. A better understanding of how boxwood blight moves through a landscape from an infected plant to other cultivars and how fungicides can be used to manage disease spread are important for preserving boxwoods in landscapes. Dr. LaMondia conducted a field trial to determine how an infected boxwood plant will spread infection to surrounding boxwoods under conditions of no fungicide treatments, the use of a protectant spray (a fungicide that stays on the surface of the plant), and the combination of protectant sprays with systemic sprays (fungicides that move into the plant). The fungicide treatments are evaluated using a calendar-based spray approach (every month regardless of disease detection or weather) versus an incidence-based spray approach (fungicides will only be applied after disease is detected). Additionally, temperature and humidity are monitored in the plot to determine how these two environmental conditions affect disease development. We used strict sanitation to greatly reduce or eliminate spread by contact. Movement of the pathogen from an infected source plant was limited to one plant, likely spread by means of water splash. Plants were mulched with composted hardwood chips and mulching likely was primarily responsible for limiting spread to only the adjacent plant. Boxwood cultivar susceptibility and fungicide spray programs influenced the incidence of spread and severity of disease; in 2018 and 2019 the more susceptible cultivar had higher disease incidence and severity, respectively, than less susceptible cultivars. Fungicide application only had a small reduction in disease incidence in 2018. We also demonstrated that spores in clumps could survive extended dry conditions, indicating the importance of sanitation procedures on reducing spread. This experiment demonstrates that boxwood blight can be controlled in a landscape by following best management practices including cultural, sanitation, host susceptibility and fungicide application tactics.



*Field plots for boxwood blight management.*



Boxwood blight

### **Epidemiology – effects of temperature and leaf wetness duration on infection**

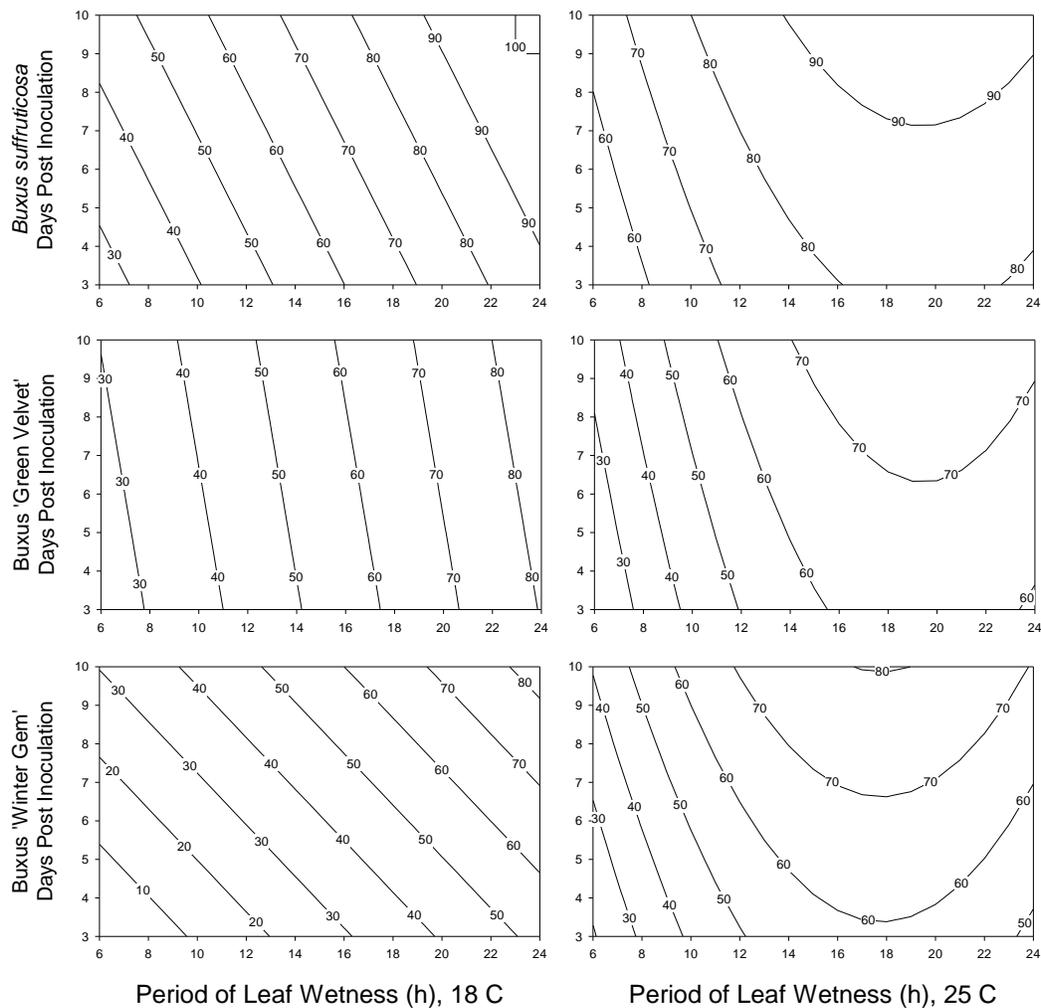
Boxwood blight causes great losses to the boxwood nursery industry and landscapes in 30 states in the USA. Understanding the epidemiological factors governing disease development will be important for disease forecasting and design of best management practices. We evaluated the effect of leaf wetness period and temperature on infection and sporulation of three boxwood cultivars under controlled conditions to develop predictive models for disease development. We conducted detached leaf assays at 18 to 27 °C, and various leaf wetness periods (lwp), with the cultivars *Buxus sempervirens* ‘Suffruticosa’, *Buxus* × ‘Green Velvet’, and *B. microphylla* var. *japonica* ‘Winter Gem’. Detached leaves were inoculated with 200 conidia in suspension and disease incidence was recorded at 3 – 13 d post inoculation (dpi). Cultivar, lwp, temperature, and most interactions significantly influenced disease development. A minimum of 5 h of leaf wetness was required for any infection. Infection incidence increased most rapidly between 12 – 15 h and continued to increase to about 21 h of leaf wetness. Temperatures between 21 and 25 °C were optimal for disease development. There was about a 7-d lag between appearance of lesions and maximal sporulation. The two less-susceptible cultivars had fewer lesions than ‘Suffruticosa’ under the same infection conditions; in addition, infections of ‘Winter Gem’ exhibited delayed sporulation and sporulation from a smaller proportion of infected leaves. Response surfaces were developed for each cultivar to predict the infection percentage using the lwp and dpi. Our findings will help refine disease forecast models to improve management of boxwood blight.

Data collection: Humidity chambers were opened for data collection at 3, 6, and 9 DPI. Number of leaves of each cultivar with infection and sporulation was recorded from different treatments.

- Leaf infections were observed three days after inoculations in high humidity moisture chambers.
- The greatest number of infected leaves noticed at 21, and 24 hours, followed by 18 hours of leaf wetness period, and was lowest for 4-12 hours.
- The highest rate infection and sporulation was observed at 25°C with humidity >95%
- Our results indicate that relative humidity has great impact on disease development.
- Temperatures between 18 and 24°C are highly favorable for infection and sporulation.
- Leaf wetness periods of 15-24h were favorable for boxwood blight and there was no difference in the disease incidence between 21 and 24h of leaf wetness.

### **Impact:**

- This identification of resistant boxwood and development of epidemiological data on spread and infection study will aid in developing better disease prediction models and effective management strategies.



Predicted response model for the amount of infection as related to hours of leaf wetness and days post inoculation, for three boxwood cultivars at two temperatures.

### Development of the Boxwood Blight Resistance Evaluation Program

The breeding of disease-tolerant boxwood cultivars is important for reducing the incidence of boxwood blight in Connecticut while providing landscapers with cultivars that have desired traits. In order to better assess boxwood tolerance to blight among cultivars, Dr. LaMondia is collaborating with researchers across the United States to create a standard protocol for boxwood evaluations that can be conducted across institutions. This will include rating cultivars against previously tested plants to assign a scaling of 1 (most susceptible) to 5 (least susceptible). The evaluation program began in 2018 and has grown in its second year to include a total of 21 cultivars being assayed at the Valley Laboratory and at 3 other institutions in the United States. These ratings will be used by plant breeders to assess tolerance and by nurseries to convey susceptibilities to consumers. Over the last two years we evaluated several hundred boxwood lines from multiple breeding programs. We observed a very good range of responses in percent leaf infection, leaf and stem lesions per plant and percent defoliation. The very susceptible varieties such as *B. suffruticosa* were severely diseased and *B. suffruticosa* was eventually killed. There is significant potential for the development and release of blight resistant boxwood cultivars in the future.

## **VALLEY LABORATORY SERVICE ACTIVITIES**

### **Requests for Information**

A total of 5,900 inquiries were answered at the Valley Laboratory during the past year. Nearly half of these queries were answered by Ms. Rose Hiskes (48%) in the inquiry office (50% of these from the public sector) or by Dr. LaMondia (21% of total inquiries; 82% of which were commercial). The majority of inquiries answered by Ms. Hiskes concerned insects (29%), diseases (13%), pesticides (15%) or horticulture (8%). Most concerned landscape and nursery (49%), vegetable (6%) and structural entomology (9%). Dr. LaMondia responded to disease (55%), horticulture (25%), insect (5%), fertility (4%), pesticide (4%), weed (1%) and animal (1%) inquiries. These inquiries primarily concerned tobacco (40%), nursery and landscape (39%), hops (8%), vegetables (6%), fruit (4%), and golf turf (3%). All scientists and many of the staff at the Valley Laboratory assist growers and homeowners.

All Valley Laboratory scientists contribute to the service effort. Scientists made 24 presentations to grower, professional and citizen groups (about 1,176 people), were interviewed 9 times and made 121 visits to commercial nurseries, greenhouses, farms, forests, and landscapes to diagnose complex problems or conduct research projects. Dr. LaMondia maintains surveillance to notify the Connecticut River Valley growers about the presence and likely threat of tobacco blue mold disease in North America and inform about management options. His laboratory conducted 203 nematode diagnostic tests and conducts testing as an APHIS-certified pinewood nematode export testing facility.

### **Soil Testing**

A total of 4,363 soil tests were expertly performed by Ms. Diane Riddle during the past year. About 42% were performed for commercial growers and 58% for homeowners. Of the commercial samples submitted, 62% were for landscapers, 12% for tobacco growers, 3% for vegetable growers, 13% for municipalities, 3% for golf course superintendents, 1% for nursery growers, 1% for small fruit, 1% for Christmas tree growers, and 3% for research. Sixty tobacco seed germination tests were conducted.

#### ***Impact:***

- Approximately 25% of soil samples tested did not require additional fertilizer. Reducing the over-application of fertilizers protects the environment.

### **The Gordon S. Taylor Conference Room**

Many agricultural organizations used the conference room at the Valley Laboratory regularly for their meetings. During the previous year, 10 different groups used the room on 27 occasions. The Conference Room was closed to the public due to the COVID-19 protocols and remained closed through the rest of the fiscal year.

## Valley Laboratory Information Office Insect, Disease and Plant Health Inquiries

Ms. Rose Hiskes diagnosed a wide range of insect, disease, weed, and plant health problems on herbaceous and woody ornamentals, lawns, vegetables, fruit, and Christmas trees for homeowners, commercial businesses, other government agencies, and nonprofits. The Diagnostic office opened to the public on July 1 after being closed because of the COVID pandemic since mid-March 2020. The drop-off bin outside continues to be used for those who want to drop off samples outside of office hours.

### Insects

The oak shothole leafminer has been a problem in Connecticut this year. This native fly in the family Agromyzidae, attacks red and white oaks as leaves are unfolding in the spring. The female fly inserts her ovipositor into leaf tissue, causing injury and sap flow, which she then laps up. She also lays eggs in leaf tissue. These larvae hatch and feed as blotch leafminers between the epidermal layers of the leaf. Mines are hard to find as the female makes many more feeding punctures than she lays eggs. Though the initial injury is very small, as the leaves expand so do the holes. In otherwise healthy trees, this insect may not cause significant damage. No control methods are mentioned in fact sheets from UMass and Ohio.

In Connecticut, the oak shothole leafminer occurred in conjunction with the oak jumping gall, *Neuroterus saltatorius*, a wasp. Attacking only white oaks, egg laying as the leaves unfold stimulates gall formation on the leaf underside and a corresponding brown spot on the upper leaf. The common name comes from the up and down movement as the mature gall drops to the ground to overwinter. The galls that end up protected in cracks and crevices in the soil have a better survival rate. Thus, they are the ones to reproduce the following year.

Both of these pests affect only the leaves of these deciduous trees. Therefore, no long-term damage is usually seen if enough leaves remain on the tree and enough photosynthetic activity occurs to feed carbohydrates to the roots for the next season. The horned oak gall, which affects twigs, can kill oak trees in a few years with repeated infestations.

### Diseases

Volutella leaf and stem blight on mature pachysandra plantings was very prevalent this spring. Stressed, crowded plantings along with extended periods of wet, warm weather and the presence of low levels of the pathogen from previous years, completed the disease triangle and made for a major outbreak of the disease.

Management should start with creating optimum growing conditions for pachysandra. Older beds need to be thinned. Cutting and removing 6 x 6" sections, roots and all, is very energy-intensive but will yield great results when compost is added to the bare spots. Mowing, followed by extensive raking, can also accomplish this.

Broad spectrum fungicides such as thiophanate-methyl, chlorothalonil, and mancozeb can be applied according to label directions to newly emerging foliage in early summer.



Pachysandra bed damaged by Volutella blight.  
Photo by Christine Pearson.

### **Weeds and Herbicides**

Oaks, Japanese maples, lilac, and hydrangea samples were submitted this spring with what looked like herbicide damage. Some inquiries turned out to have had improperly applied herbicides such as Ground Klear over the roots of trees and shrubs. Others had broadleaf herbicides applied to lawns last fall. With the drought stressing the trees and shrubs in those lawns, did the normally acceptable dose of herbicide now cause damage?

All pesticide users need to be aware. Chemical producers are using the name Roundup on products that do not contain glyphosate. For many years, Roundup equaled glyphosate. This is hard to understand given the bad publicity that the Roundup name has gotten recently.

### **Plant Health - Weather**

Lawns in Connecticut experienced chilling injury in early November. Night temperatures before this had been in the 40s and turf was not hardening off in preparation for the winter. Dr. LaMondia found and diagnosed yellow patch in some of the chilling samples that came into the lab.

Drought and heat in fall 2020 stressed woody plants. In particular, established arborvitaes did not do well.



Chilling injury on lawn November 3, 2020.  
Photo by Dave Schwarm.

### ***Impact:***

- Accurate identification of pests of agricultural and human health significance has resulted in economic savings to commercial growers and homeowners, reduced human and environmental exposure to pesticides, and increased human safety.

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