NAISMA - NYISRI

2019 JOINT ANNUAL CONFERENCE
ABSTRACTS

CONNECTING **SCIENCE**
TO **ACTION**

NAISMA
NORTH AMERICAN INVASIVE SPECIES
MANAGEMENT ASSOCIATION

NYISRI
New York Invasive Species
Research Institute

TABLE OF CONTENTS

9:00 a.m. - 10:45 a.m.

Welcome Plenary

Knowledge to Action on Invasive Species
David M. Lodge, Francis J. DiSalvo director of the Atkinson Center for a Sustainable Future, Cornell University

The invasive subset of almost 200 nonindigenous species in the North American Great Lakes cause at least $200M in annual damages. Those and the many other damages from invasive species throughout the world have mostly been accepted as a necessary by-product of global trade. Such fatalism is however unnecessary and financially foolish. Recent innovations are reducing invasions from ships, and from commerce in living organisms, while simultaneously increasing net economic benefits. New DNA-based technologies provide improved early detection tools, which, if combined with large-scale eradication and control technologies, open the door to a virtuous cycle of innovation, business opportunity, and environmental protection. Such a virtuous cycle will be hastened and enhanced by co-creation of research with decision-makers in the public and private sectors.

Connecting Science to Action from a Federal Government Perspective: Using Management Priorities to Focus Research Coordination
Jeff Morisette, Chief Scientist, National Invasive Species Council

The National Invasive Species Council (NISC) was established in 1999 to see that federal agency activities concerning invasive species are coordinated, complementary, cost-efficient, and effective, relying to the extent feasible and appropriate on existing organizations. The NISC Secretariat provides the guidance and support necessary for the Council to undertake its duties. During Fiscal Year 2019, the Secretariat has worked with the Council and senior leadership within the NISC member agencies to develop its next Management Plan, which considers a whole-of-government approach to identify current priority issues on invasive species and specific action elements that benefit from inter-departmental collaboration for implementation. But where does science fit within this coordinating function? One of the roles of NISC and the NISC Secretariat is to leverage ongoing scientific and technical work across the federal government for greater applicability and impact. This talk will highlight three relevant examples of scientific development: 1) modeling invasive species habitat, 2) invasive species phenological forecasting, and 3) early detection through environmental DNA. Each area represents significant federal investment and work that has benefitted from coordination across multiple agencies and been developed, in large part, based on management priorities. Using these examples, this presentation will consider how groups, such as NAISMA, can help to highlight management priorities and work collaboratively with federal agencies to leverage existing research and guide future scientific direction.

11:00 a.m. - 12:30 p.m.

Tools and Approaches for Invasive Species Decision Making- I

Moderator: Jennifer Price Tack, Cornell University

Approaches for Optimizing the Management of Many Invasive Species Across Space
Jennifer L. Price Tack, Cornell University; Angela K. Fuller, USGS New York Cooperative Fish and Wildlife Research Unit; Carrie Brown-Lima, New York Invasive Species Research Institute; Jennifer Dean, NY Natural Heritage Program; Qinru Shi, Cornell University; Carla Gomes, Cornell University

Resources to manage and control invasive species are limited, requiring decisions about which species to manage, which areas to treat, and which treatments to apply. Managers generally utilize two types of approaches to inform management of multiple invasive species: prioritization and optimization. Prioritization schemes rank species or areas based on pre-determined criteria. While this approach makes it relatively easy to compare a large number of species or spatial units, it does not inform managers of how to allocate resources across the ranked list or hotspot map. Optimization techniques, in contrast produce a decision by evaluating management actions based on their predicted impact on measured objectives (often cost and benefits). However, optimization has been largely restricted to applications involving one or few species, and often lack management objectives that are not easily monetized. We present a case study from New York to demonstrate how methods from the fields of decision science and computer science can be harnessed to optimize the management of many invasive species. Our tool and approach was applied to determine the optimal allocation of resources among 273 species (terrestrial and aquatic plants, animals, and invertebrates) based on their environment, social, and economic impacts, and cost of management. We evaluate four management strategies: prevention, search and destroy, direct intervention, and no direct action. We discuss the utility of our approach to inform invasive species management beyond New York, and highlight areas where additional research or monitoring can improve model performance.

Predicted Habitat Suitability Modeling for Invasive Species and Biocontrol in Montana
Jasmine Reimer, Montana Department of Agriculture; Bryce Maxell, Montana Natural Heritage Program

Predicted habitat suitability models for invasive species can be used to indicate the relative risk posed to various landscapes within a management jurisdiction. Similarly, predicted habitat suitability models for biocontrol species can be used to guide releases to areas where agents are most likely to establish successful populations. Modeling landscape-level habitat suitability of invasive species and biocontrol agents in Montana is done by using presence-only data on state listed noxious weeds and popular biocontrol species that are housed in databases at the Montana Natural Heritage Program. Using presence-only data in conjunction with pseudo-absences and 19 statewide biotic and abiotic layers models can be constructed using the Maxent maximum entropy algorithm. Presence-only data is filtered to ensure spatial and temporal accuracy and reduce spatial auto-correlation. A k-folds cross

validation methodology is employed using ten folds for model training and validation (90% of the data for training and 10% for testing). The ten estimated models are averaged to produce a map of 90-meter pixel logistic values ranging from 0-1. When enough training data is available, continuous output is reclassified into non, low, moderate, and optimal habitat suitability classes and the 90-meter pixels are aggregated into 1-square mile hexagons to ensure that models are informative to management decisions and used at the landscape scale. Natural resource managers can view model outputs and download model write ups from the Montana Natural Heritage Program's websites: mtnhp.org.

Limited Time and Resources: Evaluating the Utility of an Invasive Species Prioritization Model to Direct On-The-Ground Conservation Efforts
Mary Beth Kolozsvary, Siena College, Dept. Environmental Studies and Sciences; Jennifer Dean, New York Natural Heritage Program; Timothy Howard, New York Natural Heritage Program Amy Conley, New York Natural Heritage Program; Paulina Murray, Siena College, Dept. Environmental Studies and Sciences

The introduction and spread of non-native invasive species cause tremendous ecological and economic harm on a local, regional, and international scale. As such, there is great interest in determining where to direct conservation actions to minimize these impacts on ecosystems. Given that land managers typically have limited funds, it is essential to prioritize management efforts. But where should conservation efforts be directed? In 2016, the New York Natural Heritage Program created a spatial model to help land managers prioritize their efforts so that they can focus their limited resources on high quality natural areas that are likely to be invaded by invasive species, but no field validation of the accuracy of the model was done. In 2017, we sampled vegetation in 20m x 50m forest plots at 16 forest tracts in and around the capital region of New York State. For each site, we calculated measurements of floristic quality, species richness, and proportion of native to non-native plants to assess ecological significance and risk of invasive species spread. In general, the model predictions were supported by our field data. Sites with low ecological significance were more variable in percent non-native species and indicators of site quality (mean C, Floristic Quality Index (FQI)). Sites with high ecological significance had less variability in percent non-native species and indicators of site quality, indicating that they may be more resilient to invasion by non-native species. In 2018, the Capital-Mohawk PRISM used the results of the model to prioritize their on-the-ground conservation efforts.

INHABIT: A Web Application to Deliver Habitat Suitability Models and Bridge the Scientist-Practitioner Divide
Catherine S Jarnevich, U.S. Geological Survey, Fort Collins Science Center; Terri Hogan, National Park Service; Peder Engelstad, Colorado State University; Ian Pearse, U.S. Geological Survey; Jennifer Sieracki, National Park Service

The National Park Service Exotic Plant Management Team program is one of many groups tasked with managing invasive species on federal lands. As with all practitioners, they are hampered by the scope of the invasive species problem compared to available resources that combat invasive species.

Habitat suitability models for invasive species can provide practitioners with information to advise watch lists and target population searches. While many suitability models exist, there is often a divide between researchers creating these models and practitioners who may find them useful in informing land management actions. We have formed a scientist-practitioner partnership to create national models for several high priority species that are integrated into the Invasive Species Habitat Tool (INHABIT), a web application displaying visual and statistical summaries of nationwide habitat suitability models. The models are based on aggregated occurrence data and a species-specific set of predictors from a library of nationwide predictors we have assembled. The models are built following a common protocol, promoting model repeatability and credibility. Managers provide feedback both on the models and on INHABIT's features through various outlets. The content and functionality of INHABIT are designed to provide practical information leading to enhanced land management actions, including mapped products with interactive thresholds to define suitability based on management objectives (with field-device compatible download options), information on modeled environmental relationships, and tabular proximity summaries to inform management area watch lists. Based on comments and suggestions of practitioners, INHABIT is actively evolving to help bridge the gap between scientists and practitioners.

11:00 a.m. - 12:30 p.m.

Pathways

Moderator: Carrie Jean Brown-Lima, New York Invasive Species Research Institute

Forest Pests: How they Get Into the Country, and How to Stop Them
Gary Lovett, Cary Institute of Ecosystem Studies

Forest insects and diseases imported through global trade are among the most serious threats to forest health in the U.S. Most invasive forest pests enter the country through two pathways: solid wood packaging material such as crates and pallets, and imported live plants used for landscaping. For both pathways, current systems intended to prevent pest entry are inadequate, and pests routinely enter the country. Most of the imported pests do not cause much damage, but some explode, causing billions of dollars in damage and in some cases nearly extirpating entire tree species. We propose a series of measures called Tree –Smart Trade to prevent introductions of new forest pests. Tree-Smart Trade policies include: 1) phasing out solid wood packaging for international shipping, 2) increasing surveillance and eradication capabilities and improving coordination across agencies and states, 3) working with trading partners to make sure shipments are free of pests before they are shipped, 4) restricting importation of live woody plants that are closely related to native plants, and 5) strengthening enforcement of existing regulations and penalties for noncompliance. Taken together, these common-sense measures will tighten the country's defenses against imported pests and help protect our forests.

Biological and Economic Factors that Increase Pet Owner Release of Exotic Reptiles and Amphibians
Julie Lockwood, Rutgers University; Oliver Stringham, University of Adelaide

The legal pet trade is now the dominant pathway by which individuals of non-native reptiles and amphibians are introduced. Using information on the 1,722 species of reptiles and amphibians sold within the US as pets over the last 18 years, and the list of these species that are known to have been released, we correlated species release status with their life-history traits and economic attributes. We found that species with a high probability of being released were imported at higher quantities over our period of record, have a relatively large adult mass and commanded cheaper retail prices. The number imported and price interacted with longevity and adult mass to produce nonlinear increases in release probability. The most important interaction revealed that large-bodied species imported in high quantities have a three times higher release probability compared to large bodied species imported in lower quantities. Our results provide guidance towards targeting exotic pet reptile and amphibian species that are at a high risk of being released. Species that are both prevalent in the pet trade and large-bodied or long-lived have the highest probability of being released. This will aid in developing education and policy solutions aimed at decreasing the rate at which these pets are released, thus curtailing the invasion process before these species can establish and impacts can occur.

Informing Cost-Effective Strategies for Reducing Pest Risk from Live Plant Imports
Rebecca Epanchin-Niell, Resources for the Future; Dr. Andrew Liebhold, USDA Forest Service, Northern Research Station

The US imports more than a billion live plants annually. Live plant imports are a key input to domestic horticultural industries, but also a primary pathway for nonnative invertebrate and pathogen introductions. A variety of biosecurity measures – ranging from off-shore mitigation to inspection and phytosanitary treatment at the border to post-entry quarantine and monitoring – is available to reduce the risk of plant pest imports. How can these policies and measures be designed to reduce the pest risks from live plant imports while also maintaining the benefits from trade? Understanding how to efficiently manage risk from this invasion pathway is an important, global challenge that must balance the benefits and costs of different policies, as well as the incentives and possible unintended consequences posed by those policies. Here we report on the findings of work from a collaborative research effort that is focused on designing cost-efficient policies for reducing pest risk from live plant imports. Research findings include development of risk based inspection approaches and highlight how accounting for stakeholder interests can enhance the cost-effectiveness of invasion prevention policies.

11:00 a.m. - 12:30 p.m.

Boat Inspection and Decontamination Programs and Standards from East to West

Moderator: Brendan Quirion, The Nature Conservancy; Melissa Maggio, Missoula County Weed District

Protecting the Waters of the Columbia River Basin: The Last Frontier
Kate Wilson, Montana Dept. of Natural Resources & Conservation; Brendan Quirion, The Nature Conservancy; Melissa Maggio, Missoula County Weed District

Boat inspection and decontamination programming has expanded across many eastern and western states in recent decades in response to historic and emerging aquatic invasive species (AIS) threats. These programs operate under different regulatory authorities (voluntary vs. mandatory), jurisdictions (lake specific vs. regional), and inspection/decontamination standards (full vs. partial) and have demonstrated varying levels of effectiveness in preventing the introduction and spread of AIS. In this session we will hear from representatives of two eastern and two western states focused on boat inspection and decontamination programming as well a summaries of results, lessons learned, and recommendations. A panel session will follow to facilitate discussion and increased collaboration across juridictions.

Montana's Mandatory Watercraft Inspection Stations: A Partner's Perspective
Lindsey Bona-Eggeman, Missoula County Weed District

Montana's mandatory watercraft inspection station program is in its 15th year. Learn how this program has evolved, grown and collaborated its way to inspecting 110,000 watercraft in a single season. Through strategic partnerships Montana Fish, Wildlife and Parks has begun to utilize local organizations like tribes, conservation districts, watershed groups and weed districts to expand the capacity of the AIS prevention program. Missoula County Weed District has been a partner organization for the last 3 seasons at one of Montana's busiest stations. Lindsey with Missoula County Weed District will talk about benefits, challenges and success managing mandatory watercraft inspections stations in Montana.

Maine's Courtesy Boat Inspection Program
Karen Hahnel, Maine Department of Environmental Protection

Maine is the most northeastern state in the US with over 5,800 lakes of which 2,700 are greater than 10 acres, large enough for boater recreation. The Maine Department of Environmental Protection's Invasive Aquatic Species (IAS) Program was created in 2001 to prevent the introduction and spread of invasive aquatic plants into Maine waters. Currently, there are 39 waterbodies with invasive aquatic plant infestations. To prevent the spread of these plants and other invasive organisms into Maine waters, DEP's IAS Program promotes boat inspections via our Courtesy Boat Inspection (CBI) Program. As the name implies, boat inspections in Maine are not mandatory but instead are a courtesy. Maine supports local and regional boat CBI Programs by awarding over 70 small grants to nonprofit groups, primarily lake associations. Maine's IAS Program, originally focused on invasive aquatic plants, has expanded prevention efforts to mollusks and other organisms not yet in Maine. We promote the Clean, Drain, Dry message to prevent the spread of other invasive organisms from nearby states. Maine also considers the CBI Program an effective method to educate the public of the threat of invasive organisms. From 2,800 inspections in 2001 to over 87,000 in 2018, Maine's program continues to grow.

Mandatory and Voluntary Boat Inspection Standards in the Adirondack Park of NYS
Eric Paul, Adirondack Watershed's Stewardship Program; Dave Wick, NYS Lake George Park Commission

Two administratively separate but cooperating boat inspection and decontamination programs in the Adirondack Park operate under different inspection and decontamination protocols: one mandatory, and the other voluntary. This presentation summarizes the history, context and rationale for the different standards, similarities and differences of visitor intake, inspection and decontamination practices, and how the two programs are managed within the overall context of AIS spread prevention in the Adirondack State Park. The presenters will describe approaches to aligning boat inspector messaging, boat sealing and tracking, opportunities and challenges around reciprocity of inspections and decontaminations, and navigating visitor expectations and responses to the different standards. Boat inspection and decontamination outcomes, pubic reception, and lessons learned over five years of joint programming will be summarized.

11:00 a.m. - 12:30 p.m.

National Invasive Species Awareness Week (NISAW) 2020 Brainstorm

Moderator: Belle Bergner, NAISMA, PlayCleanGo; Chuck Bargeron, University of Georgia

Chuck Bargeron, Co-Director of the University of Georgia and Belle Bergner, Executive Director of NAISMA will lead a discussion with leaders and staff of National and Regional organizations about National Invasive Species Awareness Week (NISAW). This event has historically occurred during the last week of February when Congress is in session, and has been led by various national organizations. In this brainstorm session, participants will be invited to provide ideas for what NISAW 2020 should look like. If you are interested in contributing to this important awareness event, please come and share your ideas and energy!

1:30 p.m. - 3p.m.

Tools and Approaches for Invasive Species Decision Making -II

Moderator: Deah Lieurance, Florida Exotic Pest Plant Council/UF IFAS

Using Risk Analysis to Prioritize Management and Prevent Introductions of Non-Native Plants and Their Cultivars in Florida's Natural Areas.
Deah Lieurance, University of Florida; S. Luke Flory, University of Florida

The detrimental ecological and economic effects of invasive species are especially evident in the natural areas of Florida. Preventing high-risk species from being introduced into natural areas and managing invasive species early in the invasion process can reduce these effects. To identify plant species most likely to invade and cause damage in Florida's natural areas, the University of Florida's Institute of Food and Agricultural Sciences (IFAS) developed The UF/IFAS Assessment of Non-Native

Plants in Florida's Natural Areas. The IFAS Assessment utilizes risk analysis protocols to evaluate the status of non-native species either present in the state or prior to introduction. The goal of the IFAS Assessment is to provide reliable, comprehensive recommendations for the use of non-native plant species. Results are accessible through an interactive, searchable website that can be filtered by geographical zone, conclusion type, origin, and growth habit. Currently, conclusions are available for approximately 900 species. One unique component of the IFAS Assessment is a cultivar assessment tool used to determine if the recommendations of a cultivar, sub-species, variety, or hybrid differ from those of invasive parent species. Additionally, the IFAS Assessment recently received funding to update the risk assessment protocol to include uncertainty analysis and geopotential distribution mapping. Overall, the IFAS Assessment contributes to management and conservation efforts of our valuable natural resources by helping to reduce the introduction and spread of plant invaders.

Ecological Risk Screening Summaries: Evaluating the Risk of Potential Non-Native Species
Heidi Himes, U.S. Fish and Wildlife Service; Chris Castiglione, U.S. Fish and Wildlife Service; Katherine Wyman-Grothem, U.S. Fish and Wildlife Service; Mandi Ohar, U.S. Fish and Wildlife Service; Scott Sanders, U.S. Army Corps of Engineers

Assessing potential risk of invasive species can be a long and labor intensive process. The U.S. Fish and Wildlife Service (USFWS) has developed a rapid screening protocol to serve as a first assessment of the risks posed by non-native species. Ecological Risk Screening Summaries (ERSS) can be completed in 1-2 days, compared to 1-2 years for a comprehensive risk assessment, and considers the species' history of invasiveness, quantity and quality of information available, and results of a climate match. The outcome of the ERSS can be used to demonstrate the need for a comprehensive risk assessment. USFWS developed the companion Risk Assessment Mapping Program (RAMP) that matches 16 climate variables from the species' established native and non-native range to the same variables for a target region in the United States. RAMP uses three future climate scenarios developed by the Intergovernmental Panel on Climate Change for the years 2050 and 2070 to address the impact of climate change on the species' potential future range. The species' current climate requirements are matched to the projected future climate scenarios. The results of the ERSSs provide agencies and partnerships a science based approach to better allocate limited resources for early detection, rapid response, control, and education programs.

Data-Driven Decision Support Tools for Forest Managers and Researchers
Alexandra M. Kosiba, Forest Ecosystem Monitoring Cooperative, University of Vermont; James A. Duncan, Forest Ecosystem Monitoring Cooperative, University of Vermont

The Forest Ecosystem Monitoring Cooperative (FEMC) is a five-state organization that aims to help researchers and managers have better access to information for decision-making and management of our forested ecosystems. Here we showcase three FEMC projects that focus on helping our regional collaborators to better understand forest disturbance caused by invasive insects and diseases. (1) A New York State mapping

effort to identify riparian corridors that may be at elevated risk of hemlock woolly adelgid induced hemlock mortality. Resulting spatial maps allow managers and researchers to identify locations for additional study or management with a focus on potential impacts to water resources. (2) Using previously collected urban tree inventories, the FEMC worked with collaborators to quantify the economic costs of invasive pests in urban areas in the northeastern US. The results from this work will provide helpful information for urban forest managers and planners to better understand the values at risk when an urban forest is invaded. (3) The Northeastern Forest Health Atlas, an online mapping and data discovery tool containing aerial survey and field data related to forest damage and disturbance. Users can filter by damage agent, damage type, state, and year, download maps and data, and view graphs and tables of disturbance patterns over time.

Using Science Advisory Panels to Guide Management Decisions
Bryce Christiaens, Montana Invasive Species Council

The Montana Invasive Species Council (MISC) was created to identify priority invasive species issues and make recommendations to improve prevention and management to Montana's Governor, legislature and resource management agencies. In 2017, the Montana Legislature passed legislation directing the Montana Invasive Species Council to identify, coordinate, and maintain independent science advisory panels that "inform Montana's efforts based on the current status, trends, and emerging technology as they relate to invasive species management in Montana. In the two years since, MISC has conducted two science advisory panels. The first was to evaluate the use of environmental DNA (eDNA) for dreissenid mussel early detection and provide input and guidance to managers regarding its use. The second was to evaluate the feasibility of gaining approval to release Mogulones crucifer for biocontrol of houndstongue in the U.S. This presentation will focus on the process developed by MISC to conduct Science Advisory Panels, how topics were chosen and the results of each panel to date.

1:30 p.m. - 3:00 p.m.

How To Communicate With Policy Makers To Get Results

Moderator: Belle Bergner, North American Invasive Species Management Association

Communicating with Policy Makers
Richard Otis, Reduce Risks from Invasive Species Coalition

Ever wondered how to communicate with legislative staff and members, senior government officials, and other policy makers? This panel will provide advice and real world examples of how to work with officials at the state, interstate, and federal levels. Each level of government is different and there aren't magic techniques that work for every issue, but you'll have the opportunity to hear from and ask questions of panel members who have real world, practical experience in general and specifically with respect to invasive species.

Building Policy With Science
Gary Lovett, Cary Institute for Ecosystem Studies

In many cases, scientific information is injected into the policy process in a haphazard and ineffective way. This happens because the goal of scientists is to provide new knowledge, not to develop new policy. In this presentation I will describe an alternative approach in which the first step is consideration of the policy goal. The next steps are synthesizing science relating to that goal, making recommendations on what policy changes are needed, and communicating the information in a manner accessible to policy makers. This can be challenging, exasperating, and time-consuming, and may require a long-term commitment. I will use our efforts to improve federal policies that prevent the importation of forest pests as examples, both good and bad.

A Practical Guide to Communicating with Policy Makers
Karen Feldman, Attorney and Political Consultant, Former acting Chair and Board Member for the Adirondack Park Agency

The Invasive Plant Management Association (IPMA), A Model for Providing an Economic Voice to Promote State Funding
James L Burney, Invasive Plant Management Association

In response to the continual challenges facing the funding of invasive plant management operations during each State Legislative Session and the potentially negative influence on Florida's natural resources and those dependent on managing natural lands and waters, the not-for-profit 501(c)(6) advocacy organization, Invasive Plant Management Association (IPMA), was incorporated in 2012. IPMA was organized with the intent to provide the economic impact voice of upland and aquatic invasive plant management during our inaugural 2013 legislative session with the Mission being: "To foster sustained State funding for invasive plant management measures as an integral part of managing Florida's natural lands and waters." The predominantly private sector membership was and is comprised of application contractors, herbicide manufacturers and distributors, and support vendors capable of lobbying without public sector constraints. In 2017-18, the Strategic Outlook remained to foster an ingrained legislative culture of sustainable State funding for invasive plant control through continued representation by the lobbying firm Lewis, Longman, & Walker, PA. Specific goals for the 2018 Legislative Session (FY 2018-2019 Budget) included: Maintaining (or increasing) the Invasive Plant Management Trust Fund; Representing invasive plant management as an integral component of the Land Acquisition Trust Fund; and Continuing discussions for support of dedicated funding for invasive plant management on other State lands (in lieu of Trust money). The purpose of this presentation is to provide an introduction to IPMA, including State Budget successes, to be used as a potential model to organize invasive plant management funding advocacy in other States.

1:30 p.m. - 3:00 p.m.

Advances in eDNA Technology in Aquatic and Terrestrial Systems

Moderator: Rob Williams, The Nature Conservancy

Science, Technology and Application Frontiers of Aquatic eDNA
David M. Lodge, Cornell University

Since the first publication of a field application of aquatic eDNA in 2008 (on bullfrogs in French ponds), and the first largescale management application beginning in 2009 (on Asian Carp in the Chicago-area canals), the number and diversity of eDNA-based applications and publications has exploded. The most typical applications remain the use of PCR for early detection of specified target nonindigenous species or delimiting habitat of imperiled species, and more recently the use of metabarcoding to detect all the species "captured' by a "universal" primer. These approaches have proven their usefulness in a variety of research and management settings, and are ideally suited for large geographic scale surveys of hard to reach waterbodies, and post-management monitoring programs. Frontiers of eDNA applications undergoing rapid research and development include metrics of population size and intrapopulation variation (population genetics). I will provide examples from on-going research and management efforts including surveillance for invasive species in lakes, and for ship-borne invasive species in marine ports. At the science-management interface, the last decade of experience provides the following lessons: scientists often need to practice humility in working with managers; managers need to practice patience with researchers; and agreements on data sharing and public communications between researchers and managers must be finalized before data collection begins.

Adapting Environmental DNA Surveys to Detect and Manage Agricultural and Forest Pest Insects
Julie Lockwood, Rutgers University; Rafael Valentin, Princeton University; Michael Allen, Rutgers University

Environmental DNA (eDNA) survey methods were initially used to survey for invasive aquatic species that were cryptic and hard to survey, or were present at such low abundances that conventional techniques could not locate them. Initial successes spurred a boom in technology and techniques, which have greatly expanded eDNA surveys for use in a variety of applied management situations (e.g., conservation, fisheries). Only recently has the tool made its way toward use on land, and here we report on our successes in using eDNA surveys for agricultural and forest insect pests. Our field collection and aggregation methods are novel allowing us to produce survey information that can transform how we deploy delimiting surveys, evaluate integrated pest management strategies, and design site-level treatment protocols. Like other uses of eDNA that inform decision-making, incorporating eDNA surveys within terrestrial insect pest management requires careful deployment of field and in-lab protocols so that production of false positive detection is held very low.

Rapid and PCR-free DNA Detection of Invasive Species by Nanoaggregation-Enhanced Chemiluminescence
Snober Ahmed, University of Minnesota; Abdennour Abbas, University of Minnesota

Tree diseases caused by invasive pathogens cost hundreds of millions of dollars annually to the US. A study on Minnesota oak trees published in 2011 revealed that oak wilt (Ceratocystis fagacearum) alone cost the State up to $60 million over the last 10 years. Tubakia iowensis causal agent of Burk Oak Blight (BOB) is estimated to cost $0.7 M/ year for tree replacement and other associated expenses related to removal of infected trees. Thus, early and rapid disease detection of invasive forest pathogens is expected to have a significant economic impact by preventing the spread of diseases and the conservation of natural resources. In this study, a new rapid detection technology named Nanoparticles-Enhanced Chemiluminescence (NEC) assay was developed for early and rapid detection of Ceratocystis fagacearum and Tubakia iowensis. The assay is used to introduce a rapid and sensitive DNA detection method that does not require amplification. The limit of detection was down to 260 fM ($260 \times 10-15$ M) for C. fag and 175 pM ($175 \times 10-12$ M) for T. iowensis, two orders of magnitude higher than the performance obtained with conventional and laborious methods. Furthermore, the detection can be performed within 22 min using only a portable luminometer. In-field testing of the assay will be conducted this summer.

1:30 p.m. - 3:00 p.m.

Investigating the Health Effects of Glyphosate

Moderator: Dan Wixted, Cornell Pesticide Management Education Program; Anthony Hay, Cornell Department of Microbiology

Glyphosate (the active ingredient in herbicides like "Roundup®" and other weed control formulations) has been much in the news in today's world of social media and 24-hour news cycles. Are you hearing conflicting and confusing information about exposure, toxicity and its health effects as you try to stay abreast of the recent science? Join Dr. Anthony Hay from Cornell University's Department of Microbiology and Dan Wixted of Cornell's Pesticide Management Education Program (PMEP) as they separate the wheat from the chaff. Their presentation will give an overview of current science-based discussions about exposure, toxicity and health effects. They will also provide some background on basic principles in toxicology and pesticide registration to round out your understanding of the current information.

3:30 p.m. - 5:00 p.m.

New Invaders in the Northeast and Their Management

Moderator: Linda Rohleder, Lower Hudson PRISM / New York-New Jersey Trail Conference

The Ecology of *Haemaphysalis longicornis* Emergence on Staten Island, New York, and Its Public Health Implications
Danielle M Tufts, Columbia University; Meredith VanAcker, Columbia University; Maria Diuk-Wasser, Columbia University

Haemaphysalis longicornis, an invasive Ixodid tick, was recently reported in the eastern United States. The emergence of *H. longicornis* presents a potential threat for livestock, wildlife, and human health. We describe the distribution, host-seeking phenology, and host and habitat associations of *H. longicornis* from Staten Island, a New York City borough. We surveyed

24 forest and grassland sites for questing ticks, eight forested grid sites for questing and small mammal-derived ticks, and 16 captured deer for feeding *H. longicornis* from June-August, 2018. Here, we present the results from these efforts. We provide insight into the potential of *H. longicornis* to serve as an important vector of tick-borne pathogens to humans based on its feeding ecology, phenology, and associated pathogens within its native range.

Three New Invaders: Italian Arum, Sapphireberry and Sticky Sage
Linda Rohleder, Lower Hudson Partnership for Regional Invasives Species Management

Amur corktree (*Phellodendron amurense*) Invading Forests in the Lower Hudson Region of NY.
Jessica A. Schuler, The New York Botanical Garden; Todd Forrest, The New York Botanical Garden

The Thain Family Forest (Forest) at the New York Botanical Garden (NYBG) is the largest remnant of old growth forest in New York City. Though the Forest has remained intact since the last ice age, it has undergone many disturbances both natural and anthropogenic. This 25 hectare stand is site of long-term monitoring through forest inventories that has observed the dynamics of forest composition change over time and informs forest management including ecological restoration. Increases in invasive plant species, particularly, Amur corktree (*Phellodendron amurense*) initiated a forest restoration program in 2008 to actively managing invasive plant species and restore native plant communities. The latest forest inventory, completed in 2016, revealed long-term management needed to contain an established invasive plant species. The trends in these data reveal a shift in the trajectory of invasive plant species dominating forest canopy to the recovery of native species, however, the Amur corktree has not been eradicated. Now established in the Lower Hudson PRISM, Amur corktree is a candidate for active management and containment.

Early Detection and Rapid Response to Actinidia arguta Infestations in NYS Lower Hudson PRISM
Thomas Lewis, Trillium Invasive Species Management, INC

Early detection and rapid response efforts are a lynch pin in the strategy for regional management of emerging invasive species. In order to prioritize management efforts, New York's Lower Hudson Partnership for Regional Invasive Species Management (LH-PRISM) developed lists of widespread, established and emerging species. Hardy Kiwi (*Actinidia arguta*) was prioritized as an emerging invasive species (Tier 2) in the LHPRISM and classic early detection/rapid response actions were initiated to eradicate three infestations in the region. Partnerships between landowners, municipalities, businesses and local conservation organizations were established at each infestation in order to ensure successful eradication through continued control efforts and monitoring. These projects demonstrate the enormous value of collaborative management, and the efficacy of New York State's PRISM model that provides a forum for partners to collaborate and pool resources needed to overcome the complex challenges and resource scarcity inherent in invasive species management. This presentation will describe efforts at the three locations. The first infestation (initiated in 2014)- a single population located on private property- has been

controlled by a contractor, with follow-up work performed by the LHPRISM strike team and monitoring performed by a local land trust. The second (initiated in 2015) and third (initiated in 2016) infestations are much more complicated infestation complexes spanning several properties. Management of these infestations require a high degree of coordination to bring together the diverse group of landowners: project success was found in establishing suitable management plans for each stakeholder and maintaining constant communication throughout the management process.

3:30 p.m. - 5:00 p.m.

Applying Science to Policy Decisions

Moderator: Kelly Cooley, CoolPro Solutions Environmental Consulting

Science-Based Decision-making for Invasive Species Management and Policy at the U.S. Department of the Interior
Hilary Smith, Senior Advisor for Invasive Species

The U.S. Department of the Interior (DOI) is the steward of 20 percent of the Nation's lands, including national parks, national wildlife refuges, and other public lands. DOI supplies and manages waters in 17 western states; manages resources that supply at least 20 percent of the Nation's energy; and supplies 15 percent of the Nation's hydropower energy. DOI also upholds Federal trust responsibilities to 573 Federally recognized Indian tribes, Alaska Native villages, and affiliated island communities. To effectively address these responsibilities, it is critical to use relevant and reliable science to inform policy and management actions, including those actions to address invasive species. This presentation will describe DOI's science-based approach to invasive species management and include case studies of lessons learned. Remarks also will highlight policy perspectives across multiple scales and sectors.

Science-Based Decision-Making for Invasive Species Management and Policy at the U.S. Department of Agriculture
Samantha Simon, Executive Director, Emergency and Domestic Programs Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture

The U.S. Department of Agriculture (USDA) provides leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management. USDA's mission is to provide economic opportunity through innovation, helping rural America to thrive; to promote agriculture production that better nourishes Americans while also helping feed others throughout the world; and to preserve our Nation's natural resources through conservation, restored forests, improved watersheds, and healthy private working lands. Invasive species have the potential to disrupt USDA efforts to meet its mission. The globalization of trade, travel, and transport means that an increasing number of new invasive pests are entering the United States. To safeguard America's agricultural and natural resources from invasive species, USDA develops and implements science-based pest prevention, early detection, rapid response, and practical recovery systems. This presentation will

describe USDA's science-based approach to invasive species management and include case studies of lessons learned.

How Data Drives Invasive Species Policy Development in New York State
Megan Phillips, Senior Policy Advisor for the Environment, Office of Governor Andrew M. Cuomo

New York State has created a robust, comprehensive invasive species program that is supported in part by an annual dedicated funding stream through the Environmental Protection Fund ($13.3M for FY19-20). The unique and innovative structure of the program facilitates collaborative, multi-directional information sharing among state agencies, practitioners, academic institutions, trade organizations, and not-for-profit groups. This presentation will provide examples of how scientific data is used to guide the development of state policy and regulations. It will also explore future opportunities to address gaps and policy challenges to ensure that New York remains proactive in its approach to addressing invasive species in our state and region as a whole.

3:30 p.m. - 5:00 p.m.

An Introduction and Overview of the Aquatic Nuisance Species Task Force and its Regional Panels

Moderator: Susan Pasko, U.S. Fish and Wildlife Service

Susan Pasko, USFWS; Catherine McGlynn, Ph.D., New York State Department of Environmental Conservation; Elizabeth Brown, Colorado Parks and Wildlife/Panel Chair; James Ballard, Gulf States Marine Fisheries Commission; Erika Jensen, Great Lakes Commission

Aquatic invasive species (AIS) issues are significant in their breadth and scope as their threats emanate from numerous taxa and pathways, and in turn, endanger aquatic resources around the globe. Adequate coordination, funding, public awareness, and management expertise are critical to success, particularly because ANS can span geographic boundaries and do not recognize political boundaries or agency jurisdictions. The great extent needed to manage AIS and their impacts infers that one agency or work group cannot tackle it alone. The Aquatic Nuisance Species (ANS) Task Force was created by the U.S. Congress to coordinate efforts between Federal, State, tribes, and local agencies, the private sector, and other North American interests. Composed of 13 Federal and 15 ex-officio members, it is the only federally-mandated intergovernmental organization solely dedicated to preventing and controlling AIS. The ANS Task Force serves to protect U.S. waters by creating a unified, well-coordinated approach that raises awareness and takes action to prevent and manage AIS. While the ANS Task Force has a national focus, it recognizes the tremendous importance of actions taken at the regional, State, and local levels to achieve national ANS solutions. As such, six regional panels have been established under the ANS Task Force as a critical and effective mechanism for achieving the goals of the ANS Task Force and a means to unify local actions into a regionally-coordinated response. The Nonindigenous Aquatic Nuisance Prevention and Control Act charges the regional panels with identifying regional aquatic invasive species (AIS) priorities, coordinating AIS program activities in the region, and providing advice to public and private interests concerning AIS management and control. The regional panels also provide a host

of services and products that foster communication, cooperation, and collaboration that help ensure that the ANS Task Force achieves its strategic goals. Each panel creates a forum that allows for information sharing, collaboration, and coordination and ensures that local and regional operations are efficient and avoid duplication of effort and use of resources. These regional coordination efforts have been successful in fostering collaboration among states within watersheds or in similar geographic areas to address regional AIS threats and ongoing invasions. This session will provide perspective from the ANS Task Force and the six regional panels; Great Lakes, Mid-Atlantic, Northeast, Mississippi River Basin, Gulf and South Atlantic, and Western regarding focal species and ANS prevention, monitoring, and control efforts in their respective regions.

3:30 p.m. - 5:00 p.m.

Expanding Capacity Through Citizen Science: Train the Trainer Programs

Moderator: Charlotte Malmborg, New York State Hemlock Initiative, Cornell University; Brittney Rogers, NYiMapInvasives Program, NYSDEC

Charlotte Malmborg, New York State Hemlock Initiative, Cornell University;Brittney Rogers, NYiMapInvasives Program, NYSDEC

It can be difficult for organizations that survey for and manage invasive species to reach all potential partners and volunteers, especially when operating on a regional or statewide scale. This is even more challenging for organizations that rely on collecting citizen science data to improve research and management efforts. Even with enough staff and funding, the amount of time needed to collect data across large spatial scales limits both the quantity and quality of data that can be collected. Equipping existing partners and citizen scientist volunteers with the tools and information necessary to train others enables an organization to reach more constituents, expand capacity, and address existing gaps in both field data and community engagement. The iMapInvasives project, managed by the New York Natural Heritage Program, implemented a train- the-trainer program in 2017 to engage more iMapInvasives users around the state. The iMapInvasives Certified Trainers Network seeks to improve early detection efforts for invasive species across New York. Following the iMapInvasives model, the New York State Hemlock Initiative is developing a Train-the-Trainer network to expand hemlock woolly adelgid (HWA) survey efforts and address gaps in state HWA data. The Certified Trainers Network focus is broad, focusing on all invasive species in New York. NYSHI's program, on the other hand, concentrates on HWA and monitoring its spread in the state. In this workshop, members of organization of all sizes and scopes will learn how to implement train-the- trainer programs, drawing from the experience of NY iMapInvasives Research Project Assistant Brittney Rogers and NYS Hemlock Initiative Education and Outreach Coordinator Charlotte Malmborg. Workshop attendees will create a program development plan to address their specific organization's needs, and learn tips for making their programs more successful.

8:00 a.m. - 9:00 a.m.

Plenary

Learning From Failure in Conservation
Allison Catalano;PhD Candidate, Imperial College, UK

Failure is difficult to discuss and rarely reported in the conservation peer-reviewed literature, but in reality many conservation initiatives are partial or complete failures. Reasons for this are probably varied, but we know little because failure is seldom planned for, discussed, documented, or shared in any systematic way. Overcoming the stigma inherent in failure is a challenge, but one that disciplines such as aviation and medicine have grappled with for many decades in order to develop systems to effectively learn from mistakes and errors. While conservation activities take place in unique and complex contexts, we can examine and adapt for our own use these established learning processes to increase our individual, team, and organizational ability to learn from failure. This session will introduce and expand upon some of these ideas and facilitate an open discussion about the challenges and opportunities that failure presents.

How to Measure Success in Invasive Species Management
Bernd Blossey, Assistant Professor, Department of Natural Resources, Cornell University

All habitats of the Northeast and their inhabitants need to simultaneously respond to climate change, invasive species, habitat fragmentation and increasing deer herds. The challenge of recognizing which introduced species are drivers of ecosystem change and which species just "ride along" is therefore difficult. Ignoring multiple stressor impacts, however, handicaps our ability to develop appropriate management regimes. Targeting invasive species, for example, may not achieve the desired outcome when deer or earthworms are the major stressors. Further, projects often focus on financial investment, area treated or the amount of the target species that is removed as metrics of management success, while largely ignoring how management impacts the organisms we want to protect. But does the evidence support that invasive species management improves living conditions for native species? In some scenarios, impacts of management may be more harmful than beneficial. Evidence on impacts of herbicide treatments, although rarely collected, suggests these treatments have persistent non-target effects. This lack of information on impacts of invasions or their management point to fundamental problems in how invasive species are managed. Institutional cultures often ignore the need for accountability: agencies funding treatments disallow assessments, and those wanting to assess outcomes face the daunting task of finding appropriate metrics (largely because academia has not delivered protocols that can be implemented with reasonable knowledge and resources). I will provide examples of how land managers and scientists can collaborate and develop metrics that are both scientifically valid and can be implemented without breaking the bank.

9:15 a.m. - 10:45 a.m.

New Frameworks for Assessing Invasive Species Management

Moderator: Stacy Endriss, Cornell University

Growing or Shrinking? Measuring the Responses of Populations to Management
Wade Simmons, Graduate Student, Cornell University; Dr. Andrea Davalos, SUNY Cortland; Dr. Bernd Blossey, Cornell University

Successful management requires understanding how populations respond to control efforts. Ideally, management reduces invasive populations without decreasing non-target populations, but this information is rarely collected. By collecting data on survival, growth, and reproduction of individuals, however, we can use demographic models to describe and forecast whether populations increase, stay stable, or decline in response to various management interventions. they increase, stay stable or d This information can guide management by providing a metric (population growth rates) to assess responses of species to treatments. To illustrate how to design and develop demographic models, we highlight biocontrol research for water chestnut, *Trapa natans*. We use data from two leaf beetles that attack *T. natans* (one native to North America, one a close relative from China) to demonstrate different plant population outcomes to insect herbivory scenarios. Biocontrol of *T. natans* appears likely to suppress populations of the invasive plant, but is it safe for populations of native plants? To address this question, we describe how our approach is being used to evaluate impacts on a non-target plant water-shield, *Brasenia schreberi*. By building a deeper understanding of population dynamics, demographic models can inform management by providing insights into how populations of invasive or native species may respond to control efforts, and when populations are most vulnerable to control efforts.

Promoting Accountability in Invasive Plant Management through Outcome Monitoring - Case Studies from the Adirondacks
Brendan Quirion, The Nature Conservancy

Despite significant investments made annually to address invasive species threats to biodiversity, economies, and human health, practitioners often resort to superficial metrics, such as acres treated or resources expended, to determine management success. Thorough evaluation and measurement of invasive species reductions and natural resources protected or restored as a result of management - collectively known as outcome monitoring - is rare. It is incumbent upon researchers and practitioners, as stewards of public land and funding, to engage in co-production of methods for accurately and economically measuring progress in meeting invasive species management objectives. The Nature Conservancy's Adirondack Park Invasive Plant Program, in collaboration with partner universities and state agencies, has developed new data collection systems and processes that encourage annual assessments of infestation abundance to document management progress over time. Results from tracking management outcomes for nearly 350 invasive *Phragmites australis* infestations over seven years in Adirondacks will be shared along with examples of two new data collection

systems (the Invasive Plant Mobile Monitoring System and Lake Management Tracker) that promote outcome monitoring in both terrestrial and aquatic invasive species management.

What Can Bird and Frog Calls Tell Us About Invasions?
Stacy B Endriss, Cornell University; Bernd Blossey, Cornell University; Holger Klinck, Bioacoustics Research Program

We often justify invasive species management by claiming that our actions create or maintain habitat for native wildlife. However, evidence on how management impacts the species we want to protect is often lacking. Bioacoustic monitoring (deploying stationary recorders for extended periods of time) can bolster imperfect evidence by capturing ecological soundscapes. These soundscapes, in turn, can provide a more holistic understanding of how invasions and their management impact broad suites of vocal bird and amphibian species. To highlight the utility of this approach, we use examples of bioacoustic monitoring in *Phragmites australis*, and discuss differences in how birds and amphibians use native versus introduced stands of *P. australis*. Because recorders can be cheaply replicated through space and time, we also emphasize how this approach can be used to monitor areas before invasions happen, providing baseline data to inform future management decisions. Similarly, documenting how soundscapes differ before and after management can provide important insight into whether management was successful. For *P. australis*, bioacoustics will therefore prove especially helpful for monitoring the success of biocontrol agents, should they be approved for release. Thus, although bioacoustic monitoring is still a developing tool, it can already strongly improve understanding of how invaders and their management impact bird and amphibian communities.

Assessing Impacts of Slender False Brome (*Brachypodium sylvaticum*) on Native Understory Plants
Audrey Bowe, Cornell University; Bernd Blossey, Cornell University

Management of invasive plants is often justified in terms of protecting native communities. However, for the vast majority of introduced species, our understanding of interactions with and impact on our native flora and fauna is limited. Negative impacts of invasive plants are frequently assumed without experimental confirmation. Though this response is appropriate when confronting early detection and rapid response situations, for well-established species managing species with little impact on native species leads to misallocated resources and potential disproportionate non-target impacts. In addition, invasive species do not exist in a vacuum and other factors including native and introduced stressors can negatively impact native plant communities. We use slender false brome (*Brachypodium sylvaticum*), a low abundance, low information species present in New York State, to discuss a framework which focuses on understanding impacts of invasive plants while accounting for other ecosystem stressors, such as native deer and introduced earthworms.

9:15 a.m. - 10:45 a.m.

CISMAs, CWMAs, and Other Cooperative Partnerships

Moderator: Brent Meyer, Nebraska Weed Control Association, Lancaster County Weed Superintendent

Collective Impact: The Power of Collaborating with The Stewardship Network
Lisa Brush, The Stewardship Network

Distributed stewardship is the future of conservation. We cannot sustainably manage individual natural areas or properties as isolated unites, no matter their size. In order to preserve biodiversity, provide wildlife habitat, and protect our land, air, and waters, communication and coordination across boundaries is imperative. The Stewardship Network (TSN) provides a model for us to do just that. TSN develops and supports highly individualized collaborative conservation communities and knits them together to create landscape scale impact. We connect, support, and develop local leadership to sustain these efforts over time and link them with tools and funding streams for this important work. Come learn how The Stewardship Network has grown and continues to expand across the country and also, how you can join the movement.

Nebraska's Riparian Vegetation Management Task Force (RVMTF)
Brent Meyer, Nebraska Weed Control Association, Lancaster County Weed Superintendent

This presentation covers the managing of invasive vegetation along Nebraska's rivers with funding appropriated by Nebraska's Legislature. I will discuss the issues that led to this important legislation, along with the challenges of managing vegetation along our rivers. I will show the results of the research studies done on aquatic vegetation and will wrap up detailing the overall success of the projects and what the future holds. In 2016 the Nebraska Legislature appropriated 1 million dollars annually to manage invasive vegetation along the creeks, streams and rivers in the State and passed legislation creating the Riparian Vegetation Management Task Force to oversee the funding. This long-term funding was created because of the success of 2007 legislation that appropriated $4 million over 2 years to control invasive vegetation. The original 4 million dollar investment was leveraged with an additional 22 million in matching funds by creating partnerships to treat invasive species and increasing flow conveyance, wildlife habitat, and water available for human consumption. Nebraska has more miles of rivers (81,573) than any other State and has compacts with neighboring States stating how much water each is allowed use. Lawsuits over water use prompted the 2007 legislation to make sure Nebraska is able to deliver the required amount of water to its neighbors. By successfully managing the invasive phragmites and other vegetation in the rivers, water flows dramatically increased and Nebraska is now in compliance with our compact agreements.

What a Long Strange Trip It's Been: 35 years of the Florida Exotic Pest Plant Council
Deah Lieurance, Florida Exotic Pest Plant Council/UF IFAS; Sherry Williams, Florida Exotic Pest Plant Council/ Seminole County

Researchers and land managers have been dealing with invasive species in Florida for many years. As a direct result of this long history, the state is also rich in organizations providing resources specific to invasive species (e.g. funding opportunities, management plans, EDRR target lists). There is an alphabet soup of invasive species organization acronyms, but perhaps the most recognized one in Florida is the Florida

Exotic Pest Plant Council (FLEPPC). FLEPPC is a non-profit, 501-C3 organization officially established in 1984 in response to a need to focus on managing invasive species. FLEPPC was the first organization of its kind and served as a model for similar groups nationwide. Our mission is to support the management of invasive plants in Florida's natural areas by providing a forum for the exchange of scientific, educational, and technical information. We achieve this through various activities including our annual conference, outreach, research and education grants, and most prominently, the Plant List. For many years FLEPPC was Florida's only non-profit, volunteer group focused on invasive species. In 2008, we were joined by the Florida Invasive Species Partnership (FISP) whose mission is to facilitate partnerships that prevent and control invasive species on both public and private lands. FISP connects partners (agencies/non-profits), private landowners, and Cooperative Invasive Species Management Areas (CISMAS) to important resources related to invasive species. FLEPPC working in collaboration with FISP has intensified efforts across the state and we continue to address prevention, early detection and monitoring, management, and education in Florida.

Pulling Together Initiative In Becker County Local Weed Management
Marsha Watland, Becker SWCD

Starting in 2007, the National Fish and Wildlife Foundation (NFWF) funded "Pulling Together Initiative in Becker County" worked to develop a long term plan to continue cooperative efforts to effectively deal with invasive species. The Becker County Cooperative Weed Management Area (BSSWMA) plan targets specific invasive species and prescribes locally developed integrated pest management approaches for the management and control of designated invasive plants. Monitoring of initial efforts and follow up treatment are essential to ensure those efforts are not wasted. The management plan is meant to provide a framework for continuing cooperative weed management efforts in Becker County into the future. The primary goal of the BCCWMA is to prevent the establishment and spread of invasive species in order to conserve the natural ecosystems of the county and prevent economic impacts to agricultural and recreational lands. The focus species in 2007 were crown vetch (*Coronilla varia*), common tansy (*Tanacetum vulgare*), spotted knapweed (*Centaurea maculosa*), leafy spurge (*Euphorbia esula*), wild parsnip (*Pastinaca sativa*). As new invasive species threats, control methods and priorities emerge and evolve the BSSWMA plan has been modified accordingly. As time has progressed management practices have also been adapted to changes in the State's Noxious Weed Law and Prohibited weed list. The BSSWMA plan is reviewed yearly by committee members and has grown to include Gravel Pit Certification, Recreation Trail Management, and most recently the movement of invasive plants along utility company corridors.

9:15 a.m. - 10:45 a.m.

Invasive Forest Issues Across the Continent

Moderator: David Coyle, Clemson University

Invasive Species in Canada: Risks, Challenges, and Opportunities
David Nisbet, Invasive Species Centre; Colin Cassin, Invasive Species Centre

Canada consists of diverse climates, landscapes, and social values which pose a unique risks, challenges, and opportunities for invasive species management. In recent years, pests like the emerald ash borer have destroyed millions of trees in urban and natural settings and continue to spread across the country. Invasive plants like Phragmites and Japanese Knotweed have choked out wetlands and impacted infrastructure. Other pests such as oak wilt, Asian longhorned beetle, and Asian carps are on our doorstep. These species not only threaten to transform the wildlife, woodlands, and waterways that Canadians depend on, they can cost billions of dollars in losses to industries, reduce recreational spaces, compromise outdoor experiences and tourism, and directly affect human health and well-being. This presentation will provide an overview of some of the current and emerging invasive species threatening Canada's ecosystems, and discuss how the Invasive Species Centre is working with partners at the national and international levels to mitigate the risks.

Plants, Bugs, & Fungus: Invasive Forest Pest Issues in Southern Forests
David Coyle, Clemson University

Invasive species are a constant threat to North American forests. The southeastern U.S., in particular, has a large number of ports, and is very active in terms of international commerce. As such, several insect, fungal, and plant pests have been introduced and become established in southeastern forests. This talk will introduce the most common and impactful invasive species (e.g. laurel wilt, spotted lanernfly, emerald ash borer, callery pear) affecting forests of the southeastern U.S. How they were introduced, their current status, and effective and potential management methods will be covered in an effort to provide a thorough update on the current state of invasive species issues in forests in this part of the continent.

What's Eating the West? Invasive Species in Pacific Forests
Susan J. Frankel, U.S. Forest Service, Pacific Southwest Research Station

The Western U.S. supports over 75 million people, distributed over a variety of ecosystems and climatic conditions that provide conducive habitats for invading forest pathogens and insects. The region contains major ports and shipping corridors, particularly with Pacific Rim nations, that can serve as pathways for invasive species movement. This combination has resulted in significant damage in urban forests from numerous introductions of highly destructive invasive species such as polyphagous and Kuroshio shot hole borers (*Euwallacea spp.*), and the sudden oak death pathogen (*Phytophthora ramorum*). Over the past few years, new pathogens have been introduced into restoration areas on native plant container stock which threaten endangered species and sensitive habitats. California forests are undergoing tremendous change as evidenced by unprecedented numbers of standing dead trees and the largest and most destructive wildfires ever recorded. The interactions of invasive species, climate change, stressed trees, fragmented forests and greatly accelerated fuels reduction

projects are altering forests in new and unpredictable ways. Management and monitoring approaches for invasive species face tremendous challenges to sustain the health of western forests and conserve natural resources.

History and Management of Invasive Forest Insects in the Northeastern U.S.
Kevin J. Dodds, U.S. Forest Service

The northeastern United States has a long history of forest insect pest invasions. Ecological and economic impacts of these pests have varied, as have the responses and eventual management of these insects. For some pests, such as the Asian longhorned beetle, aggressive regulatory programs are initiated with the goal of eradication. For others, such as emerald ash borer and winter moth, which are beyond the point of eradication, management plans are developed with the hopes of slowing the spread and reducing impacts. These efforts often include restrictions on movement of trees or habitat, and development of biological control programs. For other insects that were initially a concern, such as pine shoot beetle and Sirex woodwasp, initial response leads to a better understanding of the threat these insects pose and subsequent management plans are developed. There are also invasive species in the region that have been present for decades that cause periodic damage to forest trees, but largely go unmanaged. Examples of these insects include gypsy moth, red pine scale, and browntail moth. This talk will provide an overview of the insects that threaten northeastern forest health and the approaches and techniques taken to limit their impacts.

9:15 a.m. - 10:45 a.m.

Creating Customizable Tools for Invasive Species Work

Moderator: John Marino, NYNHP; Jennifer Dean, New York Natural Heritage Program & Chuck Bargeron, University of Georgia; Brent Kinal, New York State Department of Environmental Conservation

In today's mobile-enabled world, many options exist to create personalized GIS data collection tools. Groups are collecting invasive species field data using off-the-shelf mobile tools from Esri and open-source projects with the important goal of sharing the information with larger invasive species data collectives. This workshop will empower participants to start the process of customizing off-the-shelf mobile tools while also learning important steps to take to make sure data is sharable using the new national invasive species data standards. Workshop will begin with profiles of several real-world examples of field data collection tools in use (if you would like to briefly profile a field data collection tool that you have created or use, email: JLMarino@esf.edu). Next, the workshop will provide an Esri Survey123 and Collector overview and demonstration and highlight strategies to best align formats with national data standards. Finally, following a roundtable discussion regarding strategies in the invasive species field data collection tools, attendees will have the opportunity to join one of several stations to either: Begin a draft of a new field data collection tool using an application of their choice with guidance/assistance from workshop leaders, get further information about the national data standards, or try out various applications yourself. If you have an ArcGIS Online account through your

organization, please bring your credentials for the account if you would like to try creating Survey123 or Collector forms.

11:00 a.m. - 12:30 p.m.

Biocontrol Outreach and Implementation

Development of a Predicted Suitable Habitat Model for Biocontrol Systems in Montana
Melissa Maggio, Missoula County Weed District & Extension

A major hurdle in a biocontrol of weeds programs is the introduction and establishment of viable populations of biocontrol agents in a region, locality, or site. Site selection is one of the most important choices we can make at the beginning of a biocontrol program. The majority of the information we have on best suited sites for successful weed management with biocontrol are based on anecdotal evidence. Most people assume that if the target weed is present, the agent can be released, but other factors can negatively impact success. The development of a predicted suitable habitat model allows us to determine the ideal site characteristics associated with successful establishment. This model helps to increase the efficacy of biocontrol by guiding land managers' releases of the insects to sites where they will most likely survive, establish, and assist in the management of the target weed species. In the long-term, this model will also increase the ecological and economic return for Montana. When insects are released in suitable habitat, they are more likely to reduce the weed infestation and build up their populations to the point that they can be collected and moved to new locations, or they will disperse themselves to nearby infestations.

The Remarkably Persistent Cane Toad Legacy: Beliefs and Attitudes About Classical Biological Control
Jennifer Andreas, Washington State University Extension; Chris Looney, Washington State Department of Agriculture; Shannon M. Donovan, Department of Geography and Environmental Studies, University of Alaska-Anchorage

What will they eat after they eat all the pests? Will they sting or bite me? What's going to control them? Researchers and practitioners involved in classical biological control (CBC) programs routinely hear questions like these from all sectors of the pubic, ranging from dental hygienists to conservation biologists. Such questions and other comments seem to simultaneously encompass enthusiasm for and mistrust of CBC programs. However, few studies have investigated where such concerns come from or how best to address misinformation. We conducted an online survey in Washington State to help capture the range of attitudes and beliefs about CBC. Information on survey respondents' educational background, experience with invasive species management, and their level of knowledge about biological control agent testing and approval were all assessed. Results from 420 participants indicated that there is broad support for CBC, although respondents frequently conflated the practice with other "biological control" strategies. Many respondents reported knowing of CBC agents that had negative environmental impacts, but the examples they provided similarly conflated CBC with a range of other practices, or even other invasive species. Survey results also indicated that the regulatory structure surrounding modern CBC is unknown to many respondents, suggesting that

some ambivalence towards CBC could stem from a lack of information. These results indicate that improving public communication about classical biological control, including emphasizing modern success stories, may be a good way to directly combat erroneous beliefs. We hope to expand this survey to all of the United States to determine if the attitudes and beliefs represented in the Pacific Northwest population are shared across the country.

A Post-Release Assessment Tool and Its Implementation in the USA
Joseph Milan, Bureau of Land Management

Post-release monitoring of biological control is a crucial component to determine biocontrol agent establishment and the impact on the target invasive plant and subsequent plant community response. Commonly, the initial releases of a biological control agent involve a specialized monitoring protocol conducted by the implementation entity responsible for the initial releases. As biological control agents become established at multiple locations, the time consuming monitoring protocol developed for that specific biological control agent and personnel to conduct the monitoring become scarce. As such, a group of biological control practitioners from Idaho, USA developed a regional, multi-system, interagency post-release assessment program – the 'Standard Impact Monitoring Protocol' (SIMP). SIMP was developed to be citizen-science-friendly and statistically sound with regard to data analysis. SIMP is used to document the change in vegetation cover, target weed density and biological control agent abundance over time. This provides biological control implementation specialists and land managers with a tool to assess the relative impact of the biological control agent and the corresponding change in vegetation after a biological control agent release. Beginning in 2017, a smart phone application was created to collect SIMP data and georeferenced pictures of the monitoring sites. This approach aims to eliminate hard copy data sheets and reliance on old technology that requires significant post-process editing. This, in turn, will make SIMP more user-friendly and accessible to anyone with a smart phone. Included in this presentation is a brief analysis of trends after collecting SIMP data for eleven years for various target weed species.

Considerations for Implementing Biological Control of Hemlock Woolly Adelgid (*Adelges tsugae (Ratz.)*) in Northern Climates
Mark Whitmore, Forest Entomologist, Dept. of Natural Resources, Cornell Univ., Ithaca, NY

Since first introduced into the Richmond, Virginia area in the early 1900's from Japan, the Hemlock Woolly Adelgid (HWA) has killed untold millions of hemlock trees from northern Georgia to New York, New England, and now southern Ontario and Nova Scotia. Releases of thousands of predators from Japan, China, and the Pacific Northwest have been continuing since 2002. Establishment and spread has been documented in the south but in the northern range of HWA these measures have been harder to attain. We provide explanations for this difference based on overwintering HWA mortality and predator phenology that have broad application in the Canadian Maritimes as well as colder inland areas of New England, New York, and Ontario.

11:00 a.m. - 12:30 p.m.

Sharing Invasive Species Data Among Government, Academia, and NGOs

Moderator: Annie Simpson, U.S. Geological Survey

EDDMapS One: Integrated Platform and Program for Tracking Invasive Species Management in North America
Chuck Bargeron, University of Georgia; Rebekah Wallace, University of Georgia; Joe LaForest, University of Georgia

EDDMapS has been a resource for invasive species occurrence data since 2005. In this time, EDDMapS has grown from a citizen science database focused on invasive plant data in the southeast to an aggregate database soliciting data on all invasive species taxa and biological control agents across the US and into Canada. As technology has advanced, it has allowed for more features and tools to be developed and made available to EDDMapS' partners. Whereas previous iterations of the EDDMapS website and smartphone applications focused on regional needs and, thus, regional versions of each existed, we have now launched EDDMapS One. EDDMapS One is the unification of the regions into one collective. Instead of having many websites and apps that all do very similar functions, but were separate due to the available technology at time of creation, they can now be brought into one website and one app. Concurrent to this, the EDDMapS API has also been redesigned for improved performance, increased usability, and easier implementation with a broader user base. This will allow for easier and more precise data sharing among individual users and aggregate databases alike.

Biodiversity Information Serving Our Nation: "New Things We're Doing"
Annie Simpson, U.S. Geological Survey

BISON (https://bison.usgs.gov) is an openly available online all-species mapping application, and its web services (bison.usgs.gov/#api) are specifically designed to serve training data for AI machine learning models to determine and predict current and future distributions of species, including invasive species. Because of the massive number of taxon names found in BISON, the Integrated Taxonomic Information System (ITIS, itis.gov) is used to link synonymous species names together within the species search function and provide the user with the maximum number of search results that meet the specified criteria. During the recent BISON update of data from the Global Biodiversity Information Facility (gbif.org), more than 80 million additional species occurrence records were made available through the application. This update increased the BISON application's total record count to more than 465 million (over 93% georeferenced) for all taxa in the United States, U.S. Territories, U.S. marine Exclusive Economic Zones; and for Canadian provinces. Of those 465 million species occurrences, 18,275,357 are known to be non-native to the U.S. region in which they occur (Alaska, Hawaii, and/or the conterminous 48 states). The Western Governors' Association has described* BISON as the "universal pointer" back to all local or specific invasive species data providers. Finally, because BISON includes all species, not just non-native species, it provides the potential to track the geospatial impact of invasive species on other species.* westgov.org/images/editor/WGA_Invasive_Species_Data_Findings_And_Recommendations.pdf

An Open Data Platform for Mobilizing Invasive Species Occurrence and Treatment Data
Lori Scott, NatureServe; Jennifer Dean, New York Natural Heritage Program

iMapInvasives is one of four major invasive species databases working to develop data sharing standards and practices to facilitate a common operating picture for successful management of invasive species. In 2019 the NatureServe Network launched a complete rebuild of the iMapInvasives platform to include current technologies that facilitate data sharing. The all new iMapInvasives provides open access to non-confidential and confirmed data records for Present Species, Not Detected Species, Searched Areas, and Treatments. This presentation will review approaches taken to design and develop the iMapInvasives database to support information sharing using open data standards and web map services, and to work with data contributors to adjust expectations and data permissions for an open data environment.

The U.S. Geological Survey's Nonindigenous Aquatic Species (NAS) Database: A Source for Actionable Data and Tools
Wesley M Daniel, U.S. Geological Survey, Nonindigenous Aquatic Species Program; Matthew Neilson, U.S. Geological Survey, Nonindigenous Aquatic Species Program; Ian Pfingsten, Cherokee Nation Technology contracted to U.S. Geological Survey

The U.S. Geological Survey's Nonindigenous Aquatic Species (NAS) Database has been established as an unequaled source of spatially referenced nonnative aquatic species data. The program focuses primarily on tracking the distribution of 1,220 freshwater taxa (fish, crustaceans, mollusks, mammals, reptiles, amphibians, and obligate aquatic plants) in the contiguous U.S., Alaska, Hawaii and island territories. The NAS interactive website allows users to perform a variety of queries, download data, obtain information from species profiles, see animations of species' spread, and provides information on status and trends of nonnative species. This presentation will focus on the NAS program's efforts on transitioning big data into actionable and smart data; with the development of tools and maps for managers and stakeholders. A few of the tools the program has created include Flood and Storm Tracker (FaST) maps, which evaluates the potential spread of nonnative species within and across drainage basins due to flooding. The Alert Risk Mapper (ARM) tool, which highlights stream and waterbodies at risk of invasion from new nonnative sightings and accompanies NAS Alert emails sent out to subscribers. Currently, the program is compiling a systematic literature review of ecological, economic, and human health impacts of invasive and nonnative species which are being synthesized into easy to access tables on the NAS website.

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11:00 a.m. - 12:30 p.m.

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Management of Invasive Grasses

Moderator: Daniel Tekiela, University of Wyoming

Assessing Best Management Practices for Slender False Brome
Brittany Hernon, Western New York Partnership for Regional Invasive Species Management (WNY PRISM)

Slender false brome (*Brachypodium sylvaticum*) is a highly invasive, early detection priority species that forms dense monocultures and threatens native biodiversity. This invasive grass, relatively new to the Great Lakes Basin and New York, is an important species to be on the lookout for as it spreads rapidly and negatively impacts a wide range of habitats. Western New York Partnership for Regional Invasive Species Management (WNY PRISM) is leading a collaborative, funded through the Great Lakes Restoration Initiative, to improve the understanding and management of this species. This program will review research into the management of *B. sylvaticum*, which has been implemented over two growing seasons. This study assessed the effectiveness of manual, mechanical, chemical and a combination of mechanical and chemical control on *B. sylvaticum* infestations in western New York. We will discuss the results of this research and detail the best management practices for the control of this species. This presentation provides an opportunity to learn about a new invasive species and control measures that can be used if *B. sylvaticum* is found in your area.

A National Concern, Management of Invasive Annual Grasses Coast to Coast
Daniel Tekiela, University of Wyoming

Invasive annual grasses are problematic across the United States. Downy brome (*Bromus tectorum*) invades much of the Western US arid habitat. Japanese stiltgrass (*Microstegium vimineum*) invades much of the forested Eastern US. New annual grass invaders such as ventenata (*Ventenata dubia*) and medusahead (*Taeniatherum caput-medusae*) continue to spread from the coasts into the interior causing additional negative impacts to both natural and managed ecosystems. Managing annual grasses is challenging because it depends on targeting the seedbank, not the plants themselves. Seedbanks are difficult to target and require a long-term commitment. In doing so, managers often cause undesirable effects on the surrounding plant community. These pitfalls must be overcome to successfully target these annual invaders.

Esplanade 200SC - A New Tool for Invasive Annual Grasses in Natural Areas
David Spak, Bayer; Jason Belcher, Bayer

Esplanade 200SC is an herbicide labeled for preemergence control of annual invasive grasses and broadleaf weeds in natural areas, open spaces, and other non-crop areas. Esplanade contains the active ingredient indaziflam which offers a new mechanism of action for managing herbicide resistance. Indaziflam is a long residual soil applied herbicide and has demonstrated effective, long-term control of many annual invasive grasses and broadleaf weeds in western natural areas and open spaces while having selectivity on desirable forbs and perennial grasses. Recently, Esplanade 200SC has been evaluated for its effectiveness on annual invasive grasses in the Eastern U.S. such as Japanese stiltgrass and rose natalgrass. This presentation will introduce Esplanade 200SC and discuss the methods and results of annual grass studies and implications for management.

Phragmites Adaptive Management Framework: Managing Phragmites with Science on Your Side
Emily Jameson, United States Geological Survey;Christine Dumoulin, University of Georgia; Elaine Ferrier, Great Lakes Commission; Erika Jensen, Great Lakes Commission; Clint T. Moore, USGS Georgia Cooperative Fish and Wildlife Research Unit; Samantha Tank; Great Lakes Commission; Daniel D. Engel (USGS), and Kurt P. Kowalski (USGS)

Non-native *Phragmites australis,* or common reed (hereafter Phragmites) is a perennial wetland grass that has been called one of the most invasive plants in North America, with its distribution spanning from east coast to west coast, gulf coast to fresh coast. In the Great Lakes region, Phragmites has been especially problematic as it can quickly displace native plants and become dominant in coastal wetlands and other habitats. Land managers throughout this region have put considerable effort and resources into controlling this plant for many years. However, landscape-level progress is limited and much uncertainty remains about the best strategy for minimizing its spread and associated impacts. The Phragmites Adaptive Management Framework (PAMF) was developed by the Great Lakes Phragmites Collaborative to address this uncertainty. Using a citizen science-style approach and adaptive management principles, PAMF works with land managers to systematically learn from management outcomes. In particular, PAMF seeks to answer the question "What is the most effective and efficient year-long combination of actions for reducing Phragmites under various levels of infestation?" In return for carrying out a lightweight monitoring protocol and submitting data to PAMF's central Web Hub, participating managers receive model-generated, site-specific management guidance. After two years through the iterative process, we will share progress we have made and lessons learned for using adaptive management in an invasive species context. Together, the Phragmites "phighting" community can take part in collective learning and refine best management practices.

2:00 p.m. - 3:30 p.m.

Biocontrol I

Moderator: Wade Simmons, Cornell University

Update on Promising Biological Control Options for Flowering Rush
Patrick Haefliger, CABI; Hariet L. Hinz, CABI; Carol Ellison, CABI

Flowering rush (*Butomus umbellatus*) is a perennial aquatic plant of European origin that was introduced to North America as an ornamental over 100 years ago. Biological control of this plant is very promising, because *Butomus umbellatus* is the only species in the family *Butomaceae* and therefore chances to find specific biological control agents are very high. We have currently prioritized three candidate agents. The weevil *Bagous nodulosus* was tested for oviposition on 45 test plant species and eggs were only found once on one species, confirming that adult weevils are highly host specific. After it became apparent that larvae commonly switch plants during their development, larval establishment tests were started under no-choice conditions. Results of these tests will be available in summer 2019. In impact experiments, adult feeding reduced above ground biomass of flowering rush by 33%, and below-ground

biomass was decreased by 50% on plants exposed to adults. The agromyzid fly *Phytoliriomyza ornata* is another promising agent that can cause plants to wilt after only three days exposure to a single female. Finally, the white smut *Doassansia niesslii* is being studied. The overwintering state of the smut infests plants under water, which will be very advantageous for completely submerged infestations of flowering rush. However, at the moment we are working with a strain which only attacks one rather uncommon genotype of flowering rush in Canada. Search for strains infesting the most common genotypes in the U.S. will continue in 2019.

The Role of Open-Field Tests in Host Range Testing of Potential Weed Biological Agents
Philip Weyl, CABI; Hariet Hinz, CABI; Cornelis Closca, CABI

Weed biological control has a long history of predicting risk to non-target species through host range testing, however, this remains one of the fundamental challenges. Conventional host range testing in quarantine runs the risk of being over-conservative by only determining the physiological host range and obtaining little information on non-target species which may be un-attacked under natural conditions. Agents that would usually be safe, may be rejected for release based solely on these results. Open-field tests allow the herbivore to display its full array of pre- and post- alignment behaviors when selecting a host plant. Thus, open field testing offers an opportunity to disentangle the species that are within the physiological vs. ecological host range. The no-choice host range testing of a potential biological control agent, *Ceutorhynchus cardariae*, against hoary cress, *Lepidium draba*, showed that this species has a relatively broad physiological host range, spanning seven different tribes within the *Brassicaceae*. However, during choice tests it was apparent that this species has a much more restricted host range, suggesting that pre- and post- alignment behaviors are important in host selection. Results of several open-field tests, support this assumption not only showing a restricted host range but also that only non-target plants growing in close vicinity (less than 2m) of *L. draba* were at risk of attack. We argue that even agents with a relatively broad physiological host range can be specific under natural field conditions and that open-field tests should be the standard to determine their potential risk to non-target plants once released.

Current Status of Mile-a-minute Biological Control with *Rhinoncomimus latipes*
Lisa Tewksbury, University of Rhode Island

Rhinoncomimus latipes, the mile-a-minute weevil, has been released as a biocontrol agent for invasive mile-a-minute weed since 2004. Large numbers of weevils have been released from New Jersey to Massachusetts. In many release sites the mile-a-minute populations had been present for 5-10 years before weevils were released. Results of these releases will be evaluated to enable discussion of the success of this biocontrol agent.

Biological Control of Invasive Alien Weeds: An Overview of the Research Activities Carried Out by BBCA During 2019
Francesca Marini, BBCA onlus

BBCA (Biotechnology and Biological Control Agency) is a non-profit organization located in Rome, Italy. Since 2000, BBCA is carrying out foreign explorations in remote areas of the world with the aim to study the biocoenosis of the phytophagous arthropods co-evolved with the target weed(s) and for this reason eligible as potential biological control agents for invasive alien weeds in North America. To perform these studies, BBCA has joint projects with USDA ARS and CABI Switzerland, in order to develop cooperative research activities through a networking program involving several Universities and Research Institutes worldwide. Currently, we are involved in about 18 weed biological control programs of relevance to the U.S. Among them, we will present this year results for the following 6 target weeds: dyer's woad, russian thistle, rush skeletonweed, medusa-head, cheatgrass, tree of heaven. Particular emphasis will be given to the field and laboratory research activities (host range and impact) carried out with the eriophyid mite *Aculus mosoniensis*, potential biological control agent of the tree of Heaven.

2:00 p.m. - 3:30 p.m.

Terrestrial Invasive Plant Management

Moderator: Andrea Davalos, SUNY Cortland

Wild Parsnip: Site Considerations and Management Techniques
Michael Bald, Got Weeds?

From a pure safety standpoint, wild parsnip is a hazard to both those who would recreate on the land as well as those persons tasked with maintenance or management. Parsnip denies access to the land for much of the year; its photo-activated sap is cause for avoidance during the growing season. Heavy seed production necessitates a similar avoidance of infestation sites into the onset of winter to avoid seed spread on equipment or clothing. Yet people need access to the land, whether for recreation, crop harvest, pasture availability, or right-of-way maintenance. This access requirement calls for active management of known parsnip infestations and ongoing stewardship to maintain "clean" spaces. The notion of "clean" spaces is somewhat mythical; in our current high-traffic, constantly mobile lifestyle, movement of material across landscapes is essentially an environmental constant. Nonetheless, management plans can succeed if the seed rain cycle is broken and elements of biosecurity are pursued. With an appropriate regional commitment (neighborhoods or sub-watershed level) non-chemical methods of control are particularly effective when supported by vigilance and wider-scope early detection efforts. This presentation explores the nuances of wild parsnip treatment work across twenty properties throughout Vermont and New Hampshire. Methods addressed and illustrated include solarizing, smothering, and hand-pulling. The science driving the planning considerations comes from detailed site assessments and regular benchmarking of progress. To rehabilitate degraded lands in the name of soil health, biodiversity, and safe access, non-chemical methodologies and a biosecurity commitment are the ideal transition tools.

Twelve Years of Controlling Giant Hogweed in New York: Successes and Challenges.
Naja Kraus, New York State Department of Environmental Conservation

NYSDEC and partner organizations have been monitoring and controlling giant hogweed (GH) plants in NY State since 2008. Crews visit known sites and control plants found using root-cutting, herbicide or umbel removal. Successes: Control methods are working; over 1,000 sites (43% of known sites) previously treated for GH had no plants in 2018. Collaboration is strong; most landowners grant property access permission, and partnering with county and PRISM organizations enable more sites to be controlled. Many more people know about GH's dangers now than in 2008 and the public knows how to report it. GH information line staff respond annually to 1,000-2,000 reports of giant hogweed, confirm new sites, and provide information to the public. DEC GH web pages provide a wealth of information to people worldwide, and posters and brochures were created and distributed for outreach use in NY and utilized by other states. Survey and outreach methods have led to the identification of thousands of new locations in New York. Challenges: how to find sites not yet reported, older sites have numerous seeds in the seedbank, as large sites get smaller it can be difficult for crews to find all GH plants amidst competing vegetation, landowners can deny access to property for survey and control which means it will keep spreading to neighboring areas, funding is inadequate for amount of staff needed for ideal program, riparian sites present unique challenges- seeds spread downstream and into floodplains, surveys are needed both upstream and downstream of known sites.

Assessment of Invasive Pale Swallow-Wort Management
Andrea Davalos, SUNY Cortland; Jeremy Collings, SUNY Cortland

While significant resources are devoted to invasive species management activities, we rarely measure whether we are meeting management objectives to reduce target populations and restore native species. For conservation to be successful, decision-makers need to evaluate the risks and benefits of proposed management actions. Working with land managers in New York State Parks, we evaluated interactive effects of the invasive vine *Vincetoxicum rossicum* (pale swallow-wort), white-tailed deer herbivory, non-native earthworms and *V. rossicum* management on understory plant diversity. Management of V. rossicum occurred through a combination of herbicide application and manual removal. We compared plant communities in paired open and fenced plots in management and reference areas at three forested sites. We also assessed performance of four native forest plant species transplanted at each plot. Plant and earthworm diversity varied by site, but were not associated with *V. rossicum* cover or density. After two years of management, *V. rossicum* frequency decreased at managed locations, whereas understory plant diversity did not change. We found single and interactive effects of study factors on sentinel plant species survival and growth. Negative impacts of deer overrode effects of all other study factors. A multifactor approach is needed to evaluate impacts of co-occurring factors and assess management success.

Invasive Species Reduction Program (ISRP) – Documentation

Presented from PhD study @ NMBU, 2018 and What We have Learned in the Field
Johan Rud, Heatweed Technologies

Heatweed Technologies is Europe's leading supplier of technology and machinery for non-chemical weed control in public spaces and is currently represented in 18 European countries as well as Western Australia. Heatweed's vision is to set new standard for non-chemical weed control in the green sector. The first patent for hot water weed control was established in the US in 1884, but it took more than 100 years before this method was revisited. Heatweed Technologies has more than 35 years of experience in weed control in all its forms. As a result, Heatweed was the first company to introduce hot water as a method for weed control in Europe and is still leading in innovative weed control technology, offering high-capacity machines with world patented sensor technology. Physics of weeds is important when it comes to developing the most efficient and cost- effective technology. Based on this, Heatweed developed the acclaimed Invasive Species Reduction Program. The Invasive Species Reduction Program, ISRP, has been developed by Heatweed based on the PhD study done by the Norwegian University of Life Science between 2016-1018 on controlling the species *Heracleum Mantegazzianum, Impatiens glandulifera* and *Fallopia Japonica*. Later another 15 species widely distributed in Europe have been added. This program allows municipalities and land owners to monitor reduction of invasive plant species in real-time via an app during a three-year treatment cycle. Plants like Giant Hogweed, Japanese Knotweed, Police Helmet, *Crassula Helmsii* and many other unwanted species are being treating with the Heatweed Method® by contractors in both Scandinavia, Germany and the Benelux countries. This presentation will cover alternative thermal methods for weed control in urban areas, the cost of various methods and the results of such treatments.

2:00 p.m. - 3:30 p.m.

PlayCleanGo Summit: Community-Based Social Marketing

Moderator: Ken Donnelly, Beyond Attitude Consulting Inc.

Developing a National Clean Drain Dry Program - a BC Pilot Project
Sue Staniforth, Invasive Species Council of BC

In 2011, the Invasive Species Council of BC shifted the focus of its outreach programs and began to research and implement new, innovative practices to change the public's perspectives, and ultimately their behavior relating to invasive species. Recognizing that education alone does not change ones behavior, the ISCBC implemented community based social marketing tools and approaches to identify barriers, develop strategies and implement sustainable behavior change to reduce the spread of invasive species. With great success, the ISCBC has since implemented multiple behavior change programs including PlantWise, Don't Let It Loose, Don't Move Firewood, and Clean Drain Dry. As a leader in Canada on the Clean Drain Dry program, the Invasive Species Council of BC provides the public and water recreationists alike the key resources and messaging needed to reduce the spread of aquatic invasive species. The CDD program in British Columbia has evolved and expanded considerably since 2011 and

stemming from this expertise, the ISCBC is now delivering a 3-year national CDD pilot program funded by Fisheries and Oceans Canada in partnership with the Canadian Council on Invasive Species. Engaging both provincial and national advisors, this pilot is designed to test, refine and deliver resources including signage, community partnerships, outreach resources and an extensive digital and social media campaign for the purpose of broad-scale implementation across Canada, enabling recognizable and clear messaging and tools to combat and prevent aquatic invasive species nation-wide.

Community-Based Social Marketing and Aquatic Invasive Species Prevention in Minnesota
Tina Wolbers, Minnesota Department of Natural Resources

Today's aquatic invasive species (AIS) prevention landscape in Minnesota is shaped by deep partnerships and propelled by advances in research, management, regulations and technology. Since its inception in the 1980s, the Minnesota Department of Natural Resources (DNR) Invasive Species Program has always looked for new ways to promote AIS prevention best practices, especially to reach new audiences and address new threats. In 2018, the DNR hired a contractor to conduct community-based social marketing (CBSM) research to (1) identify and prioritize AIS prevention behaviors and (2) identify the barriers to and benefits of practicing these behaviors today. The results of this statewide project will provide baseline information on pathways, audiences and behaviors of concern. The DNR will use the information to update current programs and start new initiatives to better communicate about AIS prevention while promoting long-term behavior change. Since behavior change happens at the local level, as one of the next steps the DNR plans to develop and administer a grant program for local organizations to implement recommendations developed through this project. You will hear about a brief history of AIS prevention in Minnesota, the logistics of implementing a CBSM project as a state agency, preliminary project results (pathways, audiences, behaviors, barriers, motivators), and the potential next steps for the Minnesota DNR's AIS behavior change programs.

Community Based Social Marketing for AIS in New York State: Getting Our Feet Wet
Catherine A McGlynn, NYSDEC

New York State has recently embarked on incorporating community-based social marketing into our watercraft inspection steward program (WISP). We have many water recreationists from within and out of state who use our resources. We need to ensure that they are practicing preventive measures and taking precautions even when our boat stewards are not present. In an effort to change behavior, not just raise awareness about aquatic invasive species, during the 2019 season we modified our existing education and outreach products, developed a "commitment-like" question for our recreationist surveys that are part of our Watercraft Inspection Steward Program app (WISPA), created focused messaging and products, and conducted a baseline survey to track our progress. We will talk about outcomes from this past season and plans for the next.

Enabling Canadians to Take Action on Invasive Species Through Recreation
Kellie Sherman, Canadian Council on Invasive Species

Healthy ecosystems provide the foundation for Canada's natural diversity and promote the health and well-being of residents and visitors. Invasive species can threaten ecosystems, as they often displace native species and disrupt natural ecological processes. There are numerous pathways of introduction and vectors of spread for invasive plants and one of these pathways is recreation. To reduce the spread of invasive species from the recreation pathway, the CCIS has conducted extensive research into Canadians behaviours when it comes to preventing the spread of invasive species, including through the recreation pathway. This research has provided us with critical information on barriers preventing Canadians from taking action on preventing the spread of invasive species. Therefore, we have tailored our campaigns that focus on the recreation pathway, including Clean Drain Dry and Buy Local, Burn Local to focus on easy steps Canadians can take while enjoying that activity to prevent the spread of invasive species. This presentation will review in further detail, the Clean Drain Dry and Buy Local, Burn Local campaigns and their resources, including youth specific resources, in Canada and how we are spreading the message and delivery of the campaigns through partners. Learn about how to join forces with like-minded organizations and how you can become a partner in these campaigns. The Canadian Council on Invasive Species (CCIS) serves as a national voice and hub to protect Canada from the impacts of invasive species. With members and chapters from all corners of Canada, along with governments and businesses, the CCIS brings people together to build practical solutions to prevent the spread of invasive species.

2:00 p.m. - 3:30 p.m.

Forest Pest Identification-Know the Problem: Tips to Identifying Invasive Forest and Range Pests

David Coyle, Clemson University and Caroline Marschner, NYS Hemlock Initiative, Cornell University

Accurate identification of invasive forest pests is imperative to enable proper management. Early identification often allows for more management options; but identifying unfamiliar species can be tricky. This hands-on workshop will help participants learn how to identify invasive insects and fungi in North America, including identification using the causal organism, symptoms, and/or damage. Participants will also be able to compare and contrast invasive species with common look-alikes. Identification materials include samples, Riker mounts, 3D printed models and life-size displays.

3:45 p.m. - 5:15 p.m.

Biocontrol II

Moderator: Melissa Maggio-Kassner, Missoula County Weed District

Of Beetles and Moths: Water Chestnut and *Phragmites* biocontrol
Wade Simmons, Cornell University; Patrick Haefliger, CABI Switzerland; Dr. Richard Casagrande, University of Rhode Island Lisa Tewksbury, University of Rhode Island; Dr. Bernd Blossey, Cornell University

After prolonged investigations, implementation of biocontrol for water chestnut (*Trapa natans*) and invasive *Phragmites australis* may be just around the corner. For water chestnut we describe the life history and impact of the promising agent, a Chinese leaf beetle (*Galerucella birmanica*). We are in the final stage of testing this species in quarantine and we showcase how we approach risk assessment to native plants in this program. Our findings suggest that *G. birmanica* will strongly suppress populations of water chestnut without population level impacts on non-target native species if approved for release in North America. For *P. australis*, a petition to release two stem-mining moths was submitted to authorities in the US and Canada. Release of the species has been granted in Canada and we are awaiting a response by US authorities. We will summarize how we arrived at the conclusion that introduction of *Archanara geminipuncta* and *Archanara neurica* would pose no threat to native *Phragmites australis americanus*. We also chart the path forward in implementing this program with updates based on US decision making.

Biological Control of *Rhamnus cathartica*: Where Do We Go from Here?
Philip Weyl, CABI; Hariet Hinz, CABI; Andre Gassmann, CABI

Rhamnus cathartica (common buckthorn) is a shrub or small tree of Eurasian origin, which has become invasive in North America. The biological control programme conducted by CABI in Switzerland and supported by Minnesota was active between 2002-2012. From over 30 specialized insects identified from the target plant in its native European range, internal feeders and sap suckers were prioritized as potential biological control agents. Common buckthorn has several congeners in North America and therefore any potential agent would need to be highly specialised. During preliminary host range investigations many of the internal feeders that had been identified were not sufficiently host specific under no-choice conditions. The choice-tests performed at the time, unfortunately yielded unreliable results. Interestingly the sap sucking psyllids, were promising in terms of host specificity, but are infected with the plant disease '*Candidatus Phytoplasma rhamn*i' rendering them unsuitable for introduction into North America. In 2012, the biocontrol project was therefore stopped. In case it would be decided to revisit the programme it could be beneficial / envisioned to test formerly prioritised agents under more natural conditions to fully understand their ecological host range and determine their risk to native *Rhamnus* species. Additional agents that had been identified but not tested include fruit- and seed-feeding insects which would reduce seed set and thus potentially seedling establishment, while fungal pathogens could offer new opportunities for the biological control of *R. cathartica* in North America.

Using the Past to Inform the Present: What Can Purple Loosestrife Tell Us About Biocontrol of Japanese Knotweed?
Stacy B Endriss, Cornell University; Bernd Blossey, Cornell University

Biological control of Japanese knotweed is a high priority given its widespread impacts and resiliency to chemical and physical control. Accordingly, the Japanese psyllid *Aphalara itadori* has already been released in the UK and Canada and, pending approval, will soon be released in the United States. However, this psyllid was selected after a rigorous screening process for its high host specificity, not because of high target impacts. Therefore, even if the psyllid's success improves with time, identifying complementary biocontrol agents is a worthwhile investment. Selecting new agents, however, requires us to change our thinking about how we assess risk to non-native species and what makes biocontrol programs a success. Here, I discuss how lessons learned from biocontrol of purple loosestrife can aid successful biocontrol of Japanese knotweed. For example, one reason biocontrol of purple loosestrife has been so successful is that high-impact agents were selected despite superficial spillover on non-target plants. Potential biocontrol agents of Japanese knotweed should therefore not be immediately excluded by greenhouse of quarantine host-specificity tests, as these tests tell us very little about how insects behave in the field or whether insect damage even matters to non-target plant fitness. I also discuss how we can mirror the purple loosestrife biocontrol program's success at streamlining the transition between agent selection and field release, as well as assess this program's impact following agent release. Biocontrol of Japanese knotweed therefore holds promise, especially if we learn from lessons of the past.

Progress Towards Development of Hydrilla Biological Control
Nathan Harms, US Army Engineer Research and Development Center; Dean Williams, Texas Christian University; Matthew Purcell, United States Department of Agriculture Agricultural Research Service, Australian Biological Control Laboratory; Jialiang Zhang, Wuhan Botanical Institute; Hong Sun-Hee, HanKyong National University

Biological control of hydrilla (*Hydrilla verticillata*) has been ongoing in the US since the 1980's, but has not provided consistent results. Additionally, at least two hydrilla haplotypes occur in the US, but genetic identity was not known early on and thus not considered during selection of the control agents that are currently available. Although worldwide surveys for biological control agents of hydrilla throughout its native range have been conducted since the 1970's, recent surveys for dioecious agents between 1996 and 2013 focused on China, Southeast Asia and Australia. To inform exploration for agents of monoecious hydrilla, China and South Korea were widely sampled for molecular analysis during 2013-2016, leading to identification of at least six sites with genetic matches to US monoecious plants. Since 2016 regular surveys of native range monoecious hydrilla has been ongoing but visual identification of plants and herbivore species (i.e. chironomids, Hydrellia spp.) has been difficult, and taxonomic expertise in these groups is rare. Using DNA barcoding on samples collected during 2013-2016, a number of new associations between herbivores and hydrilla haplotypes were made, including Hydrellia sp. and Dicrotendipes sp. that were collected from the US monoecious haplotype in Korea. Current focus is on quarantine biology and host-specificity of Hydrellia sp. from the monoecious hydrilla

haplotype. An unidentified defoliating moth was also collected from the US monoecious haplotype in China and will be evaluated. Further surveys are also recommended in China and South Korea where biotypes/haplotypes exist that match those found in the United States.

3:45 p.m. - 5:15 p.m.

Innovations to Improve Aquatic Invasive Species Prevention and Management

Moderator: Matt Brincka, NY State Parks Recreation and Historic Preservation

The Science of AIS Compliance
Edgar Rudberg, Ph.D., Cd3, General Benefit Corporation

Due to the high cost of high pressure, heated water decontamination, reducing the spread of aquatic invasive species (AIS) often relies upon the adoption of best management practices at the individual level. However, until CD3's 2017-2018 Waterless Cleaning Station Pilot, tools to implement best management practices were unavailable to boaters. The process for developing these tools was an example of how we caught a unicorn and changed behavior. This presentation will outline the results of the pilot including usage rates, lessons learned, adoption rate, increases in compliance, and outline the future direction of the project.

ARMOR for The Queens Shield – A New Tool For Managing The Spread Of Invasive Aquatic Species In New York
Jeremy Farrell, Rensselaer Polytechnic Institute Department of Biological Sciences and Darrin Fresh Water Insitute; Marc Frischer, Skidaway Institute of Oceanography - University of Georgia; Lawrence Eichler, Rensselaer Polytechnic Institute - Darrin Fresh Water Insitute; Joe Stanek, Lake George Park Commission; Sandra Nierzwicki-Bauer, Rensselaer Polytechnic Institute Department of Biological Sciences and Darrin Fresh Water Insitute

Although only a small fraction of introduced species establishes self-sustaining populations and cause harm, invasive species are recognized as an important driver of global environmental change. Freshwater ecosystems are especially vulnerable to species invasion and its effects. Much of the ongoing spread of Aquatic Invasive Species (AIS) can be attributed to the overland movement of small privately owned boats. Thus, an effective approach for reducing the risk of new introductions has been the implementation of boat inspection and washing stations to intercept and remove AIS from trailered boats before they enter new water bodies. Seven mandatory boat inspection stations have been operating around the Lake George basin since 2014, where all arriving and departing boaters are subject to a survey and potential introductions are detected and mitigated. From 2014-2017, inspection were conducted on 105,819 trailered boats with 454 occurrences of invasive species identified. Using these data we developed a machine learning model to help predict the presence of AIS on arriving boats. Initial tests of the model have indicated strong success, correctly identifying 96.5% of the arrivals of invasive species. Identification of watercraft of high risk at their potential points of entry will improve the efficiency and efficacy of detecting and mitigating new invasive species introductions.

Canada's Aquatic Invasive Species Regulations – Protect Freshwater and Marine Ecosystems from the Introduction or Spread of Aquatic Invasive Species
Sylvia Fitzgibbon, Aquatic Invasive Species National Core Program

Aquatic Invasive Species (AIS) pose a serious threat to fish, fish habitat, use of resources and species at risk across Canada. The Government of Canada takes the issue of AIS very seriously and is committed to preventing the introduction and spread of AIS in Canadian waters through the implementation of the Aquatic Invasive Species Regulations. The AIS Regulations came into force in 2015 under the federal Fisheries Act to enable federal action and partnerships with provincial and territorial governments through a suite of regulatory tools. As a science-based department, DFO relies on a vibrant Science program to provide qualitative and quantitative data and information combined with expert scientific analysis and advice to directly support decision-making as well as policy and program delivery for its operations across Canada and internationally. Therefore, the AIS Regulations are also a driver for identifying and prioritizing scientific needs to inform appropriate listing of species and taking action on aquatic invasive species. In order for the AIS Regulations to be effective, nationally consistent understanding and uptake are required. NAISMA provides an opportunity to further promote the regulations to a wider and potentially international audience. This will be conveyed by providing an overview of the regulations and their main elements; identifying who should be familiar with them and what they need to know to be compliant and protect Canadian and subsequently international freshwater and marine ecosystems from the threats of AIS.

3:45 p.m. - 5:15 p.m.

PlayCleanGo Summit: Education and Prevention Tools that Work

Moderator: Belle Bergner, NAISMA, PlayCleanGo

New Partnerships and Products for PlayCleanGo® Partners Across the Continent: Turn-key, Customizable Outreach Resources for the Universal Invasive Species Awareness and Outreach Brand
Belle Bergner, Executive Director, NAISMA

Since becoming the owner and steward of the PlayCleanGo®: Stop Invasive Species In Your Tracks brand in 2019, NAISMA has added new outreach products to the Partner Media Library, developed a PlayCleanGo Awareness Week Toolkit, launched an interactive map of events across the US, and created an easy to use, online store to order PlayCleanGo products such as boot brushes, Tucker the Turtle Field Guides, posters, stickers, and more. New national partnerships have been established with USDA APHIS and other federal agencies, non-profits, CWMAs, local, state, and regional agencies, and a growing number of Eastern US partners. International partnerships with the Canadian Council on Invasive Species and the Mexican National Commission for the Knowledge and Use of Biodiversity (CONABIO) have launched the PlayCleanGo campaign towards becoming the dominant, universally recognized invasive species prevention and outreach campaign in North America. Next stop: abroad! Learn how you can use PlayCleanGo and help the campaign achieve its vision: that all outdoor enthusiasts always clean their gear before and after they head outdoors to prevent the spread of invasive species.

How to Write Signs that People Actually Read, According to the Experts
Forest Eidbo, Minnesota Department of Natural Resources

Signage is the dominant medium of education at parks and protected areas. While many studies examine how visitors read signage, none have looked at how professionals write them. Using existing literature as a framework, this study collects best practices from experts in the field on how to produce interpretive text. Through two online surveys to interpretive planners, this study collects the opinions on the use of questions, personal pronouns, figurative language, audience and more. The results from the two rounds of surveying produced 12 recommendations for organizations to create signs like experts.

Boot Brush Stations to Educate and Prevent Invasive Species in the Finger Lakes region of NYS
Hilary Mosher, Finger Lakes Institute

Bootbrush stations help prevent the spread of invasive plant and animals by increasing education about high priority invasive species that are carried through trails and by encouraging recreationists to practice good environmental practices by cleaning their boots after being on a trail. The goals of the program in the Finger Lakes region of New York State (NYS) is to promote responsible prevention actions pertaining to terrestrial invasive species and incorporate the PlayCleanGo message into NYS invasive species outreach program. In 2015, the Finger Lakes Partnership for Regional Invasive Species Management (Finger Lakes PRISM) initiated a pilot project using the PlayCleanGo messaging in the 17 counties of the Finger Lakes PRISM region. Since this time, local, state, and federal partners have been engaged to place stations on their trails to promote the bootbrush programs. Currently, there are over 60 stations built throughout the region and the program is entering its fifth year of creating awareness and modeling appropriate Play, Clean, Go practices. Join us for this bootbrush station demo to build a mock station and discuss what has worked, what hasn't worked, and how we can spread the word about this important tool for invasive species management.

3:45 p.m. - 5:15 p.m.

How to Use Species Distribution Modeling to Study the Past Future Spread of Non-native Species

Moderator: Matthew Aiello-Lammens, Pace University

This workshop is focused on how to use species distribution modeling to study the past spread and predict future spread of non-native species. Distribution modeling is a mature tool for studying invasive species, but until recently has required extensive computer programing techniques to implement best practices. Here I will present a recently developed graphical user interface tool, named Walalce, that makes learning about and building distribution models easier. Importantly, this tool makes use of citizen science data as part of the model input and provides comprehensive and well documented analysis scripts as part of the output. That latter ensures that all analyses are replicable. During the workshop, we will walk through examples of how to build models for common invasive species and how to interpret the results in a way that is useful for land managers. There will also be time for guided individual practice, where participants can work on developing models for species of particular interest to them.

8:00 a.m. - 9:00 a.m.

Plenary

Implications of Climate Change for Invasive Species
Bethany Bradley, University of Massachusetts

Invasive species and climate change are two of the most prominent forms of anthropogenic global change identified by the Millenium Ecosystem Assessment. Invasive species have pronounced negative impacts on ecosystems and economies, and these impacts may be exacerbated by climate change. But, for most invasive species and invaded ecosystems, the outcomes of this interaction remain unknown. This presentation will review the current state of knowledge about how climate change influences invasive species.

The presentation covers the following topics: Effects of rising temperature, potential range shifts, novel disturbance regimes, and plant response to rising CO2.

1. Rising temperature could benefit invasive species directly by increasing growth rates relative to native species, and by expanding the growing season to create more opportunities in time for invasive species to establish and thrive.

2. Warming and altered precipitation are already causing the ranges of species to shift, including invasive species. But, many invasives are already widely introduced and will have a head start relative to native.

3. Climate change is likely to lead to a 'peakier' precipitation cycle, increasing both drought and flood events. Invasive species tend to thrive under these conditions with higher disturbance.

4. Finally, although rising CO2 provides a resource for all plants, invasive plants consistently outperform native plants with elevated CO2 and are more resistant to herbicides. Collectively, these findings suggest that we should be on the lookout for invasive species expanding into new landscapes, emerging earlier in the growing season, and becoming even more competitive.

How to Produce a Blight-tolerant American Chestnut Tree
William Powell, Professor and Director, Council on Biotechnology in Forestry, SUNY College of Environmental Science & Forestry, Syracuse, NY

The American chestnut (Castanea dentata) and the chestnut blight is a classic example of what happens when our forests succumb to invasive pests and pathogens. Because of its environmental, economic, and social importance, many tools have been brought to bear on the chestnut blight problem, most with either no or only partial success. We have focused on enhancing blight tolerance, a type of resistance that has been suggested to be a more evolutionarily sustainable type of defense. To accomplish this, we chose a gene that counteracts the pathogen's key virulence factor, oxalate, without directly harming the fungus. An oxalic acid detoxifying enzyme, called oxalate oxidase (OxO), was added using the tools of genetic engineering. This particular gene came from bread wheat (Triticum aestivum) but is also a common gene found in many crop and wild plants, fungi, and bacteria. Therefore OxO is not new to our food or the environment. According to chestnut leaf and small stem assays that predict the level of blight tolerance, the OxO has raised resistance levels in American chestnut to at least as high as those found in the blight-resistant Chinese chestnut (C. mollissima). Many environmental impact experiments have been completed and the next step is to have the trees reviewed by up to three federal regulatory agencies, the USDA, EPA, and FDA. Once approved, these blight resistant American chestnut trees can be used to rescue the genetic diversity in the remnant, surviving population of American chestnut and serve as an example to help other threatened tree species.

9:15 a.m. - 10:45 a.m.

Swallow-wort Biocontrol

Moderator: Dylan Parry, State University of New York, College of Environmental Science and Forestry

Evaluation of Field Releases of Hypena opulenta (Lepidoptera: Erebidae) a Biological Control Agent of Invasive Swallow-wort, in New England.
Lisa Tewksbury, University of Rhode Island; Alana Russell, University of Rhode Island

We initiated releases of Hypena opulenta, a biological control agent of invasive swallow-wort plants (Vincetoxicum spp.) in primarily coastal regions of Rhode Island, Massachusetts, and Connecticut from 2017 to 2019. Larvae were released into field cages initially, and then in open field releases. The first overwintering of an H. opulenta adult at these release sites occurred in June 2018 in Charlestown RI. Survival of H. opulenta larvae and feeding damage to swallow-worts was measured in varying light conditions at multiple sites. Larval survival and feeding damage to plants increased under lower light conditions.

Biological Control of Swallow-Worts (Vincetoxicum spp) in Canada: Establishment, Overwintering and Diapause Requirements of the Introduced Moth, Hypena opulenta.
Robert S. Bourchier, Agriculture and AgriFood Canada; Naomi Cappuccino, Carleton University; Ian Jones, University of Toronto; Sandy M. Smith, University of Toronto

Hypena opulenta is a multivoltine moth originating in Eastern Europe that was first released in Canada in 2013 for biocontrol of invasive swallow-worts, which are also known as dog strangling vine. The insect is now established at early release sites on Vincetoxicum rossicum in Ontario, Canada and has spread at least 2 km from release locations. In this presentation, we will update the status of H. opulenta in Canada and report on experiments assessing photoperiod requirements, diapause and overwintering survivorship of H. opulenta in the field. Understanding these factors, will inform procedures for rearing and stockpiling of H. opulenta pupae during winter and for releasing adults early in spring, to enhance the likelihood of a 2nd generation at Canadian field sites. Multiple generations of H. opulenta are required for significant impact on invasive swallow-worts.

Projected Impacts of Swallow-Wort Biological Control Agents and Initial Results from New York State
Lindsey R. Milbrath, USDA-ARS

The European vines pale swallow-wort (Vincetoxicum rossicum) and black swallow-wort (V. nigrum, Apocynaceae) are invasive perennials in eastern North America, especially New York State, New England states, and Ontario. Biological control agents of swallow-worts should be both host-specific as well as effective in suppressing swallow-wort populations. Demographic matrix modelling of invasive plant populations can be a powerful tool to identify life stage transitions for targeted disruption, and thus inform pre-release recommendations of particularly effective biological control agents. Analyses of a five life-stage matrix model, using data from six field or forest populations of both swallow-wort species and incorporating per capita impact data of candidate agents, indicated that season-long defoliation damage and predispersal seed predation can prevent population growth of slower, but not faster, growing forest and field populations of swallow-worts. Other agents that damage swallow-worts in different ways may also be effective but impact data for them is incomplete. The defoliating moth Hypena opulenta (Lepidoptera: Erebidae), which produces two generations per season, should be an effective agent in some habitats. Results of recent releases of H. opulenta in New York State will also be presented.

Two Additional Potential Biocontrol Agents for Invasive Swallow-worts: An Update from CABI
Ghislaine Cortat, CABI; Hariet L. Hinz, CABI; Lindsey R. Milbrath, USDA-ARS, Ithaca; Robert Bourchier, Agriculture and AgriFood Canada, Lethbridge Research Centre

Swallow-worts, Vincetoxicum rossicum and V. nigrum are perennial vines native to Europe. They are invasive in north-eastern North America and can form extensive monocultures. Both invasive species negatively affect natural and agricultural ecosystems through competition and habitat modification. Current management techniques have proved unsuccessful to control swallow-worts. We believe that classical biological control can provide a sustainable control method. Hypena opulenta has been released on V. rossicum in Canada since 2014. In August 2017, H. opulenta was released for the first time in the USA, in Massachusetts and Rhode Island. Up to now H. opulenta has not reached outbreak densities yet. In this presentation, we will give an update on two additional potential agents studied at CABI for the biological control of swallow-worts in North America. Two populations of the root-feeding chrysomelid Chrysochus asclepiadeus have been studied. A population from Ukraine tested at CABI was found genetically divergent from a population from France tested at EBCL USDA-ARS. However, data so far suggest that both populations have a similar host range. Since it is not possible to test the Ukrainian population in the field, we used the French population in an open-field test at CABI. Preliminary results of the open-field test confirm the very narrow host range of C. asclepiadeus under natural field conditions. The seed-feeding tephritid Euphranta connexa is a second potential agent. Data on the acceptance of V. nigrum and V. rossicum as well as host-specificity test results will be presented.

Forest Pest Resistance

Moderator: Jonathan Rosenthal, Ecological Research Institute

The Monitoring and Managing Ash (MaMA) Program: Tools to Incorporate the Search for EAB-Resistant Ash Into An Overall Ash Management Strategy
Jonathan H Rosenthal, Ecological Research Institute; Radka Wildova, Ecological Research Institute

The U.S. Forest Service's EAB Resistance Breeding Program has shown that a small percentage of native ash trees have heritable resistance to emerald ash borer and can be used for propagation of resistant trees for eventual ash restoration. The Ecological Research Institute's Monitoring and Managing Ash (MaMA) program (see MonitoringAsh.org), developed in collaboration with Dr. Jennifer Koch and Dr. Kathleen Knight of the USFS, includes citizen-science/land manager projects that facilitate the search for likely EAB-resistant "lingering ash". These are native, chemically untreated, mature trees that persist in healthy condition significantly after the overwhelming majority of nearby ash have died from EAB– such trees form the basis for EAB-resistance breeding. To ensure widespread restoration of native ash, it is necessary to find locally adapted lingering ash across the species' ranges. The MaMA program is already being implemented by ERI in collaboration with partners across multiple states in the East and Midwest, and integrates the search for lingering ash into an overall ash management strategy for EAB mitigation and ash conservation. Crucially, MaMA sets forth constructive steps to be taken at each stage of EAB invasion, ranging from pre-invasion to late-stage invasion, when virtually all mature ash have been killed by EAB. Using ash mortality data from our rigorous citizen-science projects in combination with EAB detection history data, we generate action maps indicating which areas are ripe to be searched for lingering ash (based on attaining particular mortality thresholds) and which are ready for other stage-specific actions.

Understanding and Exploiting Host Plant Resistance as a Tool for Eastern Hemlock Restoration in Northeastern Forests
Ian Gerard Kinahan, University of Rhode Island

We have conducted over a decade of research into rare eastern hemlock (Tsuga canadensis; hemlock) individuals that appear resistant to hemlock woolly adelgid (Adelges tsugae; HWA). Following vegetative propagation of these rare individuals, in 2015 we planted age- and size-matched HWA-resistant and HWA-susceptible hemlocks at reforestation plots in six states. In 2018, we re-surveyed the plots; 96% of HWA-resistant hemlocks survived compared to 36% of controls. The surviving control trees were also shorter, produced less lateral growth, had thinner trunks and were less healthy than HWA-resistant trees. Our ongoing research also confirms prior work showing substantial chemical differences between HWA-resistant and HWA-susceptible eastern hemlocks from this same population of trees. Our results demonstrate the potential for using HWA-resistant eastern hemlocks as a tool for reforestation.

New Approaches for Identifying Disease Resistant Forest Trees
Anna O. Conrad, The Ohio State University; Pierluigi Bonello, The Ohio State University

Forest trees are being impacted at alarming rates by both emerging and existing plant pathogens and insect pests. While there may be options for managing these threats on a tree-by-tree basis, often little can be done across landscapes, particularly after the threat has become established. We argue that development and deployment of resistant trees is a fundamental tool for the long-term management of diseases and pests and should become a routine component of management. Such development and deployment can be tremendously accelerated by using modern technical approaches. We present the results of our work using predictive modeling, based on spectroscopic analysis of plant extracts (chemical fingerprinting), to quickly classify resistant and susceptible trees. This approach has broad applicability, and has already been shown to be effective at differentiating between naturally resistant and susceptible trees in multiple forest pathosystems. This is clearly a viable and effective approach for rapidly screening and identifying disease resistant trees both on the landscape and as part of breeding programs. Furthermore, we believe this approach can be broadly applied to high value trees for which emerging pests or pathogens are of concern.

Incorporating Resistance Into Invasive Forest Pest Management and Policy Approaches
Jonathan Rosenthal, Ecological Research Institute; Anna Conrad, Ohio State University; Ian Kinahan, University of Rhode Island Enrico Bonello, Ohio State University; Evan Preisser, University of Rhode Island

Detection, propagation and selective breeding of resistant trees has shown significant potential as a tool for long-term conservation of species threatened by invasive forest pests. Moreover, significant progress has been made in this regard with respect to several important pests. Nevertheless, resistance is rarely factored into management approaches. Here, based on experience with a range of hosts and pests, we explore how pest resistance can be better incorporated into on-the-ground management practices and invasive forest pest policy frameworks.

9:15 a.m. - 10:45 a.m.

Monoecious Hydrilla Control Projects- A National Perspective

Moderator: Cathy McGlynn, NYSDEC

Introduction to Monoecious Hydrilla
Robert J Richardson, North Carolina State University

Hydrilla (Hydrilla verticillata) is likely the most economically damaging aquatic weed in the United States and it is the only aquatic weed that is invasive across multiple geographic regions. Two biotypes have historically been reported to infest the US, a female triploid dioecious biotype which is prevalent in the Southeastern U.S. and a triploid monoecious biotype which has invaded North Carolina to New York and westward. Monoecious hydrilla behaves as a herbaceous perennial and is a prolific turion producer. Under ideal growing conditions,

monoecious hydrilla can produce a new generation of turions in less than six weeks. These turions are also the primary challenge to management, as they may remain dormant for seven or more years. However, dormancy seems to decline with increasing latitude in the U.S. resulting in greater sprouting percentages in New York than in North Carolina. This may also mean that fewer years of management may be required in cooler climates for long term control than in climates with warmer winters. While monoecious hydrilla was first introduced to the U.S. in the 1970's, it is still spreading both in geographic range but also to new waterbodies within the current range. In North Carolina where monoecious hydrilla historically infested reservoirs and other impoundments, it is currently invading several rivers systems. This biotype is also displacing dioecious hydrilla in Georgia impoundments and pushing into the Midwest.

Successful Eradication of Monoecious Hydrilla from a Northern Indiana Lake
Eric Fischer, Indiana Department of Natural Resources; Doug Keller, Indiana Department of Natural Resources; Mark Heilman, SePRO Corporation J.T. Gravelie, SePRO Corporation; Nathan Long, Aquatic Control, Inc

In August 2006, the Indiana Department of Natural Resources (IDNR) discovered the monoecious biotype of hydrilla in Lake Manitou, a 327-ha lake located in northcentral Indiana. In response to this first discovery of hydrilla in the Midwest U.S., IDNR implemented rapid response actions followed by an eradication program utilizing season-long application strategies of the systemic herbicide fluridone (Sonar®). Point-intercept rake surveys in the late spring and mid-summer of each year failed to detect hydrilla after the start of fluridone treatments in 2007. Sediment core sampling documented hydrilla tuber decline from an average of 73 m-2 (732,339 ha-1) in 2007 to undetectable levels by 2011. SCUBA diver surveys were adaptively implemented from 2011 through 2018 to detect trace hydrilla with the last detection of hydrilla by diver in 2013. From 2014 - 2016, fluridone treatments were gradually reduced in scale and intensity to promote native aquatic plant growth while aggressively controlling any trace hydrilla. No management was conducted in 2017 and 2018. Ongoing vegetation assessments and diver reconnaissance failed to detect hydrilla through 2018, the 5th consecutive year without detection. Native plant presence and diversity decreased during the most intensive treatment years (7 native species found in 2005 – 2006 versus 2 – 6 from 2007 – 2013) but increased from 2014 – 2018 to equal or greater levels (7 – 12 species) than pre-eradication. The successful selective eradication of hydrilla and recovery of a native-dominant aquatic plant community can inform potential efforts in other lakes, and opportunities to refine future eradication attempts will be discussed.

Hydrilla and Human Dimensions – How Social, Cultural, and Economic Drivers Influence Regional Invasive Aquatic Plant Management
Brett Hartis, Duke Energy Corporation

Invasive species populations quite often exist across the very jurisdictional boundaries upon which their management is governed. To complicate things further, public opinion regarding the need and implementation of such management programs can vary widely. In the southeastern US, management

of hydrilla and other invasive aquatic plant species is often the subject of intense controversy among stakeholder groups. As a result, management of such species within multi-use water resources can differ widely from one realm of responsibility to the next. Neighboring management programs can range from planned eradication to even the promotion of invasive aquatic plant species as ecosystem services. This, in turn creating mixed messages for national policy on aquatic invasive plant species. Education and outreach, especially to teachers and their students, may be critical in finding common ground among conflicting stakeholders in the future.

California's Successful Hydrilla Eradication and Surveillance Program
Lars Anderson, Waterweed Solutions; Jonathan Heintz, California Department of Food and Agriculture

In 1977, California was the first state in the US to establish a formal, earmarked, hydrilla eradication program. The enabling legislation stemmed from two dioecious infestations found in 1976: Lake Ellis (Marysville) and the massive Imperial Irrigation District. (Monoecious hydrilla was discovered in 1993.) Hydrilla's spread in Florida and other southeastern states, and the risk to vital aquatic resources in California prompted the eradication effort. Hydrilla threatened the states $billion agriculture production by interfering with irrigation systems. The program was delegated to the California Department of Agriculture (CDFA). Best methodologies and high priorities were identified through Technical Advisory Panels whose reports help directed CDFA actions. The expert panel approach established program credibility and public trust. From 1977 to 2018 CDFA programs have successfully eradicated 28 sites out of a little over 30 total infested sites. Eradication methods have included single-use and combinations of systemic and contact herbicides, physical removal, de-watering coupled with soil sterilants, complete burial of small ponds, as well as biological control using sterile (triploid) grass carp. Early sites were infested by dioecious hydrilla but monoecious hydrilla appears to be in more recent infestations. Primary benefits of the CDFA program are: (1) protecting nearly 400 of irrigation district systems; and (2) protecting over 700 miles of waterways in the Sacramento-San Joaquin Delta, which supports $billions in economic resources for over 35 million Californians. The costs of between $2 to 3 million annually is a small "investment" to protect an important part of the state's $2.7 trillion economy.

State Overviews: New York State Hydrilla Infestations
Michael J. Greer, USACE, Buffalo District; Nicole White, NYSDEC

This 10 Minute presentation will provide an overview of 3 major infestations of monoecious hydrilla within New York State: Cayuga Lake (Tompkins County), Erie Canal and Tonowanda Creek (Erie County), and the Croton River, (Westchester County). It will highlight how NYS infestations (and the adaptive management strategies implemented for control) vary depending on location, habitat type, water uses, and species assemblage.

Updates on Large Scale Hydrilla Control Projects in New Jersey
Chris Doyle, SOLitude Lake Management

The New Jersey Water Supply Authority (NJWSA) is the lead agency on two large-scale hydrilla control programs currently ongoing in New Jersey. The Delaware and Raritan Canal is a 60-mile long canal that winds its way through central New Jersey, with a primary purpose of delivering water to end users. In 2016, hydrilla was discovered in an 18-mile stretch of the canal. Following mapping the infestation and development of a management plan, the NJWSA began a 3-year Hydrilla Control Program in 2017 which includes a low-dose herbicide injection and extensive monitoring efforts. An update on the status of the program shall be presented. In 2017, hydrilla was confirmed in the Manasquan Reservoir, a 770-acre drinking water reservoir also managed by the NJWSA. In 2018 and 2019, herbicide pilot studies were conducted to limit the spread of hydrilla and assess the feasibility of full basin treatment. In 2019, a boat steward program was initiated at the site, which is extensively used for fishing and contact recreation. An update on the pilot projects and the extensive monitoring shall be presented.

9:15 a.m. - 10:45 a.m.

Using iMap Invasives for Data Collecting and Sharing

Moderator: Jennifer Dean, NY State Department of Environment and Conservation

iMapInvasives is an invasive species data management tool that has recently been revamped by NatureServe to leverage new mapping and data sharing technologies. This workshop will start with creating accounts for participants and an interactive walk-through of the iMapInvasives system, highlighting presence, searched area, and treatment data. Then we will head outside to identify and map the invasive species found walking distance to the conference center. Participants encouraged to bring a laptop and/or mobile device, but extras will also be available.

11:00 a.m. - 12:30 p.m.

Remote Sensing Technologies

Moderator: Jennifer Pontius, UVM

Special Session:Integrating Geospatial Technologies into Invasive Species Detection, Monitoring and Management Efforts

Scientific advancements in remote sensing for invasive species applications
Jen Pontius, UVM, FEMC, USFS NRS

Historically remote sensing and geospatial modeling has been successfully used to assess and monitor vegetation condition and model invasive risk on a relative, coarse scale. But advances in remote sensing technologies and geospatial modeling now enable more advanced assessments. From improvements in host species mapping, to identifying and tracking pre-visual decline symptoms, to incorporating dendrochronological growth patterns into invasive risk and spread models. In this session, we summarize some of the novel approaches to utilizing these technologies to inform invasive species management.

Developing a Comprehensive Remote Sensing Program to Address National Forest Health Concerns
Ryan Hanavan,USFS

The US Forest Service Forest Health Protection (FHP) provides expertise in detection, monitoring and evaluation of forest health concerns across the country. The annual aerial detection survey (Insect and Disease Survey) started in 1947 and has progressed from hand-drawing insect and disease activity to digitally recording damage agent, extent and severity. The Forest Service has looked to increase the role of remote sensing to improve annual IDS efforts through data and application development to improve our ability to detect current insect and disease threats. In addition to current efforts, the Forest Service continues to look at ways to improve currently and future remote sensing efforts to capture near-real-time forest disturbance events.

Operational Remote Sensing to Manage Invasive Pests Pathogens and Plants: Case Study Review
Ryan Hanavan, USFS

In this session we review some examples of integrating remote sensing and geospatial tools into forest management. From tracking the spread and impact of hemlock woolly adelgid in the Catskills, to mapping Eurasian watermilfoil in Utah, efforts that integrate remote sensing technologies into integrated invasive management efforts is growing. These efforts highlight the need to bring together a diverse team of geospatial, invasive and management experts to tackle pressing issues.

Online Tools and Maps for Invasive Species Management
Jen Pontius, UVM, FEMC, USFS NRS

Over the past decade, a variety of publically available tools have come online to inform invasive species monitoring and management. Recognizing the need to aggregate, summarize and share information about invasive species, several organizations have developed online tools that inform invasive spread, impact and risk. Here we survey several of the tools currently available, and compare their utility for various invasive species management applications.

Looking Forward: Best practices for integrating remote sensing and geospatial technologies into invasive species efforts.

QA Session with Species Session Coordinators Ryan Hanavan and Jennifer Pontius

11:00 a.m. - 12:30 p.m.

Using Research to Inform Spotted Lanternfly (Lycorma delicatula) Management

Moderator: Julie Urban, Penn State University

Impact and Response of Spotted Lanternfly in Pennsylvania
Heather Leach, Penn State University

Spotted lanternfly is an invasive planthopper now found in several states in the Northeastern U.S. Damage from this phloem feeding insect has been noted on many important agricultural commodities and as a significant nuisance problem in parks and backyards. More information is needed about the biology and behavior of this pest as it continues to expand throughout the U.S. Data will be presented on host preference of spotted lanternfly throughout its life cycle, phenology of this pest in vineyards and best management practices, and results from recent trapping trials. The public and industry response to spotted lanternfly, and how to optimize awareness and outreach, will also be covered. Obtaining more predictability of spotted lanternfly will help us concentrate our management efforts and reduce the economic and social impact from this invasive pest.

Preliminary Research Results on Spotted Lanternfly (Lycorma delicatula) Egg Mass Dispersion Patterns to Estimate Populations Densities
Dennis Calvin, Julie Urban, and Heather Leach, Penn State University

During early spring in 2019, field research was initiated to quantify the dispersion pattern of spotted lanternfly egg masses to estimate population density. A number of one acre plot areas were established and sampled for spotted lanternfly egg masses. Using these data, plot mean densities, variances and mean crowding values were calculated. A linear regression equation was then establishment between mean crowding (dependent variable) and mean density (independent variable) to estimate slope and intercept parameters. These constants were then used in an equation to estimate the sample required to estimate population density at a given level of accuracy and precision.

How Invasive Species Affect Integrated Pest & Pollinator Management Programs in Eastern Fruit Crops.
David Biddinger, Heather Leach, and Julie Urban, Penn State University

Invasive pests are arriving at an ever increasing rate and can greatly affect existing pest control programs. Insecticide applications are often greatly increased along with grower costs at least temporarily. The conservation of effective biological control for secondary pests and of wild pollinators are often at risk because of this increased spraying and increased use of non-selective insecticides.

Research Informing Spotted Lanternfly Management Across the SLF Lifecycle
Julie Urban, Erica Smyers, Dana Roberts, and Heather Leach, Penn State University

Spotted Lanternfly (Lycorma delicatula), is a highly polyphagous insect pest, feeding upon over 70 different species of plants and trees. In order to attempt to effectively manage Spotted Lanternfly, we need to better understand this insect's developmental requirements and timing across all stages of its life cycle. Here we present results of our research concerning Spotted Lanternfly development, particularly adult female reproductive development, movement, and endosymbiont transmission.

11:00 a.m. - 12:30 p.m.

Aquatic Invasive Species Research

Moderator: Adam Doll, Minnesota Department of Natural Resources

Occurrence and Survival of Zebra Mussel Veliger Larvae in Residual Water Transported by Recreational Watercraft
Adam Doll, Minnesota Department of Natural Resources

Zebra mussels are an aquatic invasive species (AIS) that have spread to many waterbodies in North America and transient recreational watercraft are one of the primary pathways of spread. Best management practices for reducing the risk of spreading AIS include draining all water from watercraft before leaving a water body, but removing all water is impractical. Uncertainty exists about whether zebra mussel larvae (veligers) could reside within the "residual water" that remains after draining and survive overland transport to a new water body. At two Minnesota, USA water bodies we collected over 300 samples of residual water from recreational watercraft. Roughly half (48%) of these samples contained no veligers and the majority (75%) contained five or fewer. Sterndrive engines and ballast tanks ranked 1st and 2nd for volumes of residual water. Ballast tank samples contained the largest median number of veligers per sample (247) and sterndrive engines the highest maximum number of veligers. We conducted laboratory experiments on veliger survival in residual water of live wells due to the high frequency of fishing boats moving between water bodies, and ballast tanks given their high likelihood of containing veligers. We exposed live well samples to 20°, 27°, 32°, and 38°C air temperature and ballast tanks to 20° and 32°C. For veligers in live well residual water, we observed over 95% mortality after 5 hours of exposure at all temperatures. These same levels of mortality were reached more slowly in ballast tanks (over 95% mortality at both temperatures achieved at 48 hours).

Comparison of Salinity Tolerance and Feeding Behavior in Landlocked and Anadromous Populations of Sea Lamprey
Jessica Norstog, University of Massachusetts Amherst; Stephen D. McCormick, University of Massachusetts Amherst

The life histories of anadromous and landlocked Sea Lamprey are similar, though landlocked populations lack exposure to seawater and thus experience relaxed selection on traits associated with survival in seawater, including salinity tolerance and associated physiological traits. Two studies were conducted to investigated differences in anadromous and landlocked populations of Sea Lamprey in their capacity for ion regulation in seawater. Landlocked lamprey had lower survival in 35 ppt seawater compared to anadromous lamprey. All populations showed elevated gill NKA activity from ammocoetes, which increased over time after 30 ppt seawater exposure. Plasma ion concentrations were also elevated in two upper Great Lakes populations over time compared to the anadromous population after exposure to 30 ppt seawater. Additionally, feeding has been suggested to facilitate osmoregulation. Feeding behavior and associated physiological traits were assessed among anadromous and landlocked populations. This study sheds a light on the feeding behavior in different saline environments. Together these results suggest that there are population-based differences in salinity performance that are consistent with relaxed selection on traits for seawater entry in landlocked populations.

Calcium Chloride Road Salt Results in the Death of Invasive Bivalves, Not An Increase in Their Community-Wide Consequences
Kayla Dawn Coldsnow, Rensselaer Polytechnic Institute; William Hintz, Rensselaer Polytechnic Institute; Matthew Schuler, Rensselaer Polytechnic Institute; Aaron Stoler, Stockton University; Rick Relyea, Rensselaer Polytechnic Institute

Invasive bivalves are well-known to alter ecosystems, but often the calcium concentration of a body of water can influence their success and impact. One contaminant, calcium chloride ($CaCl_2$) road salt, may facilitate invasive bivalves by serving as a source of calcium, while also being toxic to organisms at higher concentrations. Using mesocosms, we exposed lake communities to a combination of invasive bivalves [i.e. Asian clams (Corbicula fluminea) and zebra mussels (Dreissena polymorpha) presence or absence] crossed with five $CaCl_2$ concentrations (35, 38, 58, 91, 187 mg calcium/L). We hypothesized that invasive bivalves remove phytoplankton and increase benthic algae, which impacts species that consume these types of algae. Further, we hypothesized that $CaCl_2$ promotes the survival, growth, and reproduction of all bivalves, and causes few toxic effects to the whole community. Lastly, we hypothesized that invaded communities exposed to $CaCl_2$ experience stronger effects from the increase in invasive bivalves. We found that invasive bivalves caused decreases in phytoplankton, periphyton, zooplankton, and native clams; they caused increases in filamentous algae and isopods. While zebra mussels survived poorly in all treatments, Asian clams were substantially reduced by high $CaCl_2$ concentrations. Therefore, the effects of Asian clams on high $CaCl_2$ communities were reduced and these communities closely resembled native communities. The highest $CaCl_2$ treatments also reduced zooplankton densities. Our results suggest that $CaCl_2$ will not promote invasive bivalves, but rather mitigate their impacts. Further work, however, is needed to understand the full range of toxic effects of $CaCl_2$ road salt on native communities.

Food Web Interactions and Early Detection of Two Aquatic Invasive Species, the Bloody Red Shrimp, Hemimysis anomala, and the Round Goby, Neogobius melanostomus
Brent T Boscarino, Lower Hudson Partnership for Regional Invasive Species Management; Meghan E Brown, Hobart and William Smith Colleges

Predicting the impacts of invasive species on native food webs requires a combination of controlled feeding experiments and structured field surveys to determine spatial distribution and help with early detection in areas of potential expansion. The bloody red shrimp (BRS), *Hemimysis anomala*, and the round goby, Neogobius melanostomus, are both recent Ponto-Caspian aquatic invasive species that have expanded their range throughout the Great Lakes region into the Capital Mohawk and greater Hudson River regions of New York State. In this study, we investigate how the consumption rate of round goby and four other potential fish predators of BRS (alewife, lake trout, yellow perch and pumpkinseed sunfish) varies as a function of BRS density, light level, and substrate type. We also performed seine and plankton net surveys to determine the

degree of spatial overlap between round goby and BRS at over 50 sampling locations along the Erie Canal and the Hudson River. The round goby predation experiments demonstrated no significant effects of substrate type on prey capture success but that increasing light levels were inversely related to consumption rate. Gobies ranked third in mean feeding rate (22 mysids hr-1) at the highest BRS density treatment compared to other fish predators (alewife lake trout round goby yellow perch   pumpkinseed). Our survey results did not detect round goby any further east than Rome, New York; however, BRS were found consistently throughout the Erie Canal and as far south as Poughkeepsie along the Hudson River.

11:00 a.m. - 12:30 p.m.

Impacts and Management of Jumping Worms

Moderator: Annise Dobson, Yale University; Andrea Dávalos, SUNY Cortland

Annise Dobson, Yale University; Andrea Dávalos, SUNY Cortland & Timothy McCay, Colgate University

Jumping worms, alternatively known as pheretimoid earthworms, crazy worms, snake worms and Alabama jumpers, are an emerging conservation threat to a broad suite of native taxa, habitats, industries, hobbies, and vital ecosystem services. These earthworms in the family *Megascolecidae* originate in Asia, while the more widespread European species are in the family *Lumbricidae*. Jumping worms alter the structure and chemistry of the soil dramatically, leaving a grainy soil full of worm excrement (castings), and they can damage lawns, landscapes and forest habitat. Observations of the negative effects of jumping worms has been independently noted not only by forest ecologists, but by botanical garden staff, ornamental plant breeders and citizens. Due to increasing recognition of their impact, the sale of jumping worms is restricted in New York (NYDEC 2014) and Wisconsin (WDNR 2009), and the California Department of Food and Agriculture lists them as an economically important pest and recommends eradication, quarantine regulation, containment, rejection, or other holding action (CDFA 2017). However, difficulty in recognizing jumping worms and our lack of knowledge about their impacts and basic life history limit our ability to adhere to these regulations and implement best-practices to limit their spread. In this workshop, we will first discuss the impacts and invasion history of jumping worms. Next, we will provide practical, hands on training to identify jumping worms. Finally we will discuss platforms such as iMapInvasives to share jumping worm distribution data.

1:45 p.m. - 3:15 p.m.

Session I: Invasive Species Management in a Changing Climate

Moderator: Bethany Bradley, University of Massachusetts, Amherst

Bridging the Research-Management Gap through the NE Regional Invasive Species and Climate Change (RISCC) Management Network
Carrie Brown-Lima, NY Invasive Species Research Institute,
Cornell University; Toni Lyn Morelli, USGS Northeast Climate Adaptation Science Center, Bethany Bradley, University of Massachusetts Amherst, and Jenica Allen, University of New Hampshire

New Tools for Identifying and Prioritizing Range Shifting Invasive Plants
Jenica M. Allen, University of New Hampshire; Jeff Garnas, University of New Hampshire; Chuck Bargeron, University of Georgia; Joseph LaForest, University of Georgia; Mei Rockwell-Postel, University of Massachusetts Amherst; Brittany Laginhas,University of Massachusetts Amherst; Bethany Bradley, University of Massachusetts Amherst

Invasive plants have the capacity to shift their geographic ranges as climate continues to change. Many species will disperse to new regions naturally or accidentally, necessitating preventative policy and early detection and rapid response (EDRR) programs. Prevention and EDRR are a cost effective approaches to the invasive plant problem, but require that we know which species to look for and where. We forecast mid-century (2050) climate-driven range shifts of nearly 900 terrestrial invasive plants in the continental U.S. based on observations in the Early Detection and Distribution Mapping System (EDDMapS) database and others. The resulting maps allow stakeholders to identify new potential invasive plants to their state before they arrive on the local landscape. We will demonstrate two new tools available for mapping and identifying these range-shifting invasive plants. One tool maps expected county level range dynamics between now and 2050 for a user-selected species, including range expansion, contraction, and stability. The other tool generates a list of invasive plants that have climate-driven range expansion potential into a user-defined state and refines the list based on user-controlled geographic proximity of current observations. The range dynamic visualizations and watch lists can be incorporated into stakeholder planning and prioritization for early detection and rapid response programs and proactive policy to stem the movement of species into new areas.

Incorporating Climate Change Into Invasive Species Management - Insights from Managers
Evelyn M Beaury, University of Massachusetts Amherst; Emily J. Fusco, University of Massachusetts Amherst; Michelle R. Jackson, University of Massachusetts; Amherst Brittany B. Laginhas, University of Massachusetts Amherst; Toni Lyn Morelli, USGS Northeast Climate Adaptation Science Center

Invasive alien species are likely to interact with climate change, thus necessitating management that proactively addresses these anticipated interactions. However, the degree to which invasive species managers incorporate climate change into their work, and what stops them from doing so, remains unknown. Therefore, we surveyed natural resource managers addressing invasive species across the U.S. about their priorities, concerns, and management strategies in a changing climate. Of the 210 managers we surveyed, most were very concerned about the influence of climate change on invasive species, and this concern was positively related to incorporating climate change into management decisions. However, managers reported that their organizations were generally less concerned about climate change, and lack of funding, personnel, and, particularly in climate change management, information limited their ability

to engage in adaptive management. Managers suggested that research identifying native communities resilient to invasions and identifying range-shifting invasive species would be especially useful for informing management under climate change. Additionally, managers reported that information about these research topics would be most effectively communicated through conversations, research summaries, and meetings/symposia. This study therefore suggests that managers are receptive to new strategies for adaptive invasive species management and support research addressing remaining knowledge gaps. By approaching these topics through an integrative framework, such as suggested in the emerging field of translational ecology, research scientists can work with managers to align research with management priorities, share research in a format accessible to managers, and create two-way dialogue about invasive species and climate change.

Are Invasive Species Managers Thinking Proactively to Address Climate Change Impacts?

Brittany Laginhas, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Organismic and Evolutionary Biology Graduate Program, University of Massachusetts, Amherst, MA; Jenica M. Allen, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH; Evelyn M. Beaury, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Organismic and Evolutionary Biology Graduate Program; Emily J. Fusco, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Organismic and Evolutionary Biology Graduate Program; Michelle R. Jackson, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Organismic and Evolutionary Biology Graduate Program; Toni Lyn Morelli, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; Northeast Climate Adaptation Science Center, US Geological Survey, Amherst MA; Bethany A. Bradley, Department of Environmental Conservation, University of Massachusetts, Amherst, MA

Climate change is causing many invasive plants to shift their ranges into novel regions. These range shifts create new challenges for management that will require additional preventative strategies to limit their spread. However, the degree to which managers are thinking about and planning for emerging invaders is unknown. Therefore, we surveyed managers to identify invasive species currently posing the greatest threat to their agency's goals and emerging species posing the greatest threat in the near future in order to assess whether managers were thinking proactively to incorporate climate change into invasive species management. We received responses from 167 managers. Of those respondents, 54% reported new emerging species (i.e., species not reported as current threats), suggesting that most managers are thinking ahead. Next, we analyzed the approximate distance between managers and the nearest records of reported emerging species based on the Early Detection and Distribution Mapping System (EDDMapS) data. Using this information, we assessed the degree to which managers are anticipating species that are close by (in the same county) vs. far away (outside the state), and calculated the proportion of emerging threats that could be managed using proactive preventative measures

(e.g., EDRR). Lastly, we used non-metric dimensional scaling (NMDS) to assess similarities between reported current and emerging threats in order to connect managers concerned about the same species. Collectively, these analyses identify emerging species of concern that are candidates for proactive management. We aim to use this information to further proactive management by facilitating communication across state boundaries.

1:45 p.m. - 3:15 p.m.

Forest Pest Management

Moderator: Thomas DeMayo, Horticultural Inspector, NYS Department of Agriculture and Markets

New York Asian Longhorned Beetle Cooperative Eradication Program
Thom Allgaier Invasive Species Coordinator-NYS DAM

From the beginning in 1996 with the first confirmation of Asian Longhorned Beetle (ALB) Anoplophora glabripennis the New York Asian Longhorned Beetle Cooperative Eradication Program has been a joint effort between NY State Department of Agriculture & Markets and the United State Department of Agriculture. With detections in NY city and on Long Island quarantines were established. Survey, treatment, and removals have been used to work towards the goal of eradication. Several other populations have been detected since its initial detection. These include the Worchester & Boston MA, Amelia, OH, Linden & Jersey City, NJ, Chicago, IL, and, Islip & Staten Island, NY. The regulatory, survey, and treatment efforts by the federal and state partners in these areas have demonstrated that cooperative eradication efforts can be successful when sustained funding and support is maintained. ALB has been successfully eradicated from NJ, IL, Boston, and most of the quarantined areas of NY. In New York the Manhattan and Staten Islands have been deemed free of ALB, as well as the area in Islip, NY. The remaining portions of NY city are on track to be declared eradicated by mid-2019, so by the time of the NAISMA conference this should have occurred and would be a great time to highlight this milestone in ALB eradication. The decades long work that has gotten the eradication program to this point has employed not only visual survey, but also the evolution of survey data recordkeeping and reporting. The science applied during this program spans hand drawn maps to GIS technology, acoustical survey, treatment methods & treatment equipment development, detector dogs, laboratory rearing methods, and determining the efficacy of larval mortality based on chip size. This program highlights the cooperative efforts of state and federal partnerships in long term commitments to eradicate terrestrial invasive species. ALB impacts many stakeholders from forest managers, forest products, residential and municipal arboriculture and safety, to ecological impacts such as streambank stabilization, fishing, maple sugaring, heating and cooling of homes and businesses, social impacts to the deforested landscapes left behind after infections have been removed, as well as other adverse effects.

Oak Wilt Management in New York: Different Tactics for Different Sites
Robert Cole, New York

The risk of oak wilt infection centers expanding and spreading to new areas differs from site to site based on soil and geological characteristics, forest/tree characteristics, time of year, and climatic conditions. Each site also comes with its own landowner and public outreach challenges and regulatory concerns. Rather than a "one size fits all" approach to managing oak, NY attempts to tailor its management tactics to the specific site. This presentation will tell the stories of different sites in NY and the tactics used at each site to achieve the desired outcome.

New Short-term Forecasts of Pest Life Cycle Stages
Alyssa Rosemartin, USA National Phenology Network; Theresa Crimmins, USA National Phenology Network; Kathy Gerst, USA National Phenology Network; R. Lee Marsh, USA National Phenology Network; Erin Posthumus, USA National Phenology Network

Timely information regarding developmental stages of pests can facilitate early detection and control of invasive insects. The USA National Phenology Network (USA-NPN) collects, stores and widely shares data, models and information on the timing of plant and animal life cycle events. The USA-NPN provides Pheno Forecasts, short-term forecasts of insect pest activity, based on accumulated temperature thresholds associated with critical life cycle stages of economically important insect pests. Pheno Forecasts indicate, for a specified day, the status of the insect's target life cycle stage in real time across the contiguous United States. The maps are available for 12 pest species including emerald ash borer, hemlock woolly adelgid and gypsy moth. Managers may sign up for notifications 1 and 2 weeks prior to a given threshold for a location and species of interest. The maps are validated with ground observations collected through the Pest Patrol campaign, part of the USA-NPN's data collection program Nature's Notebook. Underlying Growing Degree Day maps are also available as forecasts, long-term averages and daily anomalies. This presentation will provide an overview of relevant USA-NPN tools, and invite feedback on future directions.

Recent Developments from a Novel Survey Technique for Exotic Wood-Inhabiting Insects in Urban Environments
Michael Bohne, USDA Forest Service; Marc DiGirolomo, USDA Forest Service; Kevin Dodds, USDA Forest Service; Joe Charap, Green-Wood; Sara Evans, Green-Wood

Major exotic forest insect pests like gypsy moth (Boston) and Asian longhorned beetle (Brooklyn) often first establish in urban environments. In an effort to make early detections of exotic wood inhabiting species, the Forest Service set up rearing surveys using logs and branches from trees pruned or felled from arboreta located near the major international commercial Ports of Boston and New York. Over 20 known exotic species have been identified through the survey, resulting in a number of new host associations. Additionally, a previously unknown wood borer was discovered in Brooklyn, New York and is being investigated as a potential new invasive species.

1:45 p.m. - 3:15 p.m.

Aquatic Invasive Management: Novel Tools for Collecting and Analyzing Data

Moderator: Jennifer Dean, New York Natural Heritage Program; Matt Brinka, NYS Office of Parks, Recreation & Historic Preservation

Adirondack Aquatic Invasive Species (AIS) Management Tracker Program: A Citizen Science-Based Monitoring Program to Track the Effectiveness of AIS Management.
Leigh Walrath, NYS Adirondack Park Agency; Erin Vennie-Vollrath, New York Adirondack Park Invasive Plant Program

Lake associations and local municipalities in the Adirondack Park region of New York have been managing Eurasian watermilfoil and other aquatic invasive plants for decades. The majority of these entities rely on private contractors to undertake the actual management, and typically receive a year-end report documenting their management effort. The reports sometimes provide a description of the overall lake condition and recommendations for management for the following year. However, these assessments and recommendations fail to provide an effective way to measure invasive species management progress over time. Furthermore, they do not provide a means to understand the distribution and abundance of native vegetation, or if the invasive species is impacting these native populations. This citizen scientist survey program aims to address these gaps and serves as a bridge between infrequent professional plant surveys and year-end reporting produced by the contractor to allow for more informed management decisions.

Using Partnership and Data Standardization to Develop a Real-Time Data Collection Method and Analysis Tool for Watercraft Inspections
Matt Brincka, NYS Office of Parks, Recreation & Historic Preservation; Catherine McGlynn, NYS Department of Environmental Conservation; John Marino, NY Natural Heritage Program

The Watercraft Inspection Steward Program Application (WISPA) was developed to collect and analyze real-time data of aquatic invasive species collected by watercraft inspections at boat launches across New York State. To collect real-time data, a mobile survey was developed in the application Survey123, which is accessed by phone or tablet and can be accessed offline. Data collected by watercraft inspectors through the mobile survey are then uploaded through a network connection to a database associated with ArcGIS Online. The WISPA database is then made available to partner organizations and state and federal agencies to track and analyze aquatic invasive species trends to aid in prevention, education, and treatments across the state. This is a collaborative effort between more than 10 public and private organizations across New York State. In 2018 over 150,000 surveys were loaded into the database from more than 180 boat launches in New York State. Over 10,000 surveys indicated that invasive species were present during inspection.

Increasing Efficiency in AIS Data Collection & Analysis

Gabriella Cebada Mora, NYS Parks; Irene Holak, NYS Parks; April Brun, NYS Parks

NYS Parks Water Quality Unit Lakes Program has conducted surveys for both aquatic invasive and native plants and collected water chemistry data over the past 20 years. A lot can change in 20 years, and some things stay the same. Within the last 8 years, our program began to focus on ways to update our processes and data management to increase data entry and analysis efficiency, provide standardized reporting, reduce cost and waste, and ensure knowledge was not lost as staff retired or changed jobs. Within the past 20 years, following guidance from DEC and others, our data sheets became more comprehensive and transitioned from paper forms to Trimble units and now to tablets. Our data management has also morphed over the years, going from paper files to excel to an Access database and now looking to shift into R/R Studio as a means of data analysis and standardized reporting. The transition of data collection methods and management for long-term data sets required a willingness to embrace change, a deep look at our internal practices and controls, and provided many lessons learned and things to be considered.

Using Sonar-Based Technology for Aquatic Invasive Species Early Detection and Waterbody Vulnerability Assessments - Opportunities and Challenges

Ezra Schwartzberg, Adirondack Research; Janelle K Hoh, Adirondack Research; Erin Vennie- Vollrath, The Nature Conservancy Adirondack Park Invasive Plant Program

Allocating limited management resources to detect novel infestations of aquatic invasive species (AIS) within large, recreationally connected aquatic systems, like those found in the Adirondacks, is an ongoing challenge for natural resource managers. Beginning in 2018, The Nature Conservancy's Adirondack Park Invasive Plant Program contracted with Adirondack Research to advance sonar-based data collection and post-processing using C-Map BioBase to accurately map aquatic vegetation biovolume, bottom hardness, and bathymetry. The data provide detailed waterbody-specific characteristic information with increased accuracy and at reduced cost than top-water or diver-assisted surveys. We intend to utilize these data to develop geospatial vulnerability models of aquatic invasive plant establishment and spread for individual lakes to help target future early detection surveys and to direct regional AIS spread prevention measures. While this technology offers many opportunities, there are also challenges and limitations. We will discuss these in the context of our experiences using these tools.

1:45 - 3:15 p.m.

Invasive Species Identification and Managment- Part I

Moderator: Linda Rohleder, Lower Hudson PRISM / New York-New Jersey Trail Conference

This special workshop will discuss pesticide use and review New York State Part 575 Prohibited and Regulated species including common invasive plants in this region. FIFRA 2(ee) requirements will be covered including allowable and disallowed modifications to the label and the process for requesting at

2(ee) recommendation in NY. The principles of integrated pest management will be covered, and environmentally-sensitive techniques and various equipment and tools that can be used will be discussed. Pesticide applicator CEU credits will be available for NY and surrounding states.

3:30 p.m. - 5:00 p.m.

Session II: Invasive Species Management in a Changing Climate

Moderator: Jenica Allen, University of New Hampshire, Dept. Natural Resources and the Environment

"Call me another thrower": Protecting Native Biodiversity and the Reality of Managing for Non-Native Invasive Plants

Elizabeth Spinney, Invasive Plant Coordinator, Vermont Dept. Forests, Parks & Recreation

Maintaining the native biodiversity of sites in Vermont affected by the presence of non-native invasive plants requires consistent monitoring and management. This presentation will discuss several case studies and the consequences of the perdurable nature of managing established non-native invasive plant populations.

Emerging Threats: Unifying Invasive Species Management and Policy

Michael Anderson, Suffolk University Law School

The benefits of invasive species management efforts are intrinsically tied to the quality of the efforts and the information applied. By advancing state-level policy, management efforts can directly work towards statewide goals and implement far-reaching, long-term strategy. Improved coordination creates efficiency in resource allocation and fosters the needed networks that promote information dissemination and proper prioritization. Policy should serve a distinct role in coming years by enabling the necessary structures to properly manage known infestations and those species expected to invade. In Massachusetts, stakeholders are working to advance legislation that would enable state-level coordination and inter-agency communication, and importantly, create a response mechanism for the range of invasive species with shifting distribution driven by climate change. Massachusetts is lacking in state-level response to invasive species. The Massachusetts Invasive Plant Advisory Group serves an advisory role across the state, but the group has diminished in capacity and primarily functions to recommend prohibited plant species to the Massachusetts Department of Agricultural Resources. The state, like many others, is struggling to properly list and prioritize the abundance of invasive species that are documented across its landscape, let alone the species predicted to enter the state. Coordinated efforts across legislation and management are needed in order to properly advocate against and respond to invasive species.

Modeling Suitable Habitat for phragmites and Japanese barberry in Wisconsin Under Current and Future Climate Scenarios

Mark Renz, University of Wisconsin Madison; Niels Jorgensen, University of Wisconsin Madison

Phragmites (*Phragmites australis*) and Japanese barberry (*Berberis thunbergii*) are rapidly spreading throughout Wisconsin's landscape. Known locations throughout the state have increased by 300% and 53% for Japanese barberry (2018 n=1,566) and phragmites (2018 n=9,785) respectively over the last three years. Despite this spread many regions of Wisconsin have sparse to no areas infested suggesting further spread is possible. To understand the distribution of potential suitable habitat, we developed separate ensemble habitat suitability models (HSMs) for Phragmites and Japanese barberry under current climate in Wisconsin. The results of this model indicate climate is a major contributor and constraining factor driving habitat suitability for both species and field validation correctly classified suitable habitat by 85%. Because climate factors were major drivers of suitability (mean minimum winter month temperatures and seasonal precipitation most important), we developed HSMs using 12 different future climate scenarios. Three global circulation models (CCSM4, HadGEM2-ES, and INM-CM4) combined with two relative concentration pathways (RCP4.5 and RCP8.5) and two future time periods (2050s and 2080s) were explored representing conservative to extreme climate change scenarios. Each individual model was summarized into US EPA Level III Ecoregions and by land cover type using the WISCLAND 2.0 dataset. When projected into the future, our results suggest that Phragmites suitable habitat will persist along Wisconsin's Great Lakes but increase northward into what is now northern hardwood and deciduous forests and westward into the area where it is currently regulated as a prohibited species. Results predict that Japanese barberry suitability will also increase throughout the state with the potential to occupy an additional 2.5 million hectares of current forests. These results suggest that these species will expand their range in Wisconsin without management under a range of future climate scenarios. Given the potential impact these species pose, we suggest that resources be dedicated to monitoring for these species in areas with few to no populations highlighted by our models and management be initiated on these populations to prevent future impact.

Interactive Effects of Plant Invasion and Drought on Native Ecosystems
Catherine Fahey, Algoma University; Christina Alba, Denver Botanic Garden; S. Luke Flory, University of Florida

Non-native plant invasions can have significant impacts on native ecosystems and there is growing concern that plant invasions may be exacerbated by climate change such as altered precipitation patterns. Many areas are expected to experience more intense plant invasions and more frequent and prolonged droughts but little is known about their interactive effects on natural ecosystems. If an invader has higher drought tolerance than native species, the invader could be released from competition with natives, promoting dominance of the invader and suppression of native biodiversity. Conversely, if natives have higher drought tolerance than the invader then the biological resistance of the community may increase under drought. Interactions between the invader and native species could switch between competition and facilitation depending on soil water availability as facilitation is more common under high stress conditions. Furthermore, drought could interact with other aspects of ecosystem response to invasion including fire regimes, decomposition and nutrient cycling, or plant-microbe interactions. We evaluated the independent and interactive

effects of the invasive grass Imperata cylindrica (cogongrass) and drought on longleaf pine communities in the southeastern US. We found that the invader ameliorated drought effects on longleaf pine and associated understory plant communities by increasing soil moisture under drought conditions. Despite this ameliorating effect, after five years of treatment pine performance and plant diversity were severely reduced by all invasion and drought combinations. These results suggest that management strategies will need to consider plant invasion and altered precipitation regimes as barriers to restoration of natural ecosystems.

3:30 p.m. - 5:00 p.m.

Unmanned Aerial System and Other Aerial Devices for Invasive Species Detection, Monitoring and Management

Moderator: Zack Simek, The Nature Conservancy

Eyes in the Sky vs. Boots on the Ground: A Preliminary Evaluation of Small UAS for Terrestrial Invasive Plant Detection and Mapping
Zachary Simek, The Nature Conservancy

Small unmanned aerial systems (UAS) are emerging as a valuable tool to support a variety of conservation applications, including invasive species detection and mapping. UAS can provide easy access to remote locations where ground surveys may be time consuming or hazardous. This pilot project evaluated the use of low cost UAS to detect and map the spatial abundance of common reed grass (*Phragmites australis*) using true color imagery. The study evaluated: (1) the effect of flight parameters (seasonal timing, altitude, etc.) on infestation mapping accuracy; (2) infestation detection and mapping accuracy using UAS vs. ground-based surveys; and (3) total survey time using UAS vs. ground-based surveys. Results suggest UAS are a valuable complement, but not a replacement, to boots on the ground.

Implementation of an Automated Bait Manufacturing and Aerial Delivery System for Landscape-Scale Control of Invasive Brown Tree Snakes
Shane R. Siers, USDA National Wildlife Research Center; William C. Pitt, Smithsonian Conservation Biology Institute; John D. Eisemann, USDA National Wildlife Research Center; Larry Clark, USDA National Wildlife Research Center; Robert J. Gosnell, USDA Wildlife Services

The invasion of Guam by accidentally-introduced Brown Treesnakes has caused substantial ecological damage and economic burden. High snake densities preclude the recovery of Guam's native birds and pose high risk of accidental introduction to other islands, including the Northern Mariana and Hawaiian Islands. Wildlife Services (WS) and its National Wildlife Research Center (NWRC) have demonstrated that treesnake numbers can be greatly reduced by the aerial application of dead neonatal mouse baits treated with 80 mg tablets of acetaminophen into forest canopy. To scale up to landscape-level operations, NWRC partnered with a private engineering firm, Applied Design Corporation, Inc., to develop a system for the automated manufacturing and aerial delivery of baits from a helicopter platform. The system can deliver up to 3,600 baits per payload at a rate of four baits per second. At an application rate of 120

baits/ha, the maximum approved by the EPA, 30 ha of forest can be treated within 15 minutes of firing time, with the system reloaded by a ground crew in two to three minutes. After a lengthy research and development phase, this technology has been transferred to the WS Guam State Office as a tool available to land managers. Operational snake suppression has begun in a 55-hectare snake exclosure, known as the Habitat Management Unit (HMU), with the intention of evaluating the feasibility of Brown Treesnake eradication and providing snake-free habitat for ecological restoration experiments. This transformative technology holds great promise for increased biosecurity and recovery of habitat for Guam's native species.

Optimizing UAS Remote Sensing for Vegetation Data Collection
Chloe Mattilio, University of Wyoming; Dan Tekiela, University of Wyoming

Unmanned Aerial Systems (UAS) are changing the world of remote sensing, giving landowners and land managers the ability to collect cloud-free imagery whenever they like, for a small price tag, and with very small pixel sizes. But unfortunately, few resources currently exist that provide detailed, repeatable methods for collecting high quality UAS imagery, and the many flight and sensor parameters available may confuse and frustrate UAS users. Additionally, parameter settings will need to be modified for new study areas or research goals. I present methods for planning, collecting, mosaicking, and evaluating UAS imagery, including: Timing flights for best light and flight conditions, testing the optimal spatial resolution needed for identifying targets, shutter speed for flight speed and wind conditions, image overlap for collecting seamless images, and some flight planning, logging, and data management tools.

The Use of PrecisionVision UAS for the Control of Noxious Weeds
William "Bill" Reynolds, Leading Edge Aerial Technologies; Dr. Ken Giles, Leading Edge Aerial Technologies

The evolution of UAS for the use of aerial applications in many markets has successfully been integrated into many public and private agencies in the United States. Applications of insecticides, larvacides, adulticides, herbicides and other materials will be presented in this session. The workflow of aerial imagery to aerial applications on noxious weeds using UAS will highlight this presentation. Focused questions and the answers concerning the integration of UAS into the National Airspace (NAS) will be addressed, providing participants a clear understanding of exactly what is required and how to efficient and successfully accomplish requirements.

3:30 - 5:00 p.m.

Aquatic Invasive Species Management

Moderator: Hilary Mosher, Finger Lakes PRISM/Finger Lakes Institute

Full Lake Eradication of Dreissenid Mussels Using Low Doses of Ionic Copper
David Hammond, Ph.D., Earth Science Labs, Inc.; Gavin Ferris, SOLitude Lake Management, Inc.

Zebra and quagga mussels are considered among the most damaging aquatic invasive species to affect North America. There is a widespread perception that "once you have them, you can't get rid of them." Yet there is a growing body of evidence for successful eradications and rapid responses. In 2017 a treatment protocol to eradicate invasive quagga mussels from an entire 30-acre lake in Pennsylvania was designed and implemented. The treatment consisted of 3 separate applications of a liquid formulation of ionic copper called EarthTec QZ, delivered over a period of 37 days. Mussel mortality was determined through use of caged adult mussels that were suspended at different locations and depths throughout the lake. Mussels began to die within 3 days of the initiation of treatment, particularly in the top 20 feet of the water body. The death of the last caged mussel was confirmed 40 days after the initiation of treatment, in a cage that had been placed at a depth of 30 feet below the surface. Microscopic analysis of plankton tows and visual inspection of the shoreline post-treatment have indicated that all veligers and adults were successfully exterminated. Analysis of eDNA taken in December 2017 and again in July 2018 came back negative for mussel DNA, and plankton tows in July, Aug and Sept 2018 produced no live veligers. One year after treatment the non-target community of zooplankton was found to be rich and diverse. The cumulative sum of copper applied throughout the entire course of treatment totaled 0.44 mg/L – noteworthy because it is less than half the concentration that EPA allows (1.0 mg/L) in a single algaecide treatment. If future monitoring confirms the results observed thus far, this will be the first recorded instance of eradicating quagga mussels from an entire lake.

Early Detection and Eradication Program Needed for Trapa bispinosa, a New Species of Water Chestnut in the Potomac River Watershed
Nancy Rybicki, US Geological Survey

Eurasian water chestnut (*Trapa natans*) has been present in the United States since the 1880s and is a well-known invasive species. A new introduction of a relative of T. natans was discovered in Virginia. It was recognized as new by fruits that have 2 horns in contrast to the 4-horned fruits associated with *T. natans*. This new species was verified in 33 Northern Virginia locations by 2018. To determine its distribution scientists verified the species of any Trapa reported to local herbaria, extension agents, pond managers, and online invasive species databases. The locations and information on the first year of colonization, current size of colonies, recent management efforts, and verification photos of the 2-horned fruit or pink flower were incorporated into the USGS non-indigenous aquatic species database (nas.er.usgs.gov). All the recent reports (2000 to 2018) are in Fairfax and Prince William counties in Virginia. Herbaria specimens showed it was reported in Westmoreland and Stafford counties in Virginia in 1995. Scientists conducting research on this 2-horned type of Trapa have not found this type of Water Chestnut in other states in the NE US. It has only been reported in Virginia and in the Potomac River watershed. By 2019 a study of populations around the world revealed that its name is T. bispinosa Roxb. var. iinumai Nakano, and its DNA and morphology matched samples of this morphotype in Taiwan. Literature review and current data suggest that early detection and rapid response could help manage the distribution and spread of T. bispinosa.

Successful Physical Management of AIS in the Drinking Water Reservoirs Serving Greater Boston, MA

Joy Trahan-Liptak, Massachusetts Department of Conservation and Recreation, Division of Water Supply Protection; John J. Gregoire, Massachusetts Water Resources Authority

Aquatic invasive species have the potential to significantly degrade water quality. The presence and proliferation of these species are therefore a major concern for drinking water suppliers such as the Massachusetts Water Resources Authority (MWRA) which provides drinking water to 2.5+ million people and thousands of industrial users in and around the greater Boston area. The Massachusetts Department of Conservation and Recreation, Division of Water Supply Protection (DWSP) manages the source waters and watersheds including the 1,673-hectare Wachusett Reservoir. Invasive aquatic plant management in this reservoir system was initiated in 2001 following the discovery of Eurasian Milfoil (*Myriophyllum spicatum*) and Fanwort (*Cabomba caroliniana*), due to the threat these plants present to water quality and the reservoir ecosystem. A robust management program has since evolved, coupling extensive monitoring with exclusively physical control methods which have included benthic barriers, diver assisted suction harvesting (DASH), and hand-harvesting. The current methodology involves multiple seasonal rounds of harvesting within a grid system and subsequent checks by a separate quality assurance dive crew and DWSP biologists. This approach has succeeded in 98% reduction in invasive plant density within the management areas and successful recolonization of diverse native species. Additional monitoring includes plant surveys and the creation of plant biovolume maps. Finally, the program also includes additional components such as education, boat and equipment decontamination, exclusion, and a rapid response plan.

European Frog-Bit Calls for Action: How One Small Aquatic Invasive Formed One Large Regional Partnership

Shelby A. Bauer, Huron Pines - Northeast Michigan Cooperative Weed Management Area; Blake C. Cahill, Central Michigan University; Anna K. Monfils, Central Michigan University

European frog-bit (EFB) (Hydrocharsis morsus-ranae L.) is an invasive free-floating aquatic plant of widespread interest and concern among water resource managers. It forms dense floating mats that have the potential to impact the growth and diversity of native macrophytes, invertebrates, and fish and inhibit recreational and commercial use of waterbodies. Michigan management agencies have allocated substantial resources to managing EFB populations, with more resources likely to be needed in the future as it continues to expand in Michigan's coastal wetlands and more recently in inland waters. Despite this widespread interest in managing EFB, much is still unknown about its biology and ecology, impacts, and effective treatment. To identify critical information and resource needs for EFB management and improve coordination among stakeholders, researchers at Central Michigan University (CMU) partnered with decision makers, regional, state and local managers, as well as other researchers across the Midwest to establish the European Frog-Bit Collaborative. An early product of the collaborative was a stakeholder derived Standard Treatment Impact Monitoring Protocol (STIMP) for assessing the response of EFB to management activities within an adaptive management framework. Here we present on the establishment of the EFB Collaborative and highlight a partnership between CMU and on the ground invasive species managers at Huron Pines - the Northeast Michigan Cooperative Weed Management Area, a non-profit organization established to protect, restore, and conserve Michigan's natural resources, to pilot the STIMP in an inland waterbody in Northeast Michigan during the 2019 growing season.

3:30 p.m. - 5:00 p.m.

Invasive Species Identification and Managment- Part II

Moderator: Linda Rohleder, Lower Hudson PRISM / New York-New Jersey Trail Conference

This special workshop will discuss pesticide use and review New York State Part 575 Prohibited and Regulated species including common invasive plants in this region. FIFRA 2(ee) requirements will be covered including allowable and disallowed modifications to the label and the process for requesting at 2(ee) recommendation in NY. The principles of integrated pest management will be covered, and environmentally-sensitive techniques and various equipment and tools that can be used will be discussed. Pesticide applicator CEU credits will be available for NY and surrounding states.

8:30 a.m. - 10:00 a.m.

Regional Collaborations to Integrate Science and Management

Moderator: Caroline Marshner, Cornell University, NYS Hemlock Initiative

Achievements and Challenges in South Africa's Biological Invasion Control Programme
Andrew Wannenburgh and Collen Martheze, Department of Environmental Affairs, South Africa

South Africa's biological invasion control programme simultaneously promotes conservation and poverty relief through biological invasion control projects. We trace the programme's history and review the factors that led to its success. These included a sound scientific grounding, a clear demonstration that the biological invasions are a serious threat to vital and scarce water resources, and a unique opportunity presented by South Africa's transition to democratic government. The programme built on historical precedents for control, and was able to capitalise on a core of dedicated managers that delivered a good-news story, leading to increased funding. The programme has facilitated advances in biological control, raised levels of awareness, enacted legislation, and promoted research.

Get Connected: Lessons Shared from the Pacific Northwest-Garlic Mustard Working Group
Michelle Delepine, West Multnomah Soil Water Conservation District

Garlic mustard (Alliaria petiolata) threatens broad swaths of the United States, including the Northeast, the Midwest and more recently, the Pacific Northwest. Starting in 2014, a self-organized, multi-jurisdictional collaboration called the Pacific Northwest (PNW) Garlic Mustard Working Group has brought together invasive plant managers from across Oregon, Washington, Alaska British Columbia to share observational data, best management practices, prevention techniques, survey methodologies, and outreach strategies. This resulted in developing novel prevention and outreach products, a cross-jurisdictional IPM strategy, regional maps, and a shared understanding of survey gaps and management strategies. The importance of this collaboration is underscored by the lack of scientific research focused on garlic mustard adaptation and dispersal in the Pacific Northwest. Prevention technologies such as developing mobile bootwashing stations will be discussed. The presentation will address landscape-level invasive plant management principles, convey integrated pest management solutions for garlic mustard, and highlight methods for starting a working group to tackle natural resource goals across broad geographies.

The New York State Hemlock Initiative: Integrating Regional Research and Management Strategies in New York
Caroline (Carri) Marschner, NYS Hemlock Initiative, College of Agriculture and Life Sciences

The hemlock woolly adelgid (HWA) is a serious pest threatening eastern and Carolina hemlocks in the eastern United States. New York has more eastern hemlocks than any other state in the Union, and is the third most common tree in the state.

Because HWA spread and decline are slower in New York than they are in southern states, and biocontrol research is progressing, we have an opportunity to combine management to slow the spread of HWA and decline of hemlocks with biocontrol research to save our existing hemlock forests and the genetics of the species in our state. The NYS Hemlock Initiative is working with regional and international HWA programs to develop biocontrol options for this threat to our native hemlock species. Locally, we are combining biological control research, research and releases with outreach on hemlock conservation and management to maximize the opportunities for long-term hemlock conservation in New York.

The Asian Carp Regional Coordinating Committee: A Comprehensive Partnership for Great Lakes Protection
Mike Weimer, U.S. Fish and Wildlife Service

The Asian Carp Regional Coordinating Committee was formed in 2009 to address the growing threat to the Great Lakes from the upstream range expansion of self-sustaining populations of Asian carp established years earlier in the Mississippi River basin. Today, the ACRCC is a bi-national partnership of 28 U.S. and Canadian federal, state, provincial, tribal, and local agencies and organizations with the mission of preventing the introduction and establishment of Asian carp in the Great Lakes. The ACRCC, co-chaired by the U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency, develops an annual Asian Carp Action Plan, a comprehensive defense strategy comprised of early detection, rapid response, prevention, control, and research and technology development actions, with a strong emphasis on reducing risk in the primary pathway of the Illinois Waterway and Chicago Area Waterway System near Chicago. ACRCC partnership actions have helped abate the further expansion of Asian carp toward Lake Michigan. In 2019, significant effort is focused on developing long-term solutions to address potential pathways of Asian carp upstream movement, including lock systems and secondary (temporary hydrologic) interbasin connections; the development and pilot deployment of new fish deterrent systems, including underwater sound and carbon dioxide; targeted mass removal of Asian carp through focused harvest in key locations; the refinement and use of new detection and removal gears; and readiness for rapid response and removal in the event of new detections of Asian carp in upstream locations. For more information on the ACRCC please visit www.asiancarp.us

8:30 - 10:00 a.m.

Public Gardens and Nurseries as Sentinels for Invasive Species

Moderator: Jessica Schuler, The New York Botanical Garden

Weed Wrangle®, a Garden Club of America Stewardship Program in Communities Across the Country
Cayce McAllister, Garden Club of America
In 1992, The Garden Club of America launched a national stewardship program called Partners for Plants. In cooperation with state and federal agencies, Partners for Plants volunteers work to monitor and conserve rare plants, restore native habitats and remove invasive weeds on federal, state and local public lands. Using botanists and other horticultural experts, these programs provide critical assistance to park managers at a time when many public lands lack botanists and other

critical resources. Since the project was launched, Partners for Plants has spawned over 500 projects across the country. One especially successful model is Weed Wrangle®. This project, is a one-day, citywide, volunteer effort to help rescue public parks and green spaces from invasive species through hands-on removal of especially harmful trees, vines and flowering plants while encouraging the replanting of natives. In 2018, Weed Wrangle® partnered with over 110 cities across thirteen states growing from a local effort in Nashville, TN into a sophisticated multi-state volunteer force in only four years. The Garden Club of America believes that partnerships and community collaborations work and sees Weed Wrangle® as an opportunity to connect volunteers with education, eradication and restoration across the country.

Public Gardens as Sentinels: A Project Overview
Clair Ryan, Midwest Invasive Plant Network; Kurt Dreisilker, The Morton Arboretum; Theresa Culley, University of Cincinnati

This overview will describe an on-going, partnership-driven project called Public Gardens as Sentinels Against Invasive Plants (PGSIP). PGSIP is aimed at improving information exchange between public gardens (botanic gardens and arboreta) in order to better identify, control, and communicate with other key stakeholders about invasive plants. As collectors of plant species from around the world and as institutions focused on the conservation of plant biodiversity, public gardens have a unique ability and perhaps a responsibility to observe uncommon plants for their potential to spread and potentially invade native habitats. The presentation will include a brief recap of past efforts that set the stage for the current project and will discuss PGSIP progress to date, including investigation of potential methods and platforms for improving inter-garden sharing of observational data on plants that escape cultivation and the development of recommendations about how gardens should use their own observations to list and categorize escaping species. Results from various stakeholder surveys and polls will also be presented. These data indicate actions that are already being undertaken by public gardens in relation to invasive plants and opportunities for improvement. A poll of green industry professionals indicates how information supplied by public gardens might influence industry choices and result in fewer plant species with high risk of becoming invasive from being developed and marketed.

Public Garden Horticulture, Education, and Outreach Preventing Future Invasions
Jessica A. Schuler, The New York Botanical Garden; Todd Forrest, The New York Botanical Garden

The Thain Family Forest is one of the main reasons The New York Botanical Garden (NYBG) was established on its current, 250 acres in Bronx Park, Bronx, NY in 1895. NYBG is an advocate for the plant kingdom and does this through three key programmatic areas: science, horticulture, and science. Throughout NYBG's history plants from similar climates from all over the world have been grown in the 200 acres of gardens and living collections surrounding the Thain Family Forest, over a century later, many have become problematic in our region. NYBG is one of many public gardens that has been witness to this phenomenon and is working nationally, as part of Public Gardens as Sentinels for Invasive Plants (PGSIP), to take a proactive approach to learn from the past. Moving

beyond the St. Louis Declaration Voluntary Code of Conduct on Invasive Species for Botanic Gardens and Arboreta (2002), public gardens are establishing Invasive Species Policies, collecting and sharing data to prevent future invasions. This talk will be a case study as to how NYBG has learned from invasive species monitoring and management in the Thain Family Forest and established institutional changes to education, outreach, scientific research, and horticulture. Public gardens have the opportunity to take a leadership role in identifying and responding to plants escaping from cultivation by collaborating to share information and develop solutions.

The Evolution of Systems Approach to Nursery Certification and Plant Sentry™
Thomas Buechel, Nature Hills Nursery

The Green industry is thinking big to squash present and future invasive pest, disease, and invasive plant problems. The cooperative efforts of the industry, including organizations and regulation by use of systems approaches, are vastly improving odds to fend off future invasive problems and eliminate old ones. The evolution of SANC (Systems Approach to Nursery Certification) and Plant Sentry™ is changing the game on how we grow and ship plant product. These new actions are bringing everyone together to focus on one common goal: minimizing, reducing, and eliminating the spread of serious pests, disease, and invasive species. This engagement will certify that you have learned the tactical approach necessary to triumph over the next encounter you may have with pests, disease, and invasive species.

8:30 a.m. - 10:00 a.m.

Engaging Industry in Invasive Species Prevention, Monitoring and Management

Moderator: Sue Staniforth, Invasive Species Council of BC

Invasive Vegetation and the Renewable Energy Industry
Tiffany Clay, Environmental Design & Research

To meet the New York State goal of generating 50% of energy with renewable sources by 2030, development of solar and wind farms throughout the state has been growing. These facilities could potentially have a large impact on the surrounding vegetative communities. By analyzing select renewable energy projects in New York, we illustrate how invasive species requirements have changed over the years to become more comprehensive, and therefore, more stringent. We have developed a methodology to monitor invasive species alongside the New York State Department of Environmental Conservation. This includes the drafting of an invasive species control plan, followed by a baseline survey implemented within six months of the commencement of construction, and ending with two years of post-construction surveys. We conducted a case study on Jericho Rise Wind Farm to compare pre-construction baseline invasive species surveys, with post-construction surveys conducted one and three years after construction. Construction of the wind farm involved soil disturbance (approximately 138 acres) and vegetation clearing (approximately 483 acres). Certificate conditions require a 0% net increase in the aerial coverage of invasive species compared to the baseline survey. Preliminary results show a 13% increase

in invasive species from the 2016 baseline survey (1.94 acres of invasive plant cover) to the first post-construction survey (2.19 acres). The next post-construction survey is scheduled for the growing season of 2019.

Best Practices for Invasive Species Prevention: Training BC's Industry Professionals
Sue Staniforth, Invasive Species Council of BC

The Invasive Species Council of BC has an extensive history of connecting current scientific research to on-the-ground action through its development and extension of innovative training programs for an array of professionals. Invasive species are the second biggest threat to global biodiversity after habitat loss, and cost economies billions of dollars annually. Research has shown that industry, land management activities and outdoor recreation all act as vectors of spread. The Council has developed best management practices and training workshops in close consultation with key industry groups, and offers training programs to a range of land managers and field workers, including forestry, transportation, oil and gas, parks, mining, and realtors. These hands-on, practical and relevant training programs have been delivered in person across the province, and there is an increasing demand for expanded programming and new audiences. Although in-person training is still the most popular format, online course options are being requested frequently, as a flexible, accessible and adaptable tool. As of 2018, the ISCBC has developed online training programs for provincial park employees, regional government workers and Real Estate professionals. In 2019, the Council partnered with the Sustainable Forestry Initiative to develop an online course for forest practitioners. By exploring vectors of spread, impacts, improved management strategies through best practices, and enriching participants' knowledge of resource management through an invasive species lens, the ISCBC is a leader in connecting science with relevant action that makes a difference on the ground.

The Economy & The Environment...Two Sides of the Same Coin
Thomas E. Williams, Paradox Consulting Group

The Economy and the Environment…Two Sides of the Same Coin -Tom Williams Environmental and economic factions are often at odds in today's world…some of those wishing to protect and preserve our natural world believe that economic growth is detrimental to their goals. Well, I submit that these two worthy goals, are in fact compatible and neither can be successful without the other. Nowhere is this more evident, than in the battle to prevent the spread of invasive species. New York State is ground zero for invasive species in the United States…we have the highest concentration of both aquatic and terrestrial pests found anywhere. New York is a major gateway for invasive species…our proximity to the Great Lakes, the St. Lawrence and the Atlantic Ocean via the Hudson River puts us in the cross hairs. The world-wide commerce that comes to us, combined with the vast numbers of recreational tourists has stretched our capacity to keep up and prevent the spread of the multitude of invasive threats we face. Since a high percentage of invasive species make their way north from downstate, working to increase education and awareness through creative business partnerships is a critical component to prevention. Private businesses both large and small, along with regional business leaders, chambers, alliances, associations and others are the key to helping to raise awareness. Working together with these outreach partners can make both sides of the coin successful.

Bid Specifications, the Good, the Bad, and the Ugly
David Goerig, Davey Resource Group Inc.

Invasive vegetation control contractors perform difficult work in natural areas. Resources that are allocated for the control of invasive vegetation in natural areas should be used efficiently. Much of the work they perform is awarded through the competitive bidding process. Organizations release Request for Proposals that state the scope of work for the project. Developing these scopes of work can be challenging. Carefully identified bid specifications can go along way toward effectively managing these alien plants on the property you manage. Over the years, Davey Resource Group has successfully performed hundreds of contracts involving land management activities. This presentation will review some of the most effective bid specification language relating to writing good scopes of work for invasive vegetation management. Topics will cover pre-proposal considerations to help prioritize the land for an invasive vegetation control project. Considerations such as floristic assessments, and site evaluation will be shared. Proposal language dealing with invasive plant colony densities, forest floor debris, and control performance targets will be discussed. We will also cover the results that can occur when scopes are put together without careful thought or poorly written. Examples of actual bid specifications Davey Resource Group has worked under will be shared.

8:30 a.m. - 10:00 a.m.

How do We Implement Climate-Smart Invasive Species Management? Part I

Moderator: Bethany Bradley, UMass-Amherst

This workshop, led by the Northeast Regional Invasive Species & Climate Change (RISCC) Management Network, will focus on strategies for improving proactive invasive species management in light of climate change. We will discuss ways to build stronger networks and break down barriers to cross-jurisdictional collaboration. We will also explore case studies of interactions between invasion and climate change to develop ideas of future management responses.

10:30 a.m. - 12:00 p.m.

Restoration

Moderator: Todd Boller, Fillmore County, Nebraska

Facilitating Native Plant Material Development for Use in Invasive Species Management
Edward Toth, Mid Atlantic Regional Seed Bank

Wise use of genetically appropriate, local native plant material is a key component of successful invasive species management. The Mid Atlantic Regional Seed Bank (MARSB) has made thousands of collections for long-term conservation purposes and active, working collections for use on restoration projects

across 8 states. Utilization of locally sourced native plant material increases the long term sustainability of project sites, ensures full integration with the local ecosystem, and creates more resilient natural communities better able to resist invasive species.

Reconsidering Restoration and Stewardship
Michael Bald, Got Weeds?

Considering the frequency with which they appear in natural resource reports and landscape management proposals, one might think tremendous clarity accompanied the terms Restoration and Stewardship; this is in fact not the case. Whether they be conservation commissioners, land trust coordinators, watershed group leaders, or invasive species managers, people see and understand those two words from unique viewpoints and backgrounds. The resultant differences in interpretation impact plan design, project timeframes, implementation, and overall results. This is something of a problem, yet it also presents an opportunity to reconsider our approaches and refine initial project planning. This re-look is critical because everything hinges on the vision: the goals, the follow-on tasks, costs, the progress benchmarks… without a clear mission those charged with implementation cannot deliver precise outcomes. What is restoration, and what is stewardship? Management projects are site-specific, but how are restoration and stewardship refined to fit particular visions and settings and timeframes? It is vital to recognize how depleted and dis-functional landscapes have become. The work of recovery is then better viewed as site rehabilitations; one summary embracing a soil-health perspective goes as follows: We rehabilitate landscapes via regenerative management to restore ecological function and balance. Restoration finds its place in a larger equation with terms that lay out principles and define the vision. Landscapes are intricate puzzles; Stewardship is the umbrella under which actions or pieces assemble. This presentation pursues that notion of rehabilitation and the stewardship umbrella as an alternative mindset; audience participation is entirely welcome.

An Integrated Approach to Invasive Plant Management and Habitat Restoration for the Threatened American Hart's-tongue Fern
Michael Serviss, New York State Office of Parks, Recreation, and Historic Preservation; Thomas Hughes, New York State Office of Parks, Recreation, and Historic Preservation

The New York State Office of Parks, Recreation, and Historic Preservation (OPRHP) has successfully implemented an adaptive and integrated invasive species management approach at Clark Reservation State Park, Jamesville, NY, with a focus on habitat restoration for the Federally and State listed as Threatened (S1, New York Natural Heritage Program) fern species Asplenium scolopendrium var. americanum (American hart's-tongue fern, AHTF). The vining invasive perennial Vincetoxicum rossicum (pale swallow-wort, PSW) has been methodically and surgically targeted. Manual removal of over 80,000 PSW from in and around AHTF habitat and a seasonal cutting regime have all but eliminated smaller populations from the park and reduced flower and seed production since 2014. In addition, limited annual applications of foliar herbicide have greatly reduced or eliminated the densest source populations of PSW where manual removals were not effective. Sustained

success with manual removals has been achieved through the use of OPRHP's seasonal crews, including members of the Invasive Species Management Strike Team and Stewards from the Friends of Recreation, Conservation, and Environmental Stewardship (FORCES) program: parks.ny.gov/environment/forces.aspx. Manual removal and cutting of over 85,000 additional invasive plants since 2014, including Alliaria petiolata, Hesperis matronalis, Lythrum salicaria, Lonicera spp., and Berberis spp. have further mitigated the threat that invasive plants pose to critical AHTF habitat. A recently developed cut and cover management technique for Rhamnus cathartica has been adapted as of November, 2018 to address the abundance of the invasive tree throughout the park. Data collected from the Rhamnus cathartica management pilot program, including efficacy results, will also be presented.

Growing a Plant Materials Program: Providing Specialized Plant Materials for Restoration in New York State Parks
Brigitte Wierzbicki, NYS Office of Parks, Recreation and Historic Preservation; David Rutherford, NYS Office of Parks, Recreation and Historic Preservation

The Plant Materials Program provides native, regionally appropriate seed and plants for environmental stewardship projects in New York State Parks. The program works directly with Parks land managers- often on projects that require re-planting after invasive species removal. The program fulfills a need for specialized plant materials, with a focus on species diversity and localized genetics. This presentation will highlight best practices used for sustainable plant materials collection, logistics of program operation, staffing and budgetary considerations, and restoration project highlights.

10:30 a.m. - 12:00 p.m.

Outreach and Citizen Science

Moderator: Emma Antolos, NY Department of Environmental Conservation

Citizen Scientists Protect Against Invasive Species with a New Mobile App "Wild Spotter"
Rachel L. Carroll, University of Georgia-Center for Invasive Species and Ecosystem Health; Rebekah D. Wallace, University of Georgia-Center for Invasive Species and Ecosystem Health; Charles T. Bargeron, University of Georgia-Center for Invasive Species and Ecosystem Health; Michael Ielmini, USDA Forest Service; Pat Conzemius, Wildlife Forever

The University of Georgia – Center for Invasive Species and Ecosystem Health and Wildlife Forever has partnered with the USDA Forest Service to engage and empower citizen science volunteers to provide critical scientific support with a new program to better address the expanding threat of aquatic and terrestrial invasive species. "Wild Spotter" is a nationwide effort to complete a comprehensive map and survey of prioritized aquatic and terrestrial invasive species in America's wild places. Through a variety of local, regional, and nationwide invasive species awareness and reporting campaigns, outdoor recreationalists have been increasingly exposed to the invasive species issue. This diverse group can participate in Wild Spotter as volunteers to help expand local capacity and collect accurate data of high-risk populations of invasive species.

Field inventorying and mapping activities are accomplished by citizen science volunteers that efficiently collect information on invasive species occurrences through the Wild Spotter mobile application. For certain prioritized invasive species, techniques such as traps or samples (i.e., water or soil samples) can be used, and the appropriate equipment, supplies, and training is provided to the citizen scientists. To conclude, the citizen science project, Wild Spotter, aims to empower unique audiences, including individuals or groups, to have a diverse array of the visiting public and local communities mapping invasive species to provide the U.S. Forest Service and resource managers a broad cross section of data. The information gathered quantifies the extent and impact of all targeted invasive species to improve effectiveness at preventing, controlling, and eradicating invasive species.

Invasive Species Curriculum to Enhance STEM Learning in New York State K-12 Classrooms
Emily Caboot, SUNY Albany; Emma Antolos, NY Department of Environmental Conservation

In 2016, the New York State Department of Environmental Conservation (NYSDEC) released their Strategic Plan for Invasive Species Education and Outreach. This plan consists of six objectives focusing on education and outreach statewide. Specifically, objective #3 states, "develop and provide invasive species curriculum units aligned to New York's science learning standards." A workgroup was created by the NYSDEC to develop a unit curriculum leading middle school students through terrestrial plant invasive species research to fulfill objective #3. This workgroup was comprised of invasive species professionals as well as education professionals. The curriculum was developed in the summer of 2018; it includes nine forty-minute lessons with teacher tips, supplemental worksheets, and a PowerPoint for teachers to modify for their classrooms. This curriculum is also aligned to the Next Generation Science Standards (NGSS) which will begin implementation into all public school classrooms starting in the 2019 – 2020 school year. During the unit, student research groups collect data using the citizen science app, iMapinvasives, along with field forms to record other information, not recorded in the app, to be analyzed by the student groups. This was one of the main focuses of the unit to give students an authentic experience using the scientific method to learn about invasive species. Two workshops have been held within New York State with teachers as well as other types of educators, like environmental educators and stewards. Additional workshops are being planned throughout New York State to distribute the curriculum to educators.

Depoliticizing Invasive Species Messaging
Carri Marschner, Finger Lakes Partnership for Regional Invasive Species Management (PRISM) Working Group; Hilary Mosher, Finger Lakes Partnership for Regional Invasive Species Management (PRISM)

In light of the ongoing conflation of invasive species work and xenophobia as well as the misuse of invasive species messaging by social media users, invasive species programming is reframing and rebranding the message to disentangle it from these other uses. Invasive species messaging carrying other negative connotations, may alienate those who might otherwise support and benefit from the work of invasive

species managers. Further, outreach materials, when seen outside the context in which they are originally distributed, may be interpreted in a negative light. Strategies for clarifying invasive species messaging are being developed, and benefit greatly from group dialogue in which participants share their experiences and collaborate to develop a clear message. This presentation will discuss the current thread of messaging around invasive species from various platforms and potential remedies for clarifying invasive species messaging that can be utilized with all members of the public.

Overcoming Barriers to Expanding Invasive Plant Management in Woodlands.
Mark Renz, University of Wisconsin-Madison; Anne Pearce, University of Wisconsin Madison

Research suggests that private woodland owners, while interested in managing invasive species, do not have the knowledge or expertise to effectively manage this threat. Over two years we have engaged fourteen private woodland owners in Wisconsin's Kickapoo River watershed and attempted to overcome this knowledge/expertise gap. Limitations to increased control by participants included their ability to identify invasive plants, time to implement control methods and knowledge of control techniques. Landowner properties were surveyed and a map along with a list of prioritized management activities and resources to aid in the selection of appropriate management method(s) were provided. Landowners also attended a workshop that trained individuals on invasive plant identification and management methods. Participants are currently being surveyed to determine how these engagement activities influenced future management. Initial results suggest an increase in knowledge and intent to increase management as 80% that attended workshops intended to use information to enhance management activities. Surveys one year after participation in this program will determine the changes in practices (type and area) and remaining barriers. This insight will help in expanding this effort to other regions within and beyond Wisconsin.

10:30 a.m. - 12:00 p.m.

Integrated Pest Management and Invasive Species

Moderator: Deborah Grantham, Northeastern Integrated Pest Management Center

Strengthening Invasive Species Management with IPM Strategies
Deborah G. Grantham, Northeastern Integrated Pest Management Center; David Earl Lane, Northeastern Integrated Pest Management Center

Integrated Pest Management (IPM) is a science-based, adaptive management process that requires geographically broad and long-term collaborations to monitor for new pests and prioritize management to minimize risks to human, economic, and environmental health. For example, the USDA put forth an approach to IPM which emphasizes Prevention, Avoidance, Monitoring, and Suppression (PAMS). Prevention of new pest invasions is the first and most effective stage of IPM, but prevention is only effective when the pests are properly identified and prioritized according to the level of risk. The arrival of invasive

species (IS) often disrupts established IPM programs, therefore the National IPM Road Map emphasizes the importance of early detection and prioritized responses. Because IS are currently estimated to cause $140 billion in economic losses annually, systems such as the Early Detection and Distribution Mapping System (EDDMapS) along with regionally coordinated IPM programs are of critical importance. Furthermore, some species act as vectors of parasites, viruses and bacteria, potentially leading to the spread of human illnesses, such as Zika and Lyme disease. Climate change introduces new challenges because some species' ranges are shifting due to warming temperatures and changes in the seasons. In response to these challenges, The National Invasive Species Council and the USDA's Regional IPM Centers have an opportunity to ensure that federal and state programs are well coordinated, effective, and cost efficient. Correspondingly, this presentation will use applications of IPM to illustrate how IPM strategies can improve the prioritization of risks and responses to facilitate more effective IS management.

Many Tools to Address Invasive Issues: IPM and the Asian longhorned Tick
Joellen Lampman, New York State Integrated Pest Management Program

Successful management of invasive species is complex and requires the multifaceted approach of Integrated Pest Management (IPM). Using a broad range of tools, we can identify, understand the biology of, and monitor a species. Then we can evaluate all possible methods of control to determine successful combinations that will manage the pest while reducing impacts to the environment and human health. The presentation will cover the basics of IPM, illustrated with the newly discovered Asian longhorned tick. How does what we currently know about its biology and behavior help us in determining how to manage the pest and its damage? Where can we find cooperators with the research we need? Who do we need to educate to put the management strategies in place? What is the best way to get the word out? We don't have all the answers yet, but we can consider methods and practices.

Hummingbird Enrichment Encourages Predation of Spotted Wing Drosophila in Berry Plantings and Reduces Pest Prevalence
Juliet Carroll, Cornell University; Greg Loeb, Cornell University; Courtney Weber, Cornell University Laura McDermott, Cornell Cooperative Extension

Spotted wing drosophila (SWD) can destroy unprotected, susceptible fruit crops. SWD is an invasive insect from East Asia, which causes severe damage to berry crops. Without routine insecticide use, SWD causes upwards of 80% crop loss. Many berry growers in New York State are averse to routinely spraying insecticides, making it challenging to grow a clean crop before SWD infestation levels cause it to be abandoned. Hummingbirds can eat up to 2,000 small insects per day. We deployed 25 hummingbird feeders per acre, observed hummingbird behavior, and monitored SWD in a raspberry planting during four growing seasons. The observed hummingbirds spent the majority of their time in the raspberry planting. Hummingbird enrichment showed a significant reduction in SWD caught in traps in the raspberry planting when numbers were moderate, with less (40) caught

on average in the hummingbird feeder zone compared to (97) caught on average in the no-feeder zone, a 59% reduction. We set up two grower demonstration plots, one in an organic blueberry planting in Western NY and one in low-input raspberry in Eastern NY where growers found it feasible to deploy hummingbird feeders to encourage predation. Our results showed that hummingbirds spend time in raspberries, growers are willing to use this technique, and enriching a fruit planting with insect predatory hummingbirds shows promise as an alternative technique to routine insecticide use for the management of SWD.

Agricultural Invasive Species Programs in New York including: Golden Nematode (Globodera rostochiensis), European Cherry Fruit Fly (Rhagoletis cerasi), and Plum Pox virus, and more.
Thom Allgaier, NYSDAM; J. Mahoney, NYSDAM

The objective of this session would be to highlight the state-federal collaboration in eradication efforts for this often-overlooked invasive pest. Being one of the early programs targeting an invasive pest that was introduced at the close of WW1. Also, one that relies on science to eliminate the populations of this pest. Fumigation to genetic modification has allowed for an 88% reduction in regulated acreage. This program has persistently demonstrated the mission related goals and objectives of state and national agricultural concerns and those of other stakeholders. Potato Cyst Nematodes are among the most serious threats to the production of potatoes worldwide. The Golden Nematode (Globodera rostochiensis) is a very serious pest in Europe. Canada, Mexico and the United States all have imposed domestic and foreign quarantine restrictions to prevent artificial spread of the golden nematode from known infested areas. GN was discovered on Long Island in the 1940's and was spread into the Finger Lakes region through the movement of farm equipment in the 1960s. This is the only known infestation of GN in the US. New York State Department of Ag and Markets and USDA APHIS have successfully maintained a program of containment for over 40 years. Containment has involved quarantine of not only "infested" fields but also "exposed" fields. This has resulted in significant acreage being subject to quarantine, crop rotation practices, and sanitation of equipment and soil surveys. Many of these "exposed" fields have been demonstrated through survey to never have had GN present. The program has some 70 years' worth of survey and rotational records that are in various formats and largely unavailable or rather inaccessible for day to day operations. With the introduction of the NY 140 genetically modified potato variety that is resistant to Race R01 and crop rotation for areas infested with race RO2 of GN the peak acreage of 1,102,131 in 2010 has been dramatically reduced to 186,534 acres currently. Most eradication for plant pests is declared after 3 negative survey cycles. This pest requires 30 years of negative survey results. The final phase of the project, and the ultimate goal is to reduce the existing quarantine boundary to the smallest possible area and meet or exceed the 90% deregulation goal. This phase began in 2015 with the reduction of regulated acreage in Nassau and Western Suffolk and continued into Eastern Suffolk where a township by township approach is being employed. In early 2018, over 77,821 acres were removed in the Townships of Southampton and Shelter Island with two fields in East Hampton and Southold being removed from regulation as they met the

30-year requirement with negative soil samples. All exposed fields must be sampled by soil probe or trowel at a minimum of Method A (20lbs of soil per acre) as per the PCN guidelines with negative results returned before being released. There are over an estimated 100 fields with exposed status in the Southold township. Prior to sampling, a review of the survey history and exposure will take place to determine if additional soil sampling is necessary. Once all sampling is complete, new quarantine language will be drafted to decrease the current area and reworded to simplify deregulation of individual fields in future years. The program will continue the greenhouse deregulation bioassay using the protocols as outlined in the 2014 Canada/United States Guidelines on Surveillance and Phytosanitary Actions for Potato Cyst Nematodes (PCN Guidelines) as an alternate means of planting consecutive susceptible host crops over several years. The program will also continue the research in assessing the response of the Ro2 field population to resistant clone NY140. The success of GN (Globodera rostochiensis) quarantine program in New York has been adversely affected due to the emergence of Ro2, a virulent population that can reproduce on Ro1 resistant potato varieties. Since the GN find in New York State originated from a single source introduction, it can be expected that additional fields infested with Ro2 will continue to surface. Currently there is NOT a single commercially acceptable potato variety with resistance to Ro2. Therefore, the development of Ro2 resistant potato varieties is urgently needed for effective control of Ro2 in NY, which is critical for protecting the viability of the U.S. potato industry. Wild potato species represents a rich source of nature resistance to plant pathogens. Our previous study indicated that the wild species Solanum vernei is a good source to look for resistance against Ro2. The identification of new potato germplasm resistant to Ro2 may help discover new resistance genes and allow breeders to incorporate multiple sources of Ro2 resistance in U.S. potato varieties. Cornell will continue to evaluate S. vernei accessions to identify new potato germplasm resistant to Ro2.

10:30 a.m. - 12:00 p.m.

How do We Implement ClimateSmart Invasive Species Management? Part II

Moderator: Toni Lyn Morelli, U.S.Geological Survey Northeast Climate Adaptation Science Center
This workshop, led by the Northeast Regional Invasive Species Climate Change (RISCC) Management Network, will focus on strategies for improving proactive invasive species management in light of climate change. We will discuss ways to build stronger networks and break down barriers to cross-jurisdictional collaboration. We will also explore case studies of interactions between invasion and climate change to develop ideas of future management responses.