NCDA&CS
Plant Industry Division
Annual Report
2019

Steve Troxler
Commissioner of Agriculture

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NORTH CAROLINA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

Mission Statement

The mission of the North Carolina Department of Agriculture and Consumer Services is to provide services that promote and improve agriculture, agribusiness, and forests; protect consumers and businesses; and conserve farmland and natural resources for the prosperity of all North Carolinians.

Steve Troxler

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Scott Tyson

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Jose Calderon

John Carter

Jeffrey Turner

Faylene Whitaker

Doug Boyd

Franklin (Ray) Allen

Bob Sutter

CONTACT INFORMATION

Commissioner and Executive Staff

Steve Troxler	Commissioner	(919) 707-3000
N. David Smith	Chief Deputy Commissioner	(919) 707-3033
Joe Reardon	Assistant Commissioner	(919) 707-3009
Dr. Sandy Stewart	Assistant Commissioner	(919) 707-3015
Scott Bissette	Assistant Commissioner	(919) 857-4844

Division Director and Administrative Staff

Phil Wilson	Division Director	(919) 707-3732
Joy Goforth	Plant Protection Section Administrator	(919)707-3753
Brian Bowers	Seed & Fertilizer Section Administrator	(919) 707-3735
Elizabeth Heath	Administrative Officer II	(919) 707-3757

Plant Industry Division

Plant Industry Division Web Site: http://www.ncagr.gov/plantindustry/

Facilities

Plant Industry Division-Administrative Offices and NC Seed Laboratory

Physical Address: 216 West Jones Street, Raleigh, NC 27603

Support Operations

Physical Address: 1013 Blair Drive, Raleigh, NC 27603

Biological Control Services

Physical Address: 350 East Chatham Street, Cary, NC 27511

Witchweed Program Facilities

Physical Address: 450 Smith Circle, Room 108, Elizabethtown, NC 28337

Physical Address: Agri-Expo Center, 301 Mountain Dr., Rm 204, Fayetteville, NC 28306

Physical Address: OP Owens Agri. Center, 405 Country Club Dr., Lumberton, NC 28358

MAILING ADDRESS FOR ALL: 1060 Mail Service Center, Raleigh, NC 27699-1060

Industrial Hemp Pilot Program

Historical Perspective & Current Outlook

The Industrial Hemp Pilot Program began after the passing of the 2014 Federal "Farm Bill" that granted States and Tribes, in conjunction with Universities, the ability to acquire and begin cultivating industrial hemp so long as cultivation was coupled with a research objective. The State of North Carolina established an Industrial Hemp Commission that drafted and passed a set of rules to govern our pilot program. Cultivation of industrial hemp began in July of 2017. At this time, we have had our program for 3 full years of cultivation. In that time the federal government also passed the Agricultural Act of 2018 otherwise known as the 2018 Farm Bill which deregulated Industrial Hemp from the schedule I narcotics list by setting a limit on delta-9 THC of 0.3% by dry weight. This removed industrial hemp from DEA oversight and placed it in the hands of the USDA. It also made industrial hemp a legal agricultural commodity in the United States. The 2018 Farm Bill also set a timeline for the USDA to generate a set of rules that would be the minimum standard for all states to govern industrial hemp cultivation after this "pilot program" phase. Those rules were released at the end of October 2019 and officially entered the federal register on October 31st, 2019. From that date, states have exactly one year to accept the USDA rule as written, to cede control of hemp cultivation to the USDA, or to submit for approval by the Secretary of Agriculture a custom state hemp plan. North Carolina has not yet chosen which pathway they intend to pursue.

Applications & Licensing

The first round of approved application for the North Carolina Industrial Hemp Pilot Program were approved on March 13th, 2017 for 4 applicants one of whom was denied due to an incomplete application resulting from not being a bona fide farmer. Since the initial applications were approved an estimated 2500 applications have been submitted to the NCDA for approval. Duplicate licenses, applications that are incomplete, applications submitted in paper, and other reasons account for the disparity between applications received and approved license holders. Despite several hundred applications never reaching licensure we have seen dramatic increases in license holder numbers each year of the program.

At the conclusion of 2017 the North Carolina Industrial Hemp Program had approximately 124 licensed growers. By the end of 2018 the NC Industrial Hemp Program had 438 licensed industrial hemp growers. This was a 353% increase in license holders from 2017. At the end of 2019 the NC Industrial hemp pilot program had 1,393 licensed growers. This marked a 318% increase in license holders from 2018. Due to an unstable regulatory environment as a result of USDA regulation, Senate Bill 315 and others, factors, it is likely that there will be a marked decrease in the rate of growth for program participants in the year 2020 and likely 2021 as well.

Expansion of Acreage & Greenhouse

Acreage and greenhouse house space has expanded as rapidly as the number of license holders. At the conclusion of 2017 we had approximately 2,236.87 licensed acres and 242,554 licensed greenhouse sq. ft. At the end of 2018 we had approximately 6,077.08 licensed acres and 2,524,422 licensed greenhouse sq. ft. This represents a 271% increase in acres and a monumental 1040% increase in greenhouse sq. ft. At the conclusion of 2019 we had approximately 17,527.89 licensed acres and 6,819,491.59 licensed greenhouse sq. ft. This equates to a 288% increase in acreage and a 270% increase in greenhouse sq. ft. Due to an unstable regulatory environment as a result of USDA regulation, Senate Bill 315 and others, factors, it is likely that there will be a marked decrease in the rate of growth for program acreage and greenhouse sq. ft. in the year 2020 and likely 2021 as well.

Compliance Testing

Of all the interactions that the NCDA&CS has with NC Industrial Hemp Pilot Program participants compliance testing is by far the most important. The Seed & Fertilizer staff of Plant Industry Division represents the front lines of making sure that cannabis grown in the state of North Carolina complies with the federal definition of industrial hemp thereby making it legal and marketable. The Federal government defines hemp as *Cannabis sativa* L. with a delta-9 tetrahydrocannabinol concentration of no more than 0.3% by dry weight. North Carolina has, since the inception of the program, tested using GC-FID which effectively decarboxylates THCA into delta-9 THC during the testing process resulting in what is often referred to as a "Total THC" measurement of delta-9. While there is much debate about whether this is correct, or even within the language of the law, the USDA has made it abundantly clear that this is the expectation for compliance testing. North Carolina, among other states, has also allowed for scientific and testing variance rounding any result below 0.4% but above 0.3% down to 0.3%.

In year one of our program, 2017, we collected approximately 135 regulatory/compliance tests. Of those tests 14 failed by exceeding the 0.3% threshold. This is an approximate fail rate of 10% which is well within the variation of testing data seen from other states. In the year 2018, year two, we collected approximately 437 tests of which 47 failed. This is another approximate fail rate of 10%. The number of tests collected increased by 323% largely due to the 353% increase in license holders. In the most recent year, 2019, we collected 2247 samples of which 235 failed. This is also an approximate fail rate of 10% which was as much as 4 fold less than other states in the year 2019. The number of compliance tests pulled in 2019 was 514% greater than that of 2018. Specialists pulled between 213 and 302 samples in 2019. We more than maxed out our capacity to pull samples in 2019 resulting in large quantities of worked overtime for all employees.

If the USDA maintains that samples must be pulled within 15 days of harvest and that all plots must be sampled, then it will be impossible to meet those requirements with our current labor force. Similarly, the laboratories who run our samples would not be able to keep up with the workload resulting in large delays in result delivery times. Farmers would then be required to harvest without knowing their results forcing them to invest time and labor into a crop that may or may not be marketable. The USDA has also imposed more stringent testing standards indicating that allowances as high as 0.39 will likely not be possible and that test of 0.5% or higher would result in a negligent violation. Three negligent violations in a 5 year period would result in a minimum of 5 year suspension of the licensee's grower license. It also seems that no retesting will

be allowed. These protocols are expected to increase fail rates for farmers and more substantial and widespread losses for program participants.

Registered Processors

As a part of the rules drafted by the Industrial Hemp Commission it is required that processors of industrial hemp be registered with the Industrial Hemp Commission and that on an annual basis they must report the type and weight of the industrial hemp material that they processed for that year.

At the conclusion of 2017 approximately 75 processors were registered in the state of North Carolina. By the end of 2018 that number was around 322. As of the end of 2019 that number is around 984 processors. This marks an increase of 429% from 2017 to 2018 and an increase of 305% increase from 2018-2019.

The large increases in processors have not necessarily led to more marketing opportunities for farmers for several reasons. The primary reason being that a large percentage of the registered processors are retail or other establishments that make final products, repackage, or do some other form of secondary/tertiary processing that has little impact on the farmer and ultimately have registered as an insurance policy against police raids, product confiscation, etc. Another reason that processors are having little impact on farmer profit is that many processors do not have the money to pay farmers after they invest in the equipment necessary to do extractions and further have no downstream buyers to move the oil or other product along the manufacturing chain. The growers and the industry have advanced well ahead of the law and the market in this case and this is a keystone issue that will need to be solved to really move the industry forward.

Plant Protection Section

Apiary Inspection Program

To protect the health of our honey bee industry, permits to sell bees are required for anyone wishing to sell queens, package bees, nucs, or hives. In 2019, 121 permits were issued to sellers. To obtain a permit, bees must be inspected, and the producers agree to comply with standards designed to maintain healthy colonies. Beekeepers are strongly encouraged to buy only from permitted dealers to avoid buying unhealthy or Africanized honey bees.

One of our inspectors, Will Hicks, retired this year after 20 years of employment with the program. Our inspectors' regions have been adjusted and reassigned with our new region being in the southeastern portion of the state. Another inspector, John Harris, was hired to fill this area where the territories were rearranged. He is working in the territory surrounding Bladen County.

Our inspectors were not involved this year in the *Tropilaelaps* and honey bee virus survey. We were, however, involved in a pilot program to intercept potentially harmful exotic wasps and bees. The purpose of this program is focused on intercepting the threat that these invasive species might have to our native and domesticated bees, as well as to other organisms.

One of the most devastating and difficult to control bee diseases is American foulbrood (AFB). We are encouraged to see that our AFB incidence remains below 1%. We have maintained the Special Local Need 24(c) registration for the ethylene oxide (EtO) fumigation chamber as well as a source of the EtO formulation. Our ethylene oxide chamber, which is celebrating its fiftieth anniversary, is undergoing refurbishment so that we will continue to be able to provide decontamination services.

The mite *Varroa destructor* persists as a major threat to the beekeeping industry in NC and is probably a contributing factor to general poor health or mortality of bee colonies. Several new miticides have been registered; however, the mites have developed resistance to some of these materials in short order and rendered these products ineffective. Currently, the list of registered products for *Varroa* control in North Carolina includes Apistan®, CheckMite+®, Api-Life Var®, Apiguard®, Mite-Away Quick Strips®, Apivar®, oxalic acid (specifically labeled for bees), and HopGuard®. All of the aforementioned products are listed in North Carolina as Section 3 general use pesticides. Although chemical treatment of mites may be necessary, some miticides have been demonstrated to have adverse effects on bees. The growing use of unregistered materials may have adverse effects on honey bee health and may not be efficacious in controlling mites. This and, in some cases, the improper use of antibiotics to control diseases can further complicate useful treatment regimes.

Beekeepers are expressing concerns about pesticides, particularly the neonicotinoids. Bee yards can be registered through the Plant Industry Division. This list is sent to aerial applicators licensed in NC. The NCDA&CS Apiary Inspectors have developed a good working relationship with the Structural Pest and Pesticides Division of the department. The Pesticide Division responds to reports of acute bee losses and follows up according to the evidence. If a pesticide problem is suspected, timely reporting to an Apiary Inspector or the Pesticide Section is crucial for a valid

investigation and resolution. Apiary personnel have collected pollen samples from colonies suspected to be suffering sublethal effects of exposure to neonicotinoids. To date, the samples have contained no detectable levels of these chemicals. The Structural Pest Control and Pesticides Division and the Plant Industry Division are working with EPA to develop a Managed Pollinator Protection Plan.

Another threat facing the beekeeping industry of North Carolina is the establishment of Africanized honey bees (AHB) (*Apis mellifera scutellata*) in southern Florida (and finds in Georgia). We are maintaining swarm traps at the ports of Wilmington and Morehead City in order to intercept any bees coming in via ship. We hope to expand this trapping system to some of our land-based points of entry. We continue to engage in an outreach program to NC emergency response personnel to familiarize them with the potential threat of AHB. We are actively collecting samples of bees (particularly those from colonies with overly defensive behavior) to determine their geographic origin and their propensity for this behavior. The NCDA&CS and NCSU are collaborating in conducting this survey. At this time, none of the samples collected have been determined to be of the AHB type. We are striving to have our inspectors and our lab prepared to deal with any AHB incursion or incident. **We encourage beekeepers and the general public to please let us know of any colonies that seem to be displaying any unusual behavior, especially excessive defensiveness. We want to maintain a beekeeping industry in North Carolina that is not threatened by the reputation of this more defensive type of bee.**

Honey bee viruses are an issue that seems to be a growing concern among beekeepers. Currently, we do not have the capacity to provide a diagnostics service for viruses; however, we continue to enjoy a good working relationship with our friends in the NC State University Apiculture Research and Extension Program. We hope to be able to add a capacity to do some of the molecular diagnostics that they are developing. We have had the opportunity to assist them in some of their projects and would like to express our gratitude for their assistance in many of our projects.

- Don Hopkins, Glenn Hackney & Steve Turner
31 January 2020

Biological Control / Beneficial Insect Programs

The Apiary Inspection and Biological Control Programs have been based together in the Beneficial Insects Lab (BIL), located in Cary, NC since 1995. The primary mission of the Apiary Inspection Service is to maintain a viable beekeeping industry and ensure the productivity of North Carolina's diverse agriculture. The NC beekeeping industry continues to remain viable and is expanding, particularly with new hobby beekeepers. Our inspectors assist beekeepers through field inspections, educational meetings, and field days and attempt to be available to assist the beekeepers in any way necessary. Our goal is to further improve our overall inspections and, ultimately, to reduce the rate of honey bee disease and pest problems.

The mission of the biological control program is to manage exotic pests using ecologically-based methods. We focus on classical biocontrol, reuniting exotic pests with the natural enemies that keep them below damaging levels in their home ranges. Although we are primarily an implementation program, conducting these projects requires research to ascertain the appropriateness of releasing biological control agents or to follow up on agents released. Currently, our projects focus on a variety of exotic insects and weeds, and involve laboratory rearing of insects, field releases of natural enemies, and surveying. Our quarantine facility remains useful to our division as well as to outside cooperators as a secure space for research and monitoring of pests. Personnel working in the program during 2019 included Steven Turner, Biological Control Administrator, Christine Nalepa, Research Specialist, and Nancy Oderkirk, Research Specialist, quarantine officer, and safety officer. Temporary part time Biological Control Program staff included John Wilson, Sam Larsen, Nathan LaSala, Jessica Grant, Emily Ogburn and John Banask. Glenn Hackney is a Research Specialist in the Apiary Inspection Program and maintains a lab at the BIL. Other Apiary staff are based at their homes across the state. During 2019, the inspectors were: Greg Farris, western Piedmont, Nancy Ruppert, Sandhills, Will Hicks (retired in July 2019), NE central counties, Adolphus Leonard, Coastal Plain, Lewis Cauble, mountain territory, and Don Hopkins, NW central counties, State Apiarist and Apiary Inspection Services Supervisor.

The past year has seen an exciting growth in our biological control program with new initiatives to tackle existing and emerging pests and invasive species being funded by both the State and Federal Agencies. This includes the expansion of two existing programs (Hemlock Wooly Adelgid and Mile a Minute Biocontrol) and the addition of three new funded initiatives (Knotweed Biocontrol, Alligatorweed Biocontrol and Crape Myrtle Bark Scale Natural Enemies Survey). We are also collaborators in a funded research program with the NC Forest Service and NC State University focused on the lifecycle of Emerald Ash Borer in the Southeastern US. We are also continuing our EAB biosurveillance work.

Implementation of *Cerceris fumipennis* as a Biosurveillance Tool for Pest Buprestidae in North Carolina during 2019

The solitary ground nesting wasp *Cerceris fumipennis* continues to be utilized as a biosurveillance tool for the efficient collection of pest buprestid beetles in several locations in the eastern and central United States. In 2019 studies of the wasp in North Carolina were continued in partnership with the Cooperative Agricultural Pest Survey (CAPS); we conducted biosurveillance at established sites and surveyed for new sites between 22 May and 30 June 2019.

Biosurveillance was conducted in 12 sites in 12 counties, with a total of 381 beetles collected (Table 1). An additional 17 sites in 10 counties were surveyed for *Cerceris* nests, and three (Horton Park, Lee Co.; Jaycee Park, Alexander Co.; West Alexander Middle School, Alexander Co.) had potential for further biosurveillance.

The goal this year was to survey in sites that were historically important in the *Cerceris* program, and in counties where emerald ash borer (*Agrilus planipennis* = EAB) was not yet found. The first beetles collected were from Robeson Co. on 22 May and the last beetles were taken on 30 June in Alexander Co. We met out goal of 50+ beetles in 4 of the sites.

Table 1. Biosurveillance conducted for pest Buprestidae with *Cerceris fumipennis* in 2019

Site #	Site Name	County	Total Buprestidae	No. EAB	% EAB
1	Bradford Pool	Roberson 11	1	0	0
2	Faith Christian Academy	Wayne 16	65	9	9.2
3	Havelock Middle School	Craven 1	5	0	0
4	Franklinton Park	Franklin 6	55	10	18.2
5	Spring Hope	Nash 4	29	1	3.4
6	Vance Elementary	Buncombe 12	127	115	90.6
7	Horton Park	Lee 1	3	0	0
8	Mountain Heritage HS	Yancey 2	66	65	98.5
9	Wilson Park	Caldwell 27	7	4	57.1
10	Gene Turner	Burke 1	1	0	0
11	Meadowview MS	Surry 5	16	4	25.0
12	West Alexander MS	Alexander 1	6	0	0
	TOTALS: 12 sites	12 counties	381	208	Overall: 54.6%

Approximately 62% of the beetles collected by *C. fumipennis* in 2019 were in the economically important genus *Agrilus* (n=236), with EAB accounting for the vast majority. EAB was collected in seven sites and accounted for 54.6% of all beetles taken (Table 1). We established two new county records for EAB in North Carolina in 2019: *Cerceris* collected EAB 22 June 2019 in Caldwell Co. (Wilson Athletic Park, Lenoir) and 24 June 2019 in Nash Co. (Spring Hope Elementary School, Spring Hope).

Historically, EAB was first collected in North Carolina by *Cerceris* in Franklinton Park (Franklin Co.) in 2015 (Nalepa et al. 2017). None were collected at that site in 2016, 2017, or 2018. In 2019, however, it accounted for 18.2% of the beetles collected there by *Cerceris*. Two additional sites that we have been tracking are located in the NC mountains. In both Vance Elementary (Site 6, Buncombe Co.) and Mountain Heritage (Site 8, Yancey Co.), EAB was first detected by *Cerceris* in 2016, when it accounted for 10.9 and 15.2% of beetles collected, respectively. Since then, the proportion of EAB collected at those sites has steadily increased, and in 2019 EAB accounted for 90.6% of the beetles at Vance Elementary and 98.5% of the beetles at Mountain Heritage. We have begun utilizing the EAB collected at these two sites to begin studying the biology of this invasive pest in North Carolina.

Table 2. History of EAB collection by *Cerceris fumipennis* in North Carolina. Percentages represent the proportion of emerald ash borers in the total number of beetles collected by *C. fumipennis* at the site; beetle sample sizes are in parentheses.

Site Name	County	2015	2016	2017	2018	2019
Spring Hope	Nash					3.4% (29)
Wilson Park	Caldwell					57.1% (7)
Liberty Hill	Mitchell			8.2% (61)	35% (20)	No survey
Caswell Co. Pks & Rec	Caswell			0% (2)	41.2% (17)	No survey
Faith Christian Acad	Wayne		3.6% (84)	0% (30)	21.9% (73)	9.2% (65)
Vance Elementary	Buncombe		10.9% (55)	50.5% (91)	84.1% (132)	90.6% (127)
Mountain Heritage HS	Yancey		15.2% (46)	36.5% (52)	91.2% (91)	98.5% (66)
Meadowview MS	Surry		0% (24)	0% (1)	43.8% (16)	25% (16)
Swain Co. Veterans Pk	Swain		13.2% (68)	57.1% (7)	100% (4)	No survey
Franklinton Park	Franklin	1.4% (214)	0% (78)	0% (86)	0% (73)	18.2% (55)

Whitney Swink (NCDA & CS) identified collected beetles; n = 53 in the genera *Agrilus*, *Chrysobothris* and *Actenodes* are still pending identification to the species level. Biosurveillance was conducted by John Banask, Larry Greene (CAPS), Lee Huffman (CAPS), Sam Larsen, Christine Nalepa, Nancy Oderkirk, Emily Ogburn, David Pearce and Jessica Grant. We are grateful to the schools and parks that allowed us to work on their grounds.

References Cited

Nalepa, C.A., R.S. Norris and W.G. Swink. 2017. Collection of emerald ash borer by *Cerceris fumipennis* in North Carolina: case study at one nesting site. Journal of Entomological Science 52: 1-8.

C.A. Nalepa
28 January 2020

Hemlock Woolly Adelgid Predator Rearing at the Beneficial Insects Laboratory 2019 Season

Our newly implemented *Laricobius* rearing program was first planned and funded in the 2017-2018 fiscal year. We began the first stage of this project in 2017. This involved planning the logistics and facilities necessary to successfully implement a rearing program for a biological control agent that is known to be difficult to produce, as it requires very specific conditions and food sources. During FY 2018, our facility completed renovations to provide more rearing space for rearing beetles.

Over the past calendar year, the NCDA&CS Beneficial Insect Lab continued our rearing efforts focused on 2 species of *Laricobius* beetles – *L. nigrinus*, native to the Pacific Northwest that were field collected from existing populations in Western North Carolina, and *L. osakensis*, native to Japan, which were sourced from a laboratory reared colony by the Hemlock Restoration Initiative.

The *L. osakensis* colony are descendants of wild collected individuals that had been collected in Japan in 2017 by the University of Tennessee, Knoxville. Our focus for the 2019 rearing season was to increase our laboratory colony size to enable a higher mass rearing production rate. We also produced beetles that were used for our research collaboration with WCU.
We began our oviposition cages in January of 2019, following a feeding and maintenance period for our newly emerged adult beetle colonies. Where possible, 20 beetles were placed in a 1-gallon jar provisioned with enough infested hemlock to both feed the adult beetles, and to provide a resource in which females could lay eggs. The infested hemlock was replaced every 2 weeks. The hemlock extracted from oviposition cages was placed in floral foam blocks with additional infested branches added to provide food for the emergent larvae. This process was continued until late March 2019 when all adult beetles had died, or been released. From early March – May, we harvested mature larvae and placed them in pupation chambers where they lay dormant until the late Fall/early Winter when conditions were changed to trigger adult emergence. In our first season, we recorded a total of 4,700 larvae that successfully made it to the pre-pupal stage. Emergence of adult, lab reared beetles is ongoing and to date we have obtained approximately 2,000 beetles in total.

In February and March of 2019, the NCDA&CS BIL and Western Carolina University set up the first field experiment for our research collaboration. Steve Turner worked with Jim Costa, Peter Bates and Angela Mech by providing HWA ovisacs, inoculated with *Laricobius nigirinus* eggs for introduction to an experimental field site. Beetles emergence has been observed at our experimental pots and we are currently collecting the first round of emergence data to determine whether egg survivorship is a viable and more effective alternative than introducing adult beetles into the environment. We anticipate this to be the beginning of a continuous and successful partnership and are excited to be contributing to research that will better inform the HWA control effort.

*Our activities for the 2019 field season were funded by the North Carolina Policy Collaboratory. We are grateful for their continued support of our HWA biocontrol program and research initiatives.

Acknowledgements

Production of HWA predatory beetles at the BIL is supported by funding from the NC General Assembly and the NC Policy Collaboratory. We thank our collaborators at the Hemlock Restoration Initiative for assisting us in obtaining our original *Laricobius* colonies and Pat Parkman and Carrie Jubb of Univ. Tenn. Knoxville and Virginia Tech. Univ., respectively for informing our rearing protocols. Our 2019 HWA biocontrol project was conducted by Steve Turner, Biocontrol Administrator, John Wilson, Research Specialist, John Banask, Research Specialist and Nancy Oderkirk, Research Specialist. John Wilson returned in November 2019 to assume the lead role in our *Laricobius* rearing efforts.

- Steve Turner
31 January 2020

2019 Mile-A-Minute Vine Biological Control Report

Mile-a-Minute vine (MAM), *Persicaria perfoliata* (aka *Polygonum perfoliatum*,) is a fast-growing annual invasive weed found in riparian areas and along forest edges in the Eastern region of the United States. This plant was first discovered in this range in the mid-1930s. MAM is easily identified by its triangular leaves, spines on the reddish-colored stems and leaf petioles, and a modified leaf (ochrea) that surrounds each node of the vine. Its small white flowers develop into bright metallic blue, berry-like fruits. Seeds can remain viable in the soil for up to 6 years. They spread by floating great distances and are dispersed by seed-feeding birds and mammals. Patches of MAM also travel along waterways during major flooding events.
Rapid growth, prolific flowering, long-lived seeds, location along riparian areas, and ability to overtop herbaceous and shrubby plants (Fig.1) and even small trees, make chemical control of MAM difficult. Cultivation is ineffective, because seeds are released during the process, and plant remnants root at the nodes and re-grow. Biological control has therefore proven to be the most practical strategy for dealing with this weed in many cases.

Figure 1. Mile-a-Minute vine overgrowing other vegetation. Adult weevil damage can be seen on the foliage. Alleghany County weevil dispersal site, 2015.

Surveys for natural enemies in its native Asia revealed the weevil *Rhinoncomimus latipes* Korotyaev as the most promising species, with MAM as its sole hostplant. This insect has since been reared at the Philip Alampi Beneficial Insect Lab (PABIL) of the New Jersey Department of Agriculture, which has provided weevils for release throughout the Northeastern and Mid-Atlantic states, including North Carolina. Hough-Goldstein et al. (2008) provide an overview of the biology and biological control of MAM.

Delimiting surveys were initially conducted to determine the extent of MAM infestations throughout the known and expected range in North Carolina. Since the initial weevil releases,

sites have been visited at least annually, and additional surveys have determined ongoing expansion of the weevil's range.

Mile-a-minute vine is widely distributed across the northern part of NC, from the mountains to the coast (Fig. 2.) Infestations vary in density and size, from small patches to dense thickets. Alleghany, Gates and Pasquotank Counties contain the most numerous and dense streamside and roadside infestations discovered to date.

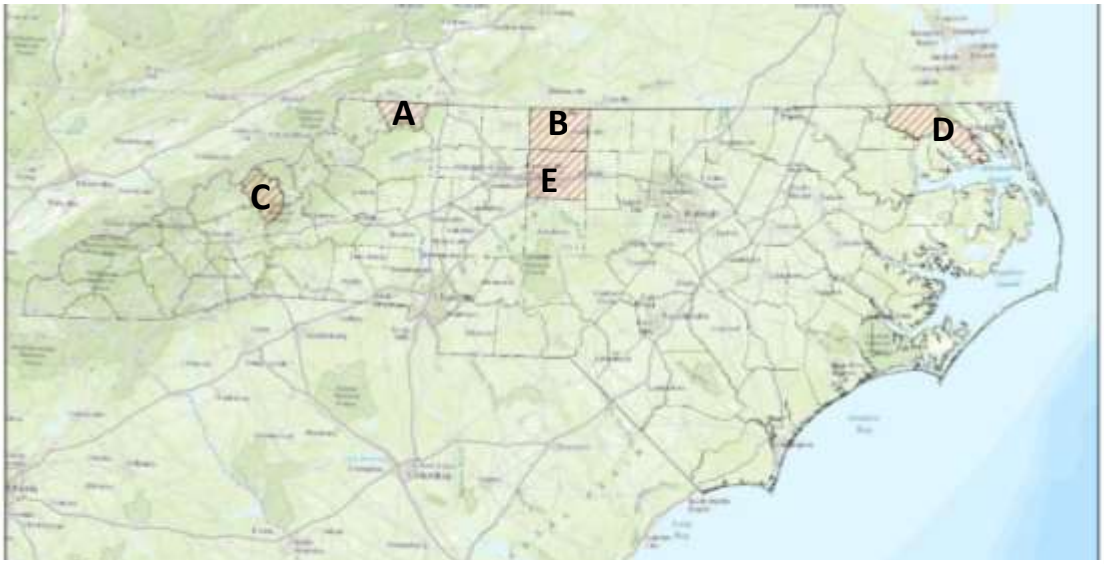

Figure 2. Mile-a-Minute infestations in North Carolina. Counties with hatch markings are infested. Letters correspond with the order in which county infestations were reported. A = Alleghany, B = Rockingham, C = Yancey, D = Pasquotank and Gates, E = Guilford.

This year NCDA&CS continued our weevil rearing and release program supported through funding from the USDA APHIS Biological Control Program. An additional 3,000 weevils were released at infested sites in Alleghany (500 weevils), Gates (1000 weevils) and Guilford Counties (500 weevils). As weevil populations are consistently recovered at all release sites, our focus has started the transition towards long term field observations to determine the effectiveness of the beetles in suppressing the weed. We have established three experimental plots that will examine the impact of beetles on MAM infestations in three distinct regions of the state: Coastal Plain, Piedmont and Mountain areas. The USDA APHIS Biological Control Program has committed to support this work for another year, through an ongoing cooperative agreement.

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Acknowledgements

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- Steve Turner
23 January 2019

2019 Fire Ant Biocontrol Summary
Phorid Flies for Biological Control of the Red Imported Fire Ant, *Solenopsis invicta*

North Carolina's first Imported Fire Ant (IFA), *Solenopsis richeteri*, the Black Imported Fire Ant, was discovered in Wake County in 1952 (Wray, 1967.) Since that time, the nearly ubiquitous IFA species in our state is the Red IFA, *S. invicta.* As of 2019, RIFA has spread to all but the northcentral and northern mountain regions (NCDA&CS, 2019.) Its painful sting can harm to humans, pets, and livestock. These ants are detrimental to agricultural productivity due to the effect on livestock, deterrent effects on workforce personnel, invasion of honey bee colonies, and reduced marketability of agricultural products. They disrupt ecological balance due to the displacement of native species. In an effort to slow the spread of non-native fire ants, federal and state departments of agriculture regulate the movement of agricultural products in areas with known IFA presence. In addition, biological control measures have been undertaken across the Southeastern United States, and recently, in California (Oi et al, 2019.) A complex of parasitoid flies in the family Phoridae is known to uniquely control *Solenopsis* spp. in their native South America (Porter, 1998.) These parasitoids, sometimes referred to as decapitating flies, lay individual eggs into worker ants while they forage or defend their mounds. The fly larva feeds and develops within the ant's head, killing the host in the process and causing the head to detach (Porter et al, 1995.) When phorid flies are present, ants are preoccupied with defense, and decrease foraging to avoid the intensely annoying flies (Feener et al, 1992.) The reduction in foraging activity results in fewer ants and smaller and/or fewer mounds, allowing native species to better compete for resources (Mehdiabadi et al, 2004.)

Releases Since 2000, we have released four species of phorid flies in twelve counties of North Carolina (see Table below.) Species were chosen for release at each locality based on the prevalent ant colony phenology, as follows: *Pseudacteon tricuspis* and *P. obtusus* flies typically attack the larger workers found in monogyne (single-queen) colonies, whereas *P. curvatus* and *P. cultellatus* prefer smaller workers common to polygyne (multi-queen) colonies (Morrison et al, 1997.)

Surveys We have employed a modified version of sticky traps developed by Puckett et al. (2007) to monitor phorid flies (Figure 1.) Each trap consists of a plastic tri-stand (sourced from restaurant supply companies) glued to a plastic petri dish. The tri-stand and sides of the petri dish are coated with liquid fluoropolymer resin (PTFE-30, sold as Fluon® or Insect-A-Slip) to prevent fire ants from escaping or climbing the tri-stand. An inverted tri-stand is anchored to the original tri-stand with hook-and-loop fastener strips, and the legs of the inverted stand are coated with a sticky barrier such as Tanglefoot®. Traps are placed alongside fire ant mounds and baited with either bits of canned sausages or droplets of safflower oil to attract ants and, therefore, phorids. Flies become ensnared in the Tanglefoot® when they alight to rest on the upright legs. The traps are collected no sooner than 24 hours after placement, so as to sample flies that are active at different times of day.

Figure 1: Sticky trap for capturing flies

Surveys are conducted annually for 2-3 years after each release, and occasionally thereafter. We typically survey in the Fall, to take advantage of peak phorid population size. Three small releases were conducted in 2017, and post-release surveys concluded in 2019. Phorid fly releases since the inception of this program are presented in the Table below. Survey results (Figure 2) confirm that *Pseudacteon curvatus* has established and spread reliably from sites of introduction in North Carolina. Prior surveys confirmed the establishment of *P. tricuspis* in Pitt County (2010) and *P. obtusus* in Franklin County (2013.) In each case, the dominant species, *P. curvatus,* was also present.

Table. Phorid Fly Release and Recovery Data for North Carolina

Release Site (County)	Nearest Town	Species released	Release Year	Number	Survey Year*	Species recovered
Beaufort	Washington	*P. tricuspis*	2000	3000	2009	--
Duplin	Warsaw	*P. tricuspis*	2002	2973	2009	--
Robeson	Lumberton	*P. tricuspis*	2003	3849	2009	--
Wayne	Goldsboro	*P. tricuspis*	2004	4962	2009	--
Wake	Cary	*P. curvatus*	2005	13,708	2018	*P. curvatus*
Pitt	Falkland	*P. tricuspis*	2006	3639	2017	*P. curvatus*
Scotland	Laurel Hill	*P. tricuspis*	2007	5206	2009	*P. curvatus*
Scotland	Laurel Hill	*P. curvatus*	2007	13,008	2009	*P. curvatus*
Wayne	Goldsboro	*P. curvatus*	2008	12,000	2009	*P. curvatus*
Gaston	South Point	*P. curvatus*	2009	11,000	2009	*P. curvatus*
Orange	Chapel Hill	N/A	N/A	N/A	2009	*P. curvatus*
Pitt	Greenville	*P. curvatus*	2010	12,000	2017	*P. curvatus*
Pitt	Greenville	*P. obtusus*	2010	1100	2017	*P. curvatus*
Randolph	Asheboro	*P. curvatus*	2011	4914	2017	*P. curvatus*
Randolph	Asheboro	*P. obtusus*	2011	2984	2017	*P. curvatus*
Franklin	Franklinton	*P. curvatus*	2012	9312	2018	*P. curvatus*

Franklin	Franklinton	*P. obtusus*	2012	2417	2018	*P. curvatus*
Wake	Raleigh	*P. cultellatus*	2013	6096	2017	*P. curvatus*
Wake	Wake Forest	*P. curvatus*	2013	2592	2018	*P. curvatus*
Wake	Wake Forest	*P. obtusus*	2013	1404	2018	*P. curvatus*
Johnston	Smithfield	*P. obtusus*	2014	5077	2017	*P. curvatus*
Johnston	Smithfield	*P. cultellatus*	2014	4128	2017	*P. curvatus*
Anson	Lowrys	*P. obtusus*	2015	1364	2017	*P. curvatus*
Anson	Lowrys	*P. cultellatus*	2015	9408	2017	*P. curvatus*
Wake	Cary	*P. obtusus*	2017	130	2019	*P. curvatus*
Wake	Raleigh	*P. obtusus*	2017	390	2019	*P. curvatus*
Wake	Wake Forest	*P. obtusus*	2017	630	2019	*P. curvatus*
Orange	Rougemont	N/A	N/A	N/A	2019	*P. curvatus*
Person	Mt. Tirzah	N/A	N/A	N/A	2019	*P. curvatus*

* Most recent survey results are shown.

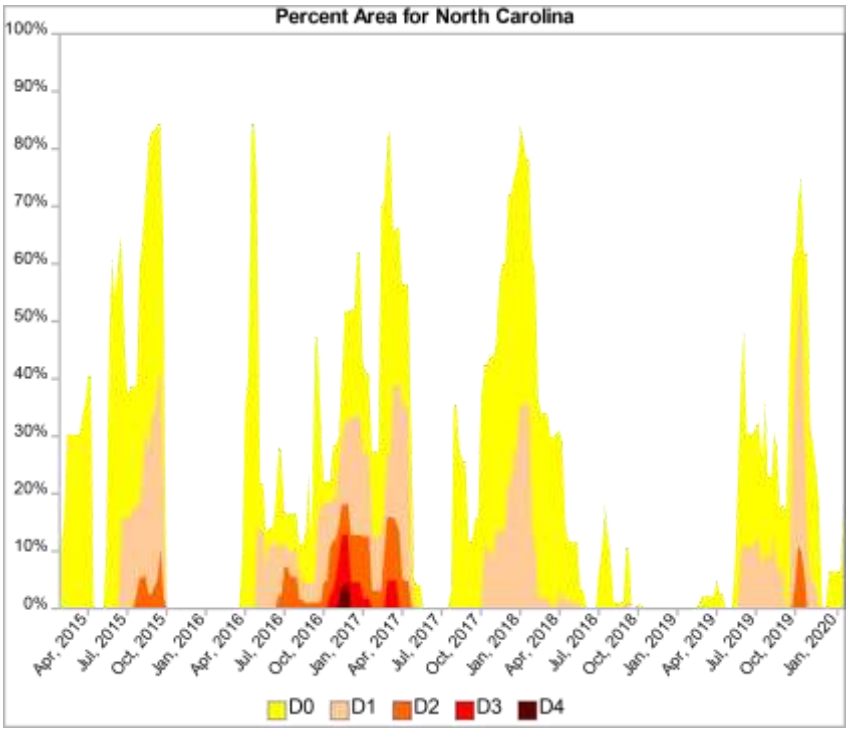
Figure 2. Results of Phorid Fly Surveys in North Carolina, 2000 – Present

Other researchers in our region have also reported tremendous success in the establishment and spread of *Pseudacteon curvatus*, as compared with more moderate success with the other three species. LeBrun et al (2009) suggested competitive displacement of other species by *P. curvatus*, and Callcott et al (2011) observed that *P. tricuspis* appears to be better adapted to the more southern range of IFA in the Southeastern U.S. Indeed, our findings indicate *S. curvatus* range expansion in concert with that of its RIFA host (Figures 2 and 3.)

Figure 3. 2019 North Carolina RIFA quarantine map with new positive survey sites

Detection of phorids has been limited recently by late-summer droughts, which are known to suppress the above-ground activity of fire ants and, consequently, their parasitoids. In 2019, North Carolina experienced drought conditions from mid-February through October. At the peak Fall phorid fly monitoring season, 71% of the state was abnormally dry or under moderate drought, and 11% was under extreme drought (Figure 4.) Only the coastal region escaped these conditions, in the wake of an active hurricane season. Based on this climatic trend, we plan to begin our 2020 surveys in late Spring, when the relatively small first generation of phorids should be present.

Figure 4. Drought status in North Carolina



Legend: D0 =Abnormally Dry D1=Moderate Drought D2=Severe Drought D3 =Extreme Drought D4 =Exceptional Drought **Source:** https://www.drought.gov

Project Summary Phorid flies released for biological control have become established across North Carolina, and are successfully tracking the fire ants as they continue to migrate inland. Of the four species released, current monitoring techniques have allowed for the sustained recovery of a single species, *Pseudacteon curvatus*, and the previous recovery of *P. tricuspis* and *P. obtusus* in a few locations. At this time, we cannot determine definitively whether these findings represent the true distribution of these parasitoids, or whether our data might be skewed due to artifacts of the trapping technique. We anticipate that final surveys to be conducted in 2020 will help to clarify this assessment.

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- Nancy Oderkirk
28 January 2020

Implementation of *Cerceris fumipennis* as a Biosurveillance Tool for Pest Buprestidae in North Carolina during 2019

The solitary ground nesting wasp *Cerceris fumipennis* continues to be utilized as a biosurveillance tool for the efficient collection of pest buprestid beetles in several locations in the eastern and central United States. In 2019 studies of the wasp in North Carolina were continued in partnership with the Cooperative Agricultural Pest Survey (CAPS); we conducted biosurveillance at established sites and surveyed for new sites between 22 May and 30 June 2019. Biosurveillance was conducted in 12 sites in 12 counties, with a total of 381 beetles collected (Table 1). An additional 17 sites in 10 counties were surveyed for *Cerceris* nests, and three (Horton Park, Lee Co.; Jaycee Park, Alexander Co.; West Alexander Middle School, Alexander Co.) had potential for further biosurveillance.

The goal this year was to survey in sites that were historically important in the *Cerceris* program, and in counties where emerald ash borer (*Agrilus planipennis* = EAB) was not yet found. The first beetles collected were from Robeson Co. on 22 May and the last beetles were taken on 30 June in Alexander Co. We met our goal of 50+ beetles in 4 of the sites.

Table 1. Biosurveillance conducted for pest Buprestidae with *Cerceris fumipennis* in 2019

Site #	Site Name	County	Total Buprestidae	No. EAB	% EAB
1	Bradford Pool	Roberson 11	1	0	0
2	Faith Christian Academy	Wayne 16	65	9	9.2
3	Havelock Middle School	Craven 1	5	0	0
4	Franklinton Park	Franklin 6	55	10	18.2
5	Spring Hope	Nash 4	29	1	3.4
6	Vance Elementary	Buncombe 12	127	115	90.6
7	Horton Park	Lee 1	3	0	0
8	Mountain Heritage HS	Yancey 2	66	65	98.5
9	Wilson Park	Caldwell 27	7	4	57.1
10	Gene Turner	Burke 1	1	0	0
11	Meadowview MS	Surry 5	16	4	25.0
12	West Alexander MS	Alexander 1	6	0	0
	TOTALS: 12 sites	12 counties	381	208	Overall: 54.6%

Approximately 62% of the beetles collected by *C. fumipennis* in 2019 were in the economically important genus *Agrilus* (n=236), with EAB accounting for the vast majority. EAB was collected in seven sites and accounted for 54.6% of all beetles taken (Table 1). We established two new county records for EAB in North Carolina in 2019: *Cerceris* collected EAB 22 June 2019 in Caldwell Co. (Wilson Athletic Park, Lenoir) and 24 June 2019 in Nash Co. (Spring Hope Elementary School, Spring Hope).

Historically, EAB was first collected in North Carolina by *Cerceris* in Franklinton Park (Franklin Co.) in 2015 (Nalepa et al. 2017). None were collected at that site in 2016, 2017, or 2018. In 2019, however, it accounted for 18.2% of the beetles collected there by *Cerceris*. Two additional sites that we have been tracking are located in the NC mountains. In both Vance Elementary (Site 6, Buncombe Co.) and Mountain Heritage (Site 8, Yancey Co.), EAB was first detected by *Cerceris* in 2016, when it accounted for 10.9 and 15.2% of beetles collected, respectively. Since then, the proportion of EAB collected at those sites has steadily increased, and in 2019 EAB accounted for 90.6% of the beetles at Vance Elementary and 98.5% of the beetles at Mountain Heritage. We have begun utilizing the EAB collected at these two sites to begin studying the biology of this invasive pest in North Carolina.

Table 2. History of EAB collection by *Cerceris fumipennis* in North Carolina. Percentages represent the proportion of emerald ash borers in the total number of beetles collected by *C. fumipennis* at the site; beetle sample sizes are in parentheses.

Site Name	County	2015	2016	2017	2018	2019
Spring Hope	Nash					3.4% (29)
Wilson Park	Caldwell					57.1% (7)
Liberty Hill	Mitchell			8.2% (61)	35% (20)	No survey
Caswell Co. Pks & Rec	Caswell			0% (2)	41.2% (17)	No survey
Faith Christian Acad	Wayne		3.6% (84)	0% (30)	21.9% (73)	9.2% (65)
Vance Elementary	Buncombe		10.9% (55)	50.5% (91)	84.1% (132)	90.6% (127)
Mountain Heritage HS	Yancey		15.2% (46)	36.5% (52)	91.2% (91)	98.5% (66)
Meadowview MS	Surry		0% (24)	0% (1)	43.8% (16)	25% (16)
Swain Co. Veterans Pk	Swain		13.2% (68)	57.1% (7)	100% (4)	No survey
Franklinton Park	Franklin	1.4% (214)	0% (78)	0% (86)	0% (73)	18.2% (55)

Whitney Swink (NCDA & CS) identified collected beetles; n = 53 in the genera *Agrilus*, *Chrysobothris* and *Actenodes* are still pending identification to the species level. Biosurveillance was conducted by John Banask, Larry Greene (CAPS), Lee Huffman (CAPS), Sam Larsen, Christine Nalepa, Nancy Oderkirk, Emily Ogburn, David Pearce and Jessica Grant. We are grateful to the schools and parks that allowed us to work on their grounds.

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C.A. Nalepa
28 January 2020

North Carolina Survey for Crape myrtle Bark Scale (*A. lagerstroemia*)

In 2004, a landscaping company in Richardson, Texas discovered a new, invasive pest of crape myrtles identified as *Acanthococcus lagerstroemiae* (Kuwana) (Hemiptera: Eriococidae) in 2014. Commonly referred to as Crape myrtle bark scale (CMBS), this felt scale is a non-native scale insect from Asia, most likely China (Gu et al 2016). Since its discovery in Texas in 2004, CMBS has spread throughout the southern US and, in China, can be found at least as far north as the 40th parallel or the same latitude as the KS, NE border (Wang 2015) The pest is most commonly transported on infected stock by humans, but can be spread locally by wind or animal dispersal. CMBS was first found in North Carolina in 2016 near Charlotte. In 2018, it was reported again near the VA border, which prompted this state-wide survey for the spread of crape myrtle bark scale by the North Carolina Department of Agriculture and Consumer Sciences Beneficial Insects Lab (NCDA BIL) in 2019.

Pest:

Figure 1 and 2. Crape myrtle bark scale, *Acanthococcus lagerstroemiae* (Kuwana) at low (left) and high (right) densities. Photos by S. Larsen

Figure 3 and 4. Whole (left) and smushed (right) Crape myrtle bark scale, *Acanthococcus lagerstroemiae* (Kuwana). Photos by S. Larsen

Distribution

Since its discovery in Texas in 2004, CMBS has spread throughout the southern US (**Figure 5**) including Oklahoma (2011), Louisiana (2012), Georgia (2013), Tennessee (2013), Arkansas (2014), New Mexico (2014), Alabama (2014), Virginia (2014), Mississippi (2015), North Carolina (2016), Kansas (2019) and South Carolina (2019) (EddMaps, 2020). In North Carolina, crape myrtle bark scale was reported in two sites: one in Mooresville, near Charlotte in Iredell county in 2016 and the other in Currituck county in the northeastern corner of the state on the Virginia border in 2018.

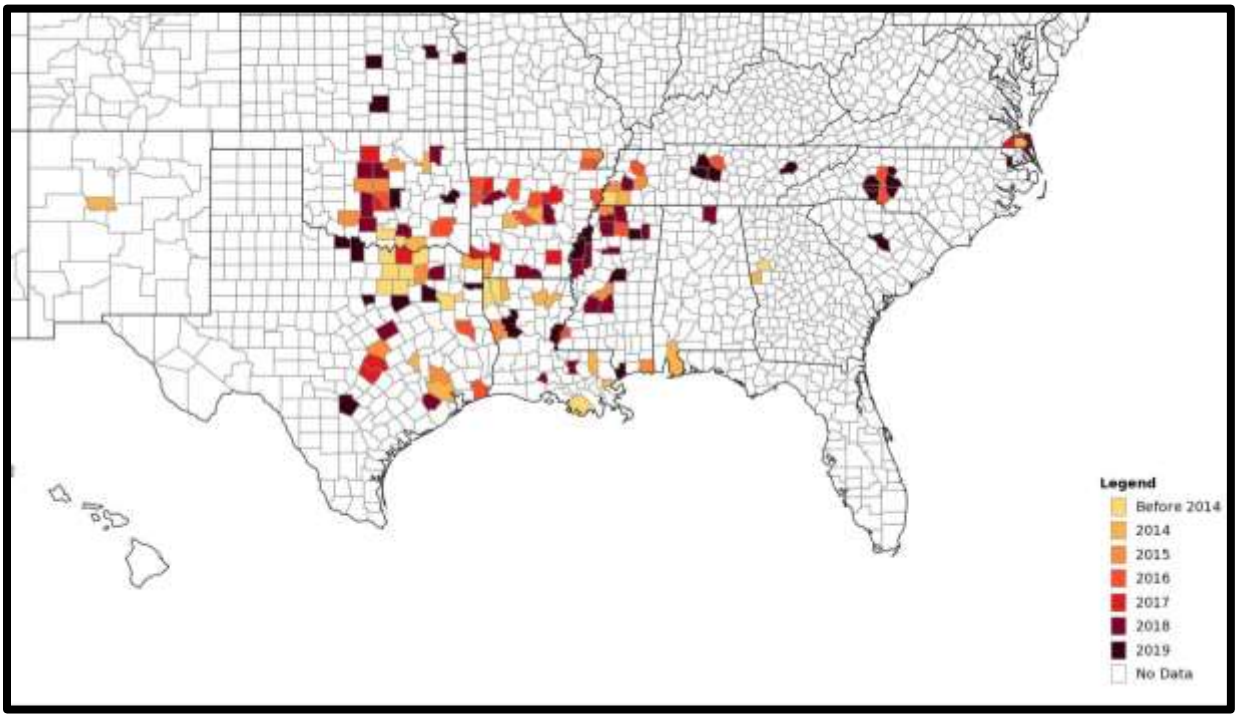

Figure 5. Counties with verified reports of crape myrtle bark scale, *Acanthococcus lagerstroemiae* (Kuwana), as of January 2020.
Map: https://www.eddmaps.org/cmbs/distribution.cfm.

Damage and Control Measures

Crape myrtle bark scale (CMBS) damages crape myrtles by feeding on the sap of the tree which decreases vigor and causes smaller blooms (Borden 2018). Scales feed on the tree's sap which contains low levels of nutrients and high levels of sugar and water. Excess sugar and water are excreted by the scale as honeydew, which is a sweet and sticky liquid that falls on and around the infected tree. The honeydew attracts ants (which are often an indicator of infestation (Wang 2016)) and coats the leaves and trunk of the tree leading to unattractive sooty mold growth. This mold decreases the vigor of the trees by reducing photosynthesis and significantly reduces the aesthetic value for which crape myrtles are prized.

Current control measures include chemical, mechanical, and biological controls. Monitoring is key for any pest control, but especially for scale insects that are protected from chemical sprays by their felt coating. Foliar applications of pesticides, including horticultural oils which must be applied to crawler stages of the scales before they form the protective felt covering to provide control. Soil drenches that are taken up by the tree have also proven effective against the pest (Gu 2016). Any chemical control does have the potential for non-target effects, resistance development, and costly application.

Mechanical control measures include scrubbing the bark with a mild detergent, power washing, hand squashing (for low numbers), or tree removal. Cultural control includes planting trees in sunny locations rather than in shade or planting varieties that are less prone to heavy infestations. Many predators such as lady beetles and lacewings act as biological controls agents, but no exotic parasitoids or predators have been approved for release yet, although several have been discovered and are possible candidates currently being testing in the quarantine facility at Texas A&M (Heinz, Cai et al. 2015, Wang et al. 2016) Unpublished data by Merchant et al. suggests that predatory lady beetle provide 75% of CMBS suppression when present.

Survey

State-wide survey sites in North Carolina were chosen based on accessibility and previous scale detection sites (**Figure 6**). State rest areas, welcome centers, and visitors' centers across the state were mapped via Google Maps to be surveyed, as well as 2 previous CMBS detection sites (Singleton Rd in Iredell Co. and a neighborhood in Currituck Co.). The state-wide survey began in March 2019 and was concluded in June 2019. There was no crape myrtle bark scale found at the original site in Currituck county previously reported in 2018. The neighborhood had numerous trees at every house, but it was concluded that the landscapers may have eradicated the pest previous to our arrival. The second reported infestation in Iredell county was confirmed and one other site in the state-wide survey (Cabarrus Co Rest Area) was also positive for CMBS. Limited surveys in the westernmost counties did not provide evidence for further CMBS spread.

Following the initial surveys, we concentrated our efforts in counties surrounding the initial positive site in Iredell County. New infestation sites were recorded and reported through the Early Detection and Distribution Mapping System, EddMapS. The county-wide survey began in July 2019 and concluded in November 2019. Two additional positive reports of CMBS in Pasquotank and Chowan counties were reported to EDDmaps after our survey was concluded. These sites, located in northeastern NC, suggest infestations from VA or the previously infested site in Currituck Co. Future plans include further surveys in this region. Samples of potential native natural enemies were taken at each positive site and are currently awaiting identification.

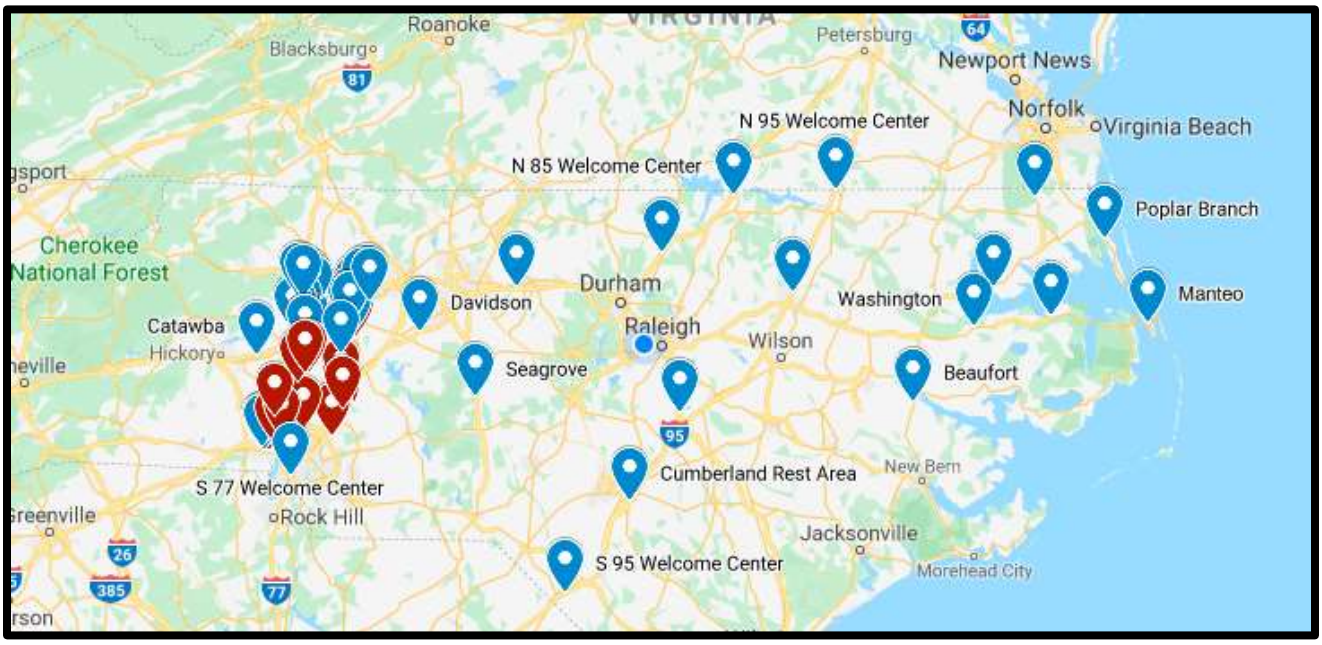

Figure 6. Site survey locations plotted in Google Maps. Blue markers are negative for crape myrtle bark scale (*Acanthococcus lagerstroemiae* (Kuwana)). Red markers are positive for crape myrtle bark scale. Note: This map only includes sites surveyed by S. Larsen and does not include most recent positive reports from EDDmaps by K. Shook and B. James.

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- Samantha Larsen & Steven Turner
31 January 2020

NCDA BIL Alligatorweed Biocontrol Program

Our newly initiated alligatorweed biocontrol program completed its first full year and has proven to be highly successful. Mass-rearing protocols were established for two natural enemies of alligatorweed, the flea beetle, *Agasicles hydrophila* and the thrips, *Amynothrips andersoni*. We used funding from a Farm Bill cooperative agreement to build the laboratory facilities needed to rear these insects, and hire our research specialist for this project. Daniel Russell was hired to lead this program. Enclosed water tables with full spectrum lighting were designed and built in the lab for flea beetle rearing, along with a larger water table on the lab grounds for plant cultivation. We received a small starter colony of approximately 200 *A. hygrophila* beetles from the US Army Corps of Engineers. Our Thrips colony was provided by Dr. Diana Rashash (Onslow County Extension). Collaborations were established with city park owners and US Army Corps of Engineers. The lab now has a dependable source of fresh plant material, as well as multiple augmentative release locations for the coming (2020) season.

As of the beginning of September 2019, there have been five releases totaling almost five thousand insects at two sites. There have been three releases of *Agasicles hygrophila* and two releases of *Amynothrips andersonii* at Apex Community Park Lake in June and July. The alligatorweed flea beetles have successfully oviposited on the target plants there, and the signature feeding damage of both insects has been observed at the two locations chosen in the lake. The most recent release was at River Park North in Greenville, which has been the source for the alligatorweed plants for the mass-rearing program at the lab. A floodplain at the southern end of the property was found to have alligatorweed covering an area approximately the size of a football field with a creek running through it. 1,100 adult beetles, 550 larvae, 20 egg masses, and approx. 900 thrips were released along the banks of the creek - which is a tributary of the Tar River - and on the edge of the floodplain. Below are summaries of our biocontrol release activities.

Alligatorweed Biocontrol Releases

RELEASE DAY ONE: 6/27/19

Site: Apex Lake

Released:
- 500 adult *Agasicles hygrophila* beetles, 200 larvae, 50 egg masses.
- Approx. 100 *Amynothrips andersoni*.

Weather: Sunny, clear, 90°F, high humidity.

Attended by: Daniel Russell, Steven Turner, Jessica Grant, Emily Ogburn

Location:

One: 35.7523, -78.82379. All insects released here.

Photos:

RELEASE DAY TWO: 7/8/19

Site: Apex Lake

Released:
- 600 adult *Agasicles hygrophila* beetles only
- Approx. 150 *Amynothrips andersoni*.

Weather: Overcast, 75°F, high humidity.

Attended by: Daniel Russell, Steven Turner

Location:

One: 35.7523, -78.82379. Northwest end of lake for augmentative beetle release.

Two: 35.75135, -78.82207. "Beach" area for thrips release.

Evidence of beetles from previous release on 6/27/19, taken 7/8/19

RELEASE DAY THREE: 7/30/19

Site: Apex Lake

Released: • 680 adult *Agasicles hygrophila* beetles only at same site as previous

Weather: Partly cloudy, 90°F, high humidity.

Attended by: Daniel Russell, Steven Turner

Location:

35.7523, -78.82379. Northwest end of lake for augmentative beetle release. CONCENTRATED beetles around waterside edge of mat with waders.

RELEASE DAY FOUR: 8/8/19

Site: River Park North

Released: • 500 adult *Agasicles hygrophila* beetles
• 350 larvae
• Approx. 20 egg masses (oviposited while in transit)
• Approx. 100 *Amynothrips andersoni*.

Weather: Sunny, 85°F, 51% humidity

Attended by: Daniel Russell, Steven Turner

Location:

35.622063, -77.359883
Concentrated beetles in submerged plants in creek along West bank. Thrips in 20 feet from West bank.

RELEASE DAY FIVE: 9/3/19

Site: River Park North

Released:
- 500 adult *Agasicles hygrophila* beetles
- Approx. 200 larvae
- Approx. 200 *Amynothrips andersoni* on infested Greenville material

Weather: Sunny, 91°F, 54% humidity

Attended by: Daniel Russell, Sam Larsen

Location:

35.622063, -77.359883

Concentrated ~370 beetles in submerged plants in creek along West and East banks. ~130 beetles released along edge of marshy floodplain, 10m from creek (close as possible without waterproof shoes). Thrips along West bank and on edge of marshy floodplain near beetle release.

Notes: Some mortality (10 adults, 20-30 larvae) while in transit. Aspirated on day of release, so no food provided in transit.

RELEASE DAY SIX: 9/19/19

Site: River Park North

Released: • 106 adult *Agasicles hygrophila* beetles
• Approx. 600 *Amynothrips andersoni* on infested Greenville material

Weather: Sunny with low clouds, 77°F, 44% humidity

Attended by: Daniel Russell, Steven Turner

Location: 

35.622063, -77.359883

Concentrated beetles in submerged plants in creek along West and East banks. Thrips along West bank and on edge of marshy floodplain near beetle release.

Notes: Aspirated on day of release, so no food provided in transit. No mortality observed. Collected fresh plant material for mass-rearing program from last pond on right from entrance. Observed hydrolea taking over an adjacent pond.

- Danny Russell & Steve Turner
31 January 2020

Cooperative Agricultural Pest Survey (CAPS) Program

The CAPS program is a national, early warning pest detection network, funded through a cooperative agreement with USDA-APHIS-PPQ for domestic surveillance of exotic plant pests. Such pests hold economic, agricultural and/or environmental importance to North Carolina (NC) and the U.S. and typically include plant pests that are not known to occur domestically. These surveys help safeguard our nation's agriculture and natural resources through early detection, especially for those pests that pass through front-line inspections at our ports of entry. Surveys also concentrate on pests of export significance which are of concern to our trading partners. The CAPS program follows guidelines to ensure that data, on a continuing basis, is scientifically valid, current and reliable. The state CAPS advisory committee helps drive and focus surveys for each state. Its core members include the State Plant Health Director (SPHD), State Plant Regulatory Official (SPRO), Pest Survey Specialist (PSS) and the State Survey Coordinator (SSC). Other members may be invited to provide guidance in their area of expertise. National and/or State level surveys concentrate on three main areas of importance; entomological, pathological or exotic weed species. All data collected from these surveys are entered into the National Agricultural Pest Information System (NAPIS) before December 1st for inclusion into the Nation Plant Board's annual report.

Executive Summary

The 2019 North Carolina CAPS program was successful in procuring funding for CAPS and Farm Bill surveys for early detection of exotic plant pests. Seven independent surveys were conducted throughout the state, covering 45 counties. Surveys included; mollusk, forest pests, oak commodity, grape commodity, Asian defoliators, a phytophthoras state specific survey, solanaceous commodity and spotted lanternfly. A total of thirty-eight different exotic plant pests were surveyed from April through the end of October. All surveys were completed following the 2019 CAPS guidelines, so that negative data were reportable. **There were two positive detections for black velvet leatherleaf slug (*Belocaulus angustipes*), found in New Hanover and Onslow Counties. These findings were determined to be non-actionable. Otherwise, there were no positive detections for any of the targeted plant pests during the 2019 survey season.**

Some Farm Bill surveys also fall under the direction of the CAPS program. Grant applications are submitted annually to conduct survey work in solanaceous commodity (tomatoes, peppers, tobacco, etc.), phytophthoras (important plant pathogens affecting nursery and natural areas), grape commodity and Asian defoliators (largely surveyed at ports of entry). A new survey, specific to early detection of spotted lanternfly, was initiated during 2019. Many of these surveys follow CAPS guidelines for how they are conducted. Survey priorities for 2019 were determined with help from the CAPS advisory committee and new survey proposals were submitted through CAPS and Farm Bill (PPA 7721). All grant proposals were funded for 2019 surveys, while proposals for the 2020 survey season were successfully submitted in August, 2019.

CAPS Surveys

Three CAPS surveys were selected for the 2019 season in North Carolina; mollusk, forest pests and oak (Figure 1).

Mollusk Survey

The mollusk survey was completed in June and July at six locations (Figure 1). Eight exotic species of mollusk were surveyed; giant African snail (*Lissachatina fulica*), Hygromiid snails (*Cernuella spp.*) and Leatherleaf slug spp. (*Veronicella spp., Belocaulus spp., Celosias spp., Laevicaulis spp., Sarasinula spp.,* and *Semperula spp.*). Both the Pest Survey Specialist (PSS) at PPQ and State Survey Coordinator (SSC) at NCDA&CS completed the surveys at ports of entry and state Field Specialists completed several at private nurseries. Black velvet leatherleaf slug (*Belocaulus angustipes*) was found in New Hanover Co. This specimen was collected by someone from the public and turned into the County Extension Office with no further information given. It was officially confirmed by USDA but no further action could be taken since its origination could not be confirmed within the county. A second black velvet leatherleaf slug was found one month later in Onslow County and confirmed as positive. USDA determined this pest to be non-actionable for our state. Follow-up work is currently underway to determine who, if anyone, should be informed about this detection since this slug has the potential to vector a harmful human disease.

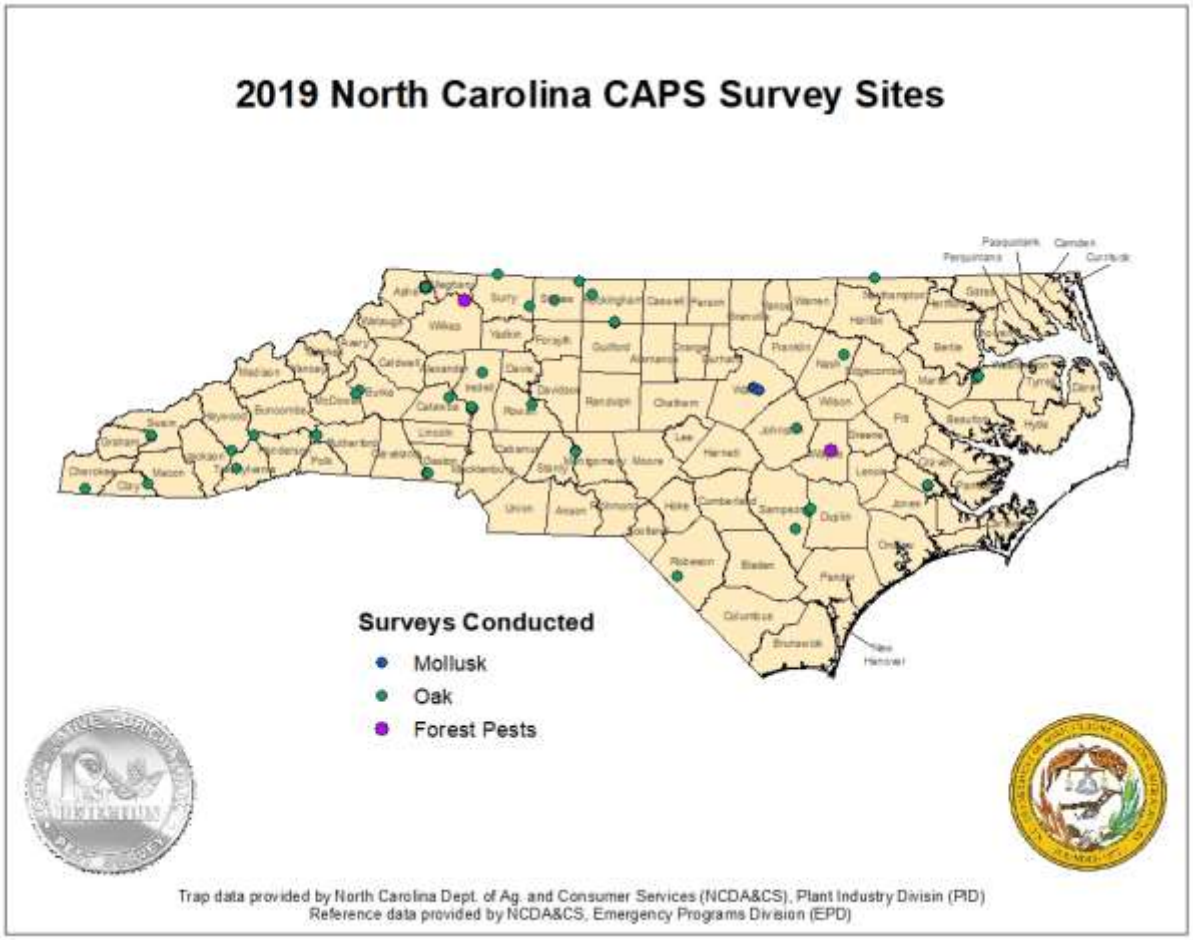
Oak Commodity Survey

North Carolina completed the 2019 oak commodity survey for the following exotics; Japanese oak wilt (*Raffaelea quercivora),* variegated golden tortrix moth (*Archips xylosteanus),* false codling moth (*Thaumatotibia leucotreta),* oak processionary moth (*Thaumetopoea processionea),* green oak tortrix moth *(Tortrix viridana)* and oak ambrosia beetle (*Platypus quercivorus*). Trapping for this survey began in May and ended in September. Monthly visits were conducted at forty-five locations for lure replacement, sticky card collection or trap replacement. Bi-weekly visits for the oak ambrosia beetle multi-funnel trap were accomplished to limit the decomposition rate of beetle specimens so identification could be possible.

Forest Pests Survey

The Forest Pest survey was completed during June and July throughout the state concentrating on three pests; oak splendor beetle (*Agrilus biguttatus*), Goldspotted oak borer (*Agrilus auroguttatus*) and Asian Longhorned beetle (*Anoplophora glabripennis*). Both Agrilus species were surveyed by utilizing the cerceris wasp at ballfields throughout the state. This biosurviellance is a unique way to survey for target buprestid spp. and can be used in lieu of purple prism traps. The specimens produced from this method are nearly perfectly preserved versus the prism traps since specimens typically become covered in the trap's glue. Asian longhorned beetle was surveyed utilizing declining maple near industrial parks.

Figure 1. All CAPS survey sites during 2019 season.



Farm Bill Surveys

The SSC annually applies for Federal assistance for the state to conduct exotic plant pest surveys. In 2018, money for four Farm Bill surveys were awarded to NC; Asian defoliators, grape commodity, solanaceous commodity and a *Phytophthora spp.* survey.

Asian Defoliators

Nine exotic plant pests were surveyed under Asian defoliators; Asian Gypsy Moth *(Lymantria dispar asiatica)*, Okinawa gypsy moth (*L. albescens*), Japanese gypsy moth (*L. dispar japonica)*, Hokkaido gypsy moth (*L. umbrosa)*, Rosy Moth (*L. Mathura*), Nun Moth (*L. monacha*), Pine Tree Lappet (*Dendrolimus pini*), Masson Pine Moth (*D. punctatus*) and Siberian Silk Moth (*D. sibiricus*). Locations included ports of entry and military installations.

An introduction of any of these exotics would have serious implications for North Carolina forests. Host trees for these pests are considered economically important and include oak, pine, ash, elm, maple and walnut.

A total of 20 trapping locations were placed at ports of entry over a four-month period from June to September (Figure 2). Monthly site visits were used to replace sticky cards and/or lures. Typical survey sites include deep water ports and military installations. It was previously determined that multiple survey locations exist on larger installations, and may include a combination of several forms of conveyance including deep water ports with rail yards, airstrips or a combination thereof. These are important pathways for this survey and are prioritized accordingly. All samples were collected at the servicing of each trap and screened for the presence of target pests.

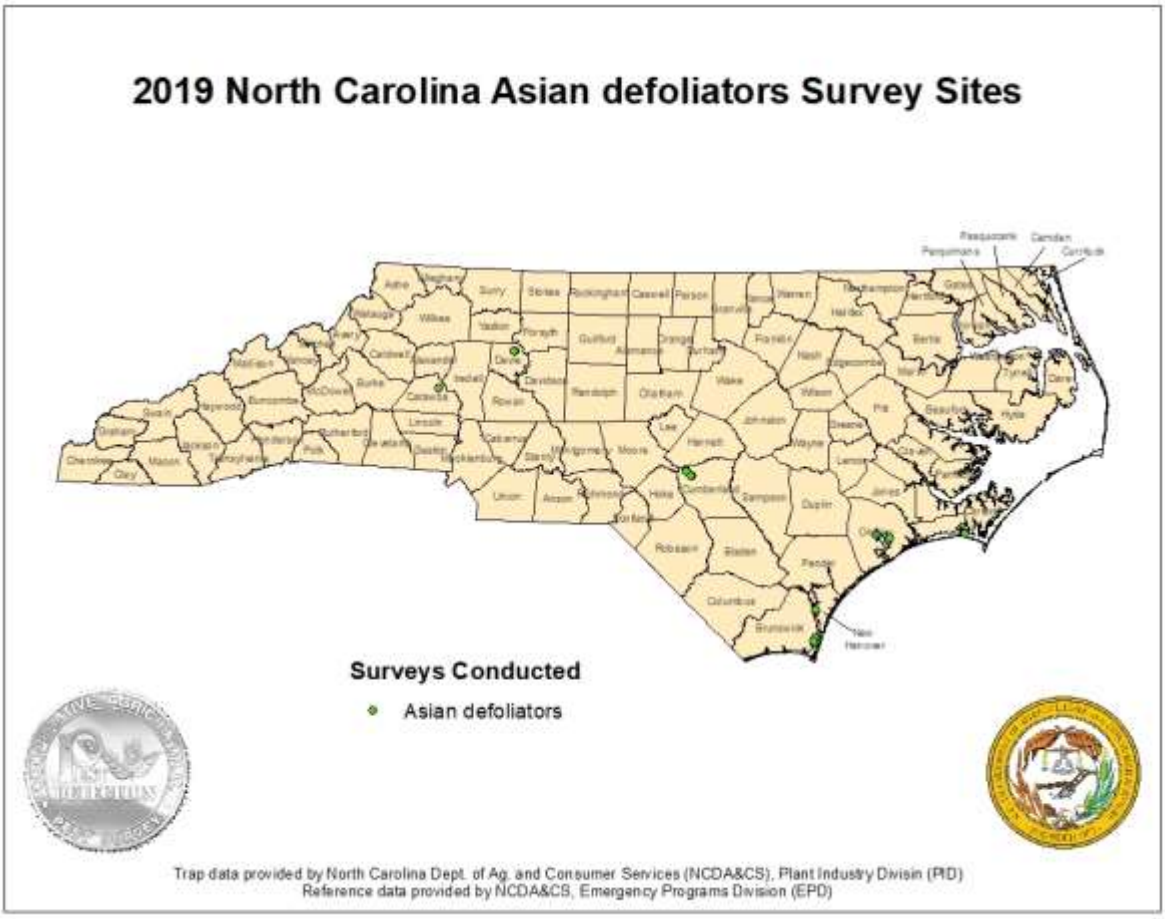


Figure 2. Asian defoliators survey sites for 2019 season.

Grape Commodity

We surveyed for six exotic species; Christmas berry webworm (*Cryptoblabes gnidiella)*, spotted lanternfly *(Lycorma delicatula)*, light brown apple moth *(Epiphyas postvittana)*, European grapevine moth *(Lobesia botrana)*, Egyptian cottonworm *(Spodoptera littoralis)* and cotton cutworm (*Spodoptera litura*). The survey was completed at twenty-nine locations using plastic delta and bucket traps that were set in July and pulled in September (Figure 3). The spotted lanternfly was visually surveyed within vineyards since there is no approved trap/lure combination for this pest.

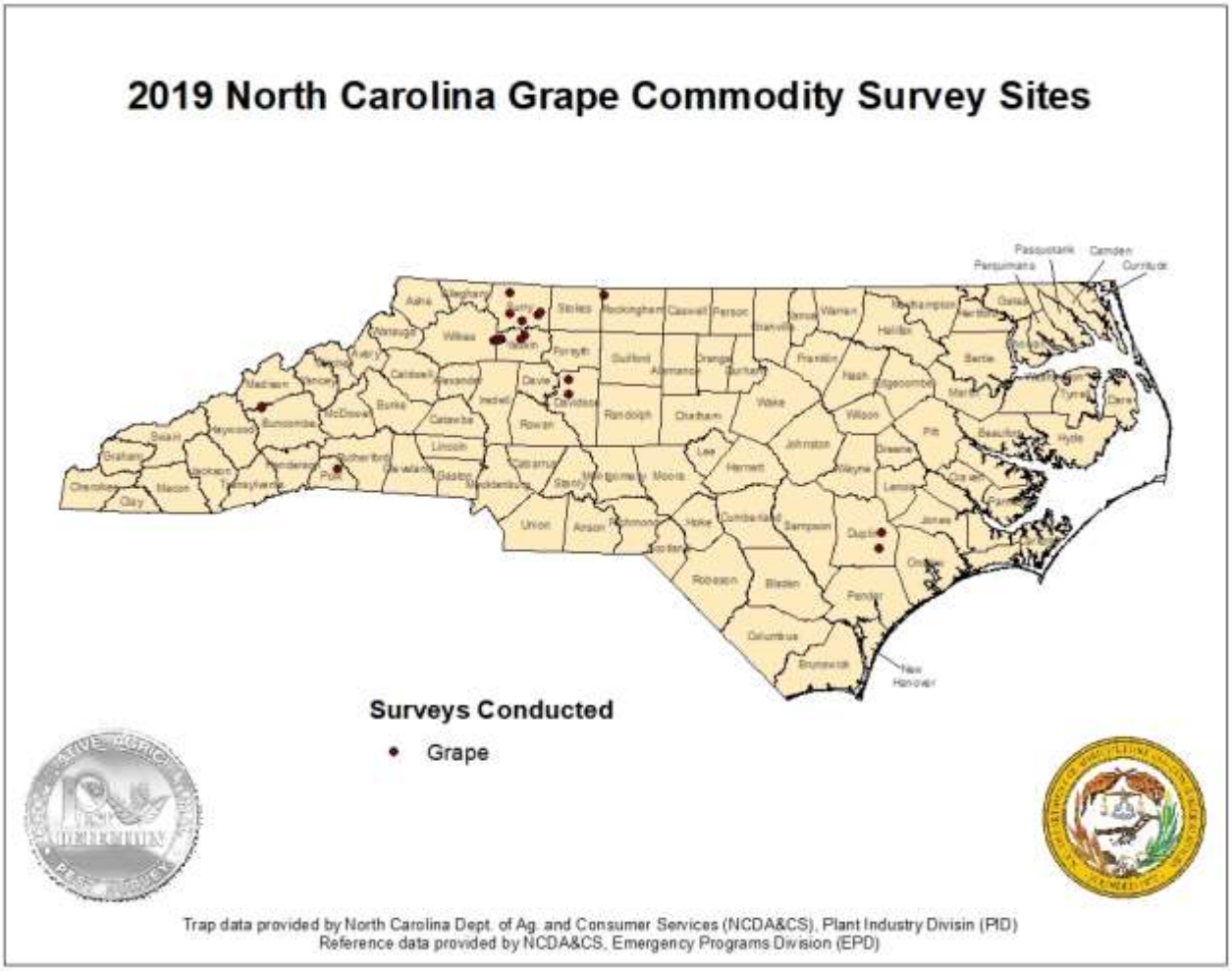


Figure 3. Grape commodity survey sites for 2019 season.

Solanaceous Commodity

Four exotic plant pests of the solanaceous commodity were surveyed; tomato leaf miner (*Tuta absoluta),* old world bollworm *(Helicoverpa armigera),* Tomato fruit borer (*Neoleucinodes elegantalis)* and golden twin spot moth (*Chrysodeixis chalcites).* All are regarded as being highly destructive pests of solanaceous crops and pose a significant threat to North Carolina agriculture as the state has host material and climate conducive to supporting these exotics. We surveyed thirty-five host sites that included commercial tomato, eggplant, tobacco and pepper production fields (Figure 4).

Old world bollworm is known for quickly developing levels of resistance to commonly used insecticides, including resistance to transgenic crops using Bt. Capable of long-distance migration, it may adapt to environmental conditions if it becomes too warm or dry. Economically, it is one of the costlier pests and reports of serious losses up to 100% are common in infested areas. Early detection and identification of this pest will limit spread to the natural environment and aid in eradication.

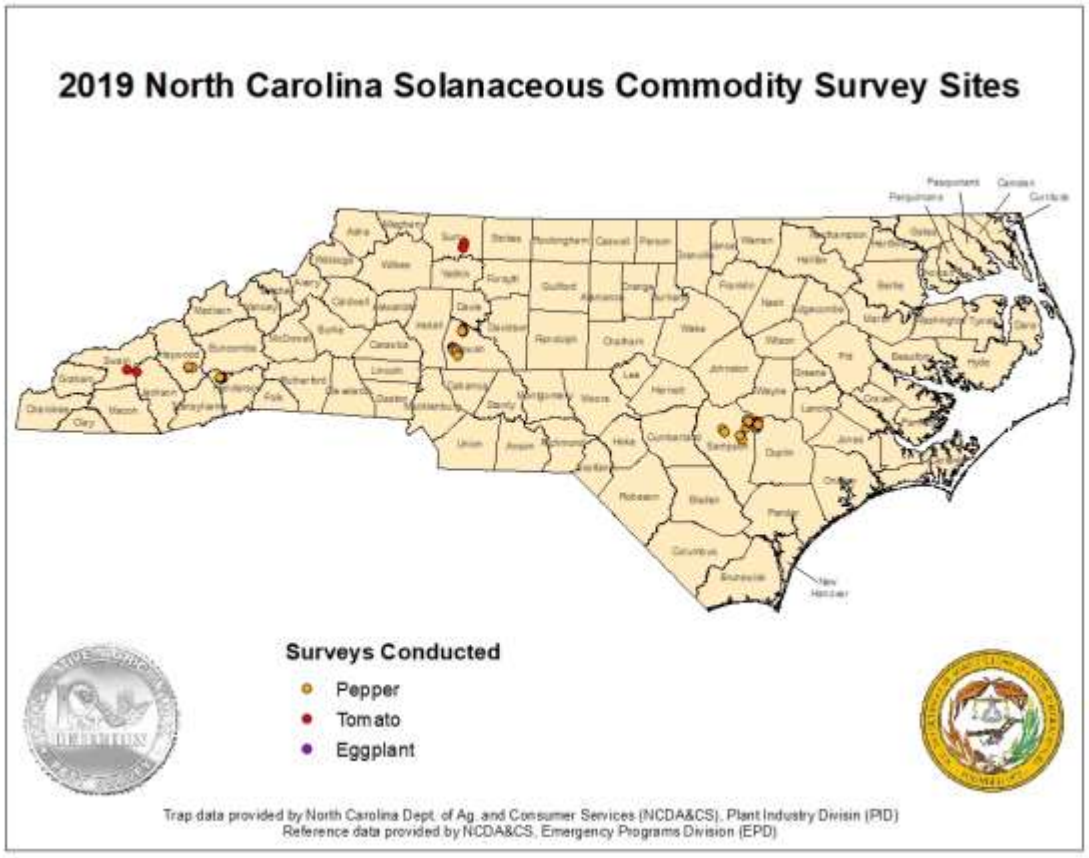


Figure 4. Solanaceous commodity survey sites for 2019 season.

Samples were collected from all traps and were later screened for the presence of target pests during the month of October. A taxonomic expert hired to help with this project conducted acid digestions to rule out positive identifications for *Helicoverpa armigera.*

Phytophthora spp.

North Carolina conducted a *Phytophthora ramorum and P. kernoviae* survey during 2019. Both pathogens pose a significant threat to NC forests and nurseries. *Phytophthora kernoviae*, also known as phytophthora leaf blight, is not known to occur in the U.S., but does infect important plant species including; *Quercus*, *Magnolia*, *Rhododendron* and *Pieris*. *Phytophthora ramorum*, also known as sudden oak death, has been present along parts of the Pacific Northwest since the mid-1990s. The primary pathway for these pathogens is from trade of infected ornamental plants and since both pathogens share common hosts and affect stem and leaf tissue, a survey was developed to include both pathogens for improved efficiency. This survey is still ongoing and will not finish until spring 2020. All suspect samples were screened for the presence of *Phytophthora spp*. using Enzyme Linked Immunosorbent Assay (ELISA) with positive samples forwarded to Kansas State University-Manhattan Diagnostic Laboratory for further diagnostics. To date, all forwarded samples have tested negative for our targets.

Entomological Programs

SWEETPOTATO WEEVIL PROGRAM

North Carolina's sweet potato production continues to be a success as demand for sweet potatoes increases in the national and international markets. The success of the sweet potato industry in NC is attributed to several factors including an efficient marketing strategy and strong research programs at state universities aimed at developing new and better varieties of sweet potatoes. Additionally, at NCDA&CS Plant Industry Division, we manage an intensive regulatory program intended to keep the sweetpotato weevil (*Cylas formicarius*; SPW), the most important pest of sweet potatoes in the world, out of production areas in NC. SPW is a pest of regulatory concern that can significantly affect the NC sweet potato industry by 1) reducing yields in affected fields, 2) damaging the quality of infested sweet potatoes, 3) increasing the production cost for farmers, and 4) imposing restrictions to the movement of sweet potato from affected to non-affected areas in NC and outside of NC.

Our mission at NCDA&CS Plant Industry Division is to implement effective plant pest programs to reduce the risk of accidental introductions of SPWs into NC sweet potato production areas and to mitigate and eradicate weevil populations that might have been introduced to the state in order to protect the NC sweet potato industry. Early detection and rapid response (EDRR) of weevil detections is instrumental for a successful eradication program. Our most important tool for EDRR is surveys. Every year, surveys are conducted throughout the state using traps baited with lures containing a female-produced pheromone that attracts male sweetpotato weevils. These traps are deployed in production fields, regulatory sites including but not limited to storage, processing and packing facilities, micropropagation greenhouses, and/or any other sites where regulated articles for sweetpotato weevil are found. Traps are also deployed in the NC sweetpotato weevil quarantine area in New Hanover and Brunswick counties to monitor potential movement of sweetpotato weevils into the production areas and to conduct research.

Field Surveys

Field surveys were conducted from mid-August through September 2019 in 56 counties, primarily in eastern North Carolina. 12,505 traps were set in 11,352 fields in approximately 93,020 reported acres (Table 1), a significant acreage increase from 2018. Trap set was done following the established guidelines and protocols developed by the Southern Plant Board (SPB) in 1995. Traps were deployed at a minimum of one trap per 10 acres with a minimum of two traps per field (exceptions were made if a field was under two acres). Conventional green boll weevil traps were used because of their low cost (Figure 1a). Traps were deployed at an average density of one trap for every 5.73 acres and left in the field for an average of 30 days. These values are in accordance with the established SPB sweetpotato weevil survey guidelines. Custom-made georeferenced pdf maps were used in mobile devices (iPad minis) to navigate and locate sweet potato fields and to collect data including time and date of trap set, field type (reported, unreported, and absent), and coordinates (latitude and longitude) for each trap set. Data collected during the trap pull process include the trap condition (lost, damaged, good) and the number of weevils found. **No weevils were found in field surveys during this period in 2019.**

TABLE 1. NC SWEETPOTATO WEEVIL FIELD TRAPPING SUMMARY (2019)

County	Mapped Fields	Reported Acres	Traps Set[1]	County	Mapped Fields	Reported Acres	Traps Set[1]
Anson	1	0.02	--	Martin	110	1375.97	115
Avery	1	1	1	Montgomery	11	74.8	24
Beaufort	80	296.54	42	Moore	1	0.05	1
Bertie	64	768.29	115	Nash	1301	8747.84	1464
Bladen	22	291.72	16	Northampton	21	224.14	18
Brunswick	2	9	2	Onslow	10	54.14	10
Camden	1	3	2	Orange	1	0.56	1
Carteret	3	4.99	7	Pamlico	20	105.24	24
Chowan	43	435.21	69	Pasquotank	5	45.57	9
Columbus	96	781.94	107	Pender	23	316.87	33
Craven	30	250.62	37	Person	5	49.08	9
Cumberland	158	1798.87	265	Pitt	427	4213.78	544
Davidson	1	0.75	1	Polk	2	8.48	4
Duplin	275	2654.43	374	Robeson	56	905.97	109
Edgecombe	982	9698.651	1190	Rockingham	5	20	8
Forsyth	6	30.55	10	Rowan	1	0.1	--
Franklin	38	204.31	38	Rutherford	4	1.49	3
Granville	54	200.05	54	Sampson	1456	14893.56	1933
Greene	531	5136.4	507	Scotland	1	0.25	--
Guilford	18	92.08	12	Stokes	1	5	2
Halifax	165	1067.97	152	Tyrrell	2	7	4
Harnett	526	2968.67	530	Vance	2	4.9	3
Hertford	51	801.38	106	Wake	131	850.39	133
Jackson	1	1	--	Warren	18	87.44	13
Johnston	1710	12168.16	1529	Washington	1	1.4	2
Jones	6	60.08	4	Wayne	919	7833.8	1008
Lee	6	11.88	9	Wilson	1592	9915.049	1329
Lenoir	354	3537.5	524	Yadkin	1	2	2
				Total	11,352	93,019.93	12,505

[1]Counties with traps set labeled '--' reported acres with no crop present therefore no traps were placed.

Regulatory Sites

Sweet potato regulatory sites include but are not limited to storage facilities, processing plants, micropropagation units and greenhouse operations growing ornamental sweet potatoes and were surveyed all year long. Because of the inter- and intra-state movement of sweet potatoes these regulatory sites are a high risk pathway for the introduction of sweetpotato weevil. Universal moth traps (or bucket traps) were used instead of the conventional green boll weevil traps in the field because of the higher trapping efficiency (Figure 1b). For these operations, a minimum of two traps (one inside and one outside) were set per structure containing sweet potatoes. Traps were placed in strategic locations where sweet potatoes are stored and/or in and around the locations outside the buildings were sweet potatoes are loaded or unloaded. Lures were changed in each

trap once a month and data collection was done using the same procedure detailed for the field surveys. A total of 249 regulatory sites (totaling 3,600 inspections) were surveyed and **no weevils were found in storage facilities during the 2019 season.**

a)  b) 

Figure 1. a) Green boll weevil trap baited with sweetpotato weevil lure used to survey sweet potato fields; b) bucket traps used to survey storage facilities

Sweetpotato Weevil Eradication (Phase 2)

NCDA&CS Plant Industry Division was awarded a Specialty Crop Block Grant (SCB Grant; USDA Farm Bill 2014) to determine the spatial and temporal distribution of sweetpotato weevil populations in the quarantine area of North Carolina (portions of New Hanover and Brunswick Counties) with the goal using the data collected to develop a plan to eradicate the pest North Carolina. Phase 1 of the project (the population data collection phase) concluded in December 2017. We were awarded a second SCB grant for Phase 2 of the project (the eradication phase) which began January 2018. From January through March new high efficiency traps were designed and built. These traps are a modification of the traps used in Phase 1 and include a galvanized mesh "skirt" for the weevils to easily walk into the bucket traps and a solar-powered LED light that produces a green light at night to attract the weevils (Figure 2). These traps were deployed in the SPW quarantine area in April 2018 and are being checked weekly for presence of weevils. This project is ongoing and is expected to continue beyond the SCB grant duration (expires June 2020).

Figure 2. Details of the sweetpotato weevil trap to use in the MAT. The base of the trap is a funnel made with galvanized mesh (3). This allows weevils to walk to the bucket trap fitted within a PVC ring that holds the funnel (2). The bucket trap includes a solar cell (1) that charges an LED diode

that produces a green light shown to attract more weevils. The diode is activated late in the evening when weevils are active and deactivated when there is sunlight.

GYPSY MOTH SLOW THE SPREAD AND ERADICATION PROGRAM

In 2019, NCDA&CS, in cooperation with USDA-APHIS-PPQ, USDA-Forest Service (USFS), and the Slow the Spread (STS) Foundation, carried out an extensive trapping, treatment, regulatory, and alternate life stage survey program aimed at detection and eradication of European gypsy moth (EGM), a major invasive pest of hardwood trees. The program in North Carolina is divided into two different areas, STS and Eradication, as shown in Figure 1.

Trapping

A total of 17,612 traps were set in 100 counties in NC from April to June 2019 and removed from July to September 2019. Traps were baited with disparlure, the female-produced sex pheromone of gypsy moth (2-methyl-7R, 8S-epoxy-octadecane). Trap locations and data were recorded in iPad units. 1,019 adult gypsy moth males were captured in 507 positive traps in NC in 2019. Positive catches were entered into the gypsy moth trapping database at Virginia Tech. Results of these surveys are shown in Table 1 and in Figure 1.

Male moth captures in 2019 were much higher than last year. As expected, higher captures were along the Virginia-North Carolina border, probably due to pressure from mounting populations within the generally infested area to the north of those areas. Seven Mating Disruption (MD) treatments totaling 18,580 acres, one Larvacide (*Btk*) treatment of 490 acres, and multiple delimiting grids are proposed for 2020 to follow up in high-capture locations.
Per 2019 USDA-APHIS-PPQ protocol as stipulated in the cooperative agreement (AP19PPQFO000C145), trapping surveys were conducted in the Eradication area (all non-STS area). Delta traps were set in an area-wide grid of 1 trap per 3 kilometers, with some delimit areas where one trap is placed every 500 or 1000 meters to closely monitor a suspected reproducing EGM population. Funding provided by USDA-APHIS-PPQ was used to employ 10 temporary employees, buy the necessary survey supplies (including traps, lures, trap assembly supplies, and office supplies), and for operational expenses (including fuel and maintenance for survey vehicles).

In the STS area, 9 contractors set traps in 30 bid units, according to site data provided by the STS Foundation in cooperation with Virginia Tech. Delta traps were set in an overall grid of 1 trap per 2 kilometers along the northern portion of the STS area; all other portions of the STS area were trapped at a density of 1 trap per 3 kilometers. Locations with high catches the previous year or areas under evaluation from treatments in previous years were surveyed in a 500-meter or 1000-meter grid utilizing either high-density milk carton traps or delta traps. Temporary personnel and permanent NCDA&CS personnel performed quality control work at a minimum of 10% on traps set by contractors, and no significant quality issues were noted.

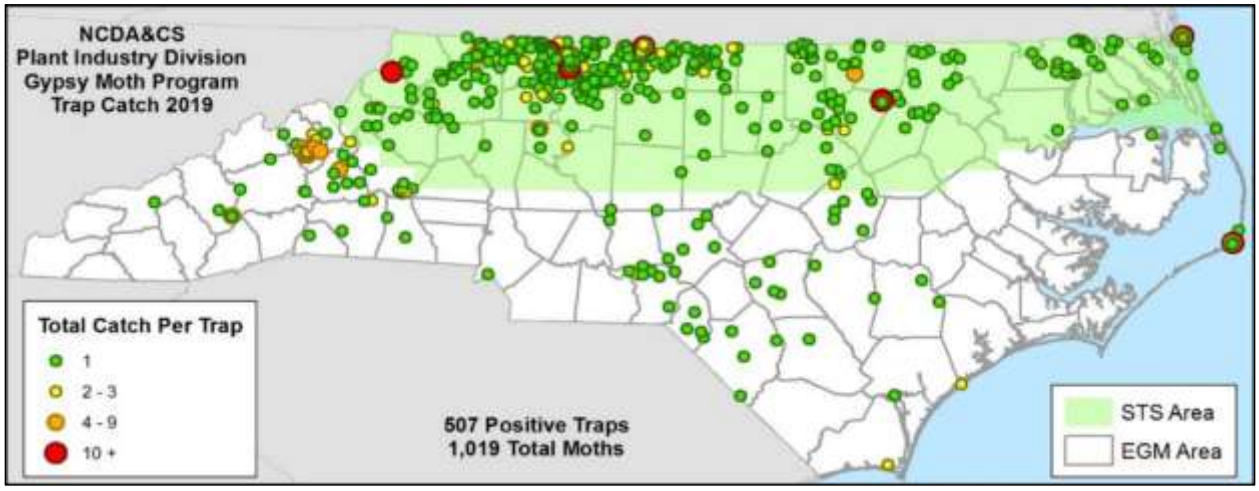


Figure 1. North Carolina gypsy moth trap catches in 2019.

Table 1. 2019 survey results in NC showing total number of traps placed per county, number of positive traps for gypsy moth in each county, and the total number of moths in positive traps.

County	Total Traps	Positive Traps	Moths Caught
Alamance	176	3	3
Alexander	78	1	1
Alleghany	181	18	32
Anson	148	0	0
Ashe	304	4	4
Avery	73	4	4
Beaufort	203	0	0
Bertie	309	1	1
Bladen	260	1	1
Brunswick	243	1	2
Buncombe	180	4	5
Burke	161	9	13
Cabarrus	103	0	0
Caldwell	142	5	6
Camden	138	3	3
Carteret	106	0	0
Caswell	271	26	30
Catawba	122	0	0
Chatham	201	0	0
Cherokee	96	0	0
Chowan	82	0	0
Clay	40	0	0
Cleveland	134	2	2

Columbus	266	0	0
Craven	151	0	0
Cumberland	187	4	4
Currituck	198	13	223
Dare	216	7	25
Davidson	167	0	0
Davie	102	6	14
Duplin	234	2	2
Durham	119	3	3
Edgecombe	149	0	0
Forsyth	206	8	8
Franklin	247	22	80
Gaston	111	0	0
Gates	267	22	28
Graham	35	0	0
Granville	380	14	15
Greene	75	0	0
Guilford	267	5	5
Halifax	452	7	7
Harnett	171	0	0
Haywood	121	3	6
Henderson	114	0	0
Hertford	228	3	5
Hoke	108	0	0
Hyde	126	0	0
Iredell	176	1	1
Jackson	103	0	0
Johnston	230	8	9
Jones	73	0	0
Lee	72	0	0
Lenoir	108	0	0
Lincoln	87	0	0
McDowell	101	7	12
Macon	83	0	0
Madison	110	0	0
Martin	126	0	0
Mecklenburg	169	1	1
Mitchell	60	1	1
Montgomery	127	1	1

Moore	206	6	6
Nash	170	6	6
New Hanover	63	0	0
Northampton	359	5	5
Onslow	145	0	0
Orange	178	2	2
Pamlico	86	0	0
Pasquotank	148	1	1
Pender	206	2	3
Perquimans	146	1	1
Person	263	0	0
Pitt	184	0	0
Polk	66	1	1
Randolph	220	2	2
Richmond	134	8	9
Robeson	272	4	4
Rockingham	499	41	69
Rowan	150	0	0
Rutherford	167	3	4
Sampson	273	2	2
Scotland	87	4	4
Stanly	116	0	0
Stokes	493	68	101
Surry	492	53	71
Swain	45	1	1
Transylvania	65	0	0
Tyrrell	54	1	1
Union	183	0	0
Vance	248	6	9
Wake	249	4	4
Warren	317	5	5
Washington	83	0	0
Watauga	184	8	34
Wayne	166	0	0
Wilkes	432	23	25
Wilson	118	0	0
Yadkin	189	7	9
Yancey	83	23	83
Total	**17612**	**507**	**1019**

Treatment

One mating disruption treatment was conducted in North Carolina in 2019 totaling 1,095 acres (see below in Figure 2). This block received one dose of SPLAT Gypsy Moth-Organic at a rate of 6 grams per acre. This site will be trapped in 2020 and 2021 to determine the efficacy of the treatments.

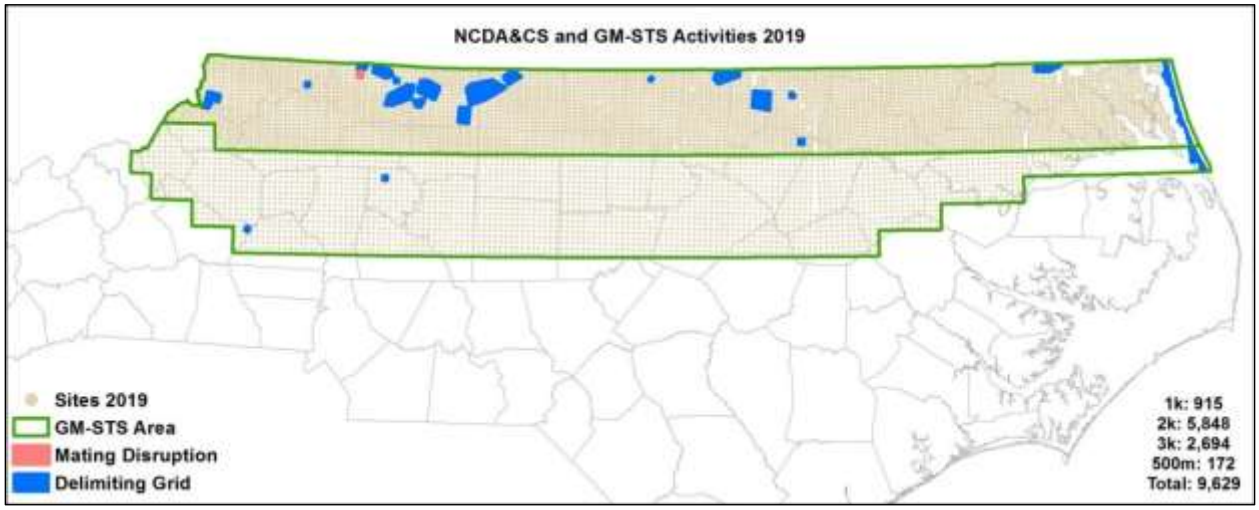


Figure 2. 2019 gypsy moth treatment site and delimiting grids.

Table 2. 2019 gypsy moth treatment, county, and acreage. For product, MD 6g = mating disruption at 6 grams per acre.

Year	Block Name	County	Product	Dosage	Acres
2019	NC_Lambsburg_1	Surry	SPLAT GM-O	6g	1095
TOTAL					1095

Regulatory

The gypsy moth program also seeks to mitigate the risk of artificial introduction and spread through a comprehensive regulatory program. An area that is generally infested is quarantined so that the movement of certain high-risk articles, such as logs, outdoor household articles, and nursery plants, is strategically restricted per USDA-APHIS-PPQ regulations. In North Carolina, all of Currituck County and a small portion of Dare County were quarantined in 1988. A map of the North Carolina gypsy moth quarantine area is shown in Figure 3.

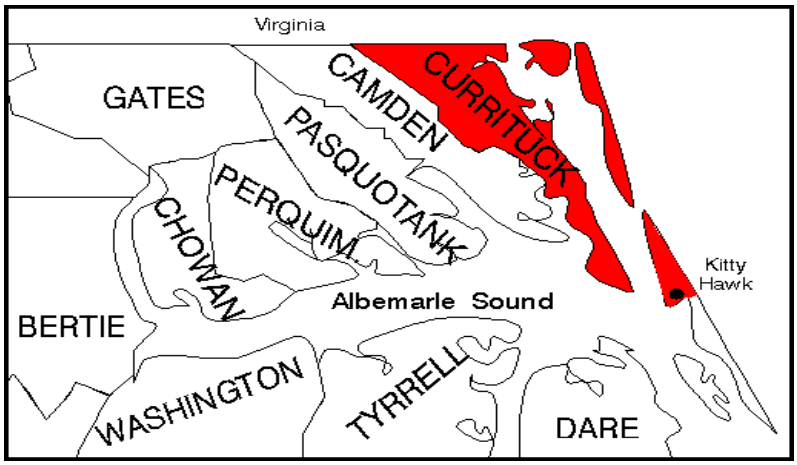


Figure 3. Gypsy moth quarantine in North Carolina, shown in red.

Regulated articles may be moved from quarantined to non-quarantined areas if the appropriate personnel undergo training and submit to the stipulations of a Compliance Agreement with NCDA&CS. These compliance agreements require inspection and/or treatment of articles to ensure that they are free of gypsy moth life stages. Several businesses and individuals received training for new staff and several new Compliance Agreements were issued.

Public education efforts are also an important part of the regulatory program. Staff visits NC Cooperative Extension and NC Forest Service offices to update county personnel on program changes. Also, program personnel monitor all high-risk locations in the STS program area by the placement and removal of traps. However, NCDA&CS receives no dedicated funding for these efforts, so the future character of the program will be determined by future allocations.

IMPORTED FIRE ANT PROGRAM

The Imported Fire Ant (*Solenopsis invicta*; IFA) continues to be a serious pest in the southern United States with infestations occurring in 14 states and Puerto Rico. North Carolina is on the leading edge of the expanding range of fire ants. Currently, 75 of North Carolina's 100 counties are either partially or entirely infested. NCDA&CS' objective is to prevent the artificial spread of IFA from infested areas to non-infested areas through regulatory actions.

Survey

Drive-by surveys were conducted in sixteen counties (Alexander, Buncombe, Burke, Caldwell, Davie, Forsyth, Guilford, Haywood, Henderson, Iredell, Jackson, Madison, McDowell, Person, Swain, and Transylvania) in NC (Figure 1; Table 1). Data was collected using iPads and the ESRI Survey 123 for ArcGIS application and included new IFA mounds and established sites. The option to choose '0 mounds' was included and indicates sites with no mounds reported. This was used to show the areas surveyed in all counties (negative controls). There were a few cases where the surveyor returned to an established site to find that the fire ants successfully treated and thus no mounds were found where there were some previously. Based on the results of the 2019 IFA survey we recommend expanding our North Carolina IFA quarantine to include all or parts of Burke, Guilford, Jackson, and McDowell Counties in 2021. Virginia has expanded their IFA quarantine along the North Carolina border extending beyond our current NC IFA quarantine boundaries. In 2020, we will expand our survey to include the NC-VA border along the newly expanded VA IFA quarantine line.

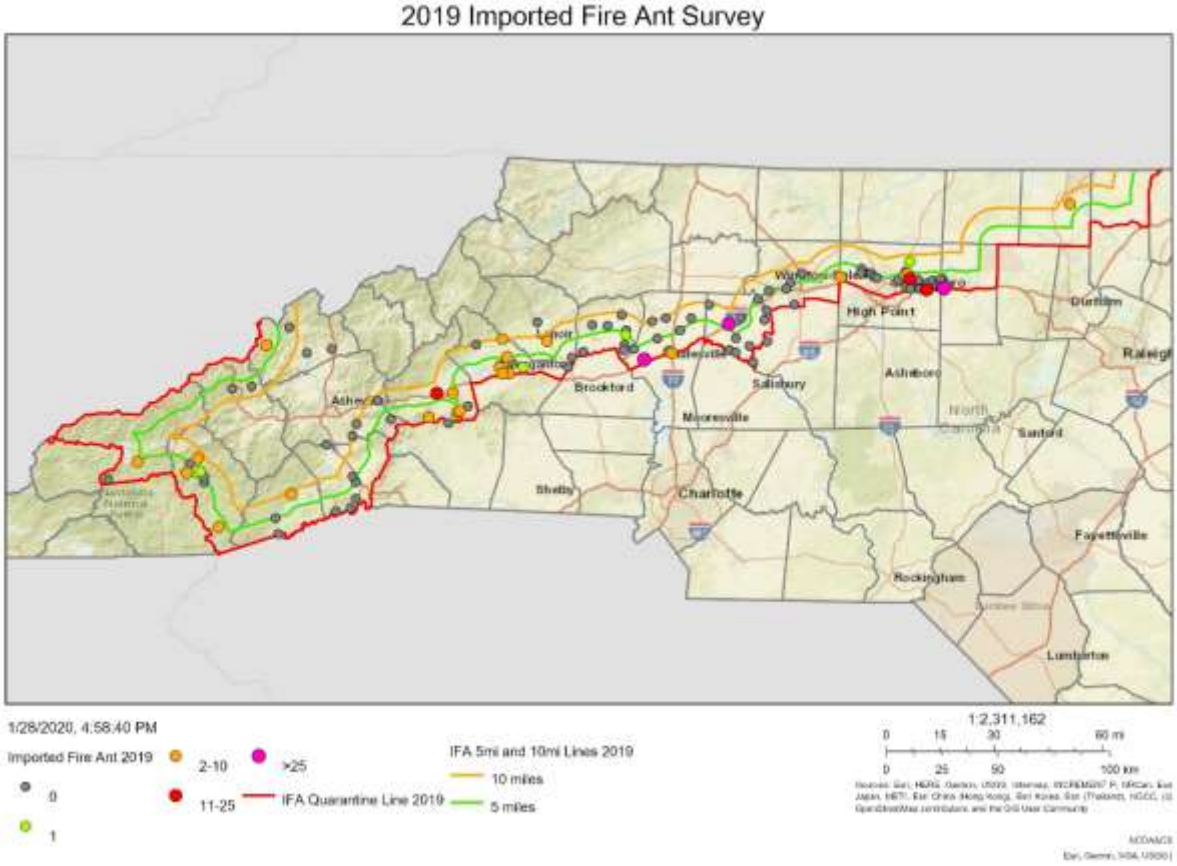


Figure 1. 2019 NC Imported Fire Ant survey results

TABLE 1. NC IMPORTED FIRE ANT SURVEY SUMMARY (2019)

County	Areas Surveyed	Regulatory Action Recommended[1]	Absent	Established Sites	New Observation[2]	Total
Alexander	10-mile strip from the NC IFA quarantine line	No action	7		1	**8**
Buncombe	10-mile strip from the NC IFA quarantine line	No action	5			**5**
Burke	5-mile strip from the NC IFA quarantine line	Expand 2021	3	5	5	**13**
Caldwell	10-mile strip from the NC IFA quarantine line	No action	2	1	1	**4**
Davie	5-mile strip from the NC IFA quarantine line	No action	10		1	**11**
Forsyth	10-mile strip from the NC IFA quarantine line	No action	6			**6**
Guilford	5-mile strip from the NC IFA quarantine line	Expand 2021	31		10	**41**
Haywood	5-mile strip from the TN IFA quarantine line	No action	2			**2**
Henderson	5-mile strip from the NC IFA quarantine line	No action	5			**5**
Iredell	10-mile strip from the NC IFA quarantine line	No action	6	3	1	**10**
Jackson	10-mile strip from the NC IFA quarantine line	Expand 2021	3	4	1	**8**
Madison	5-mile strip from the TN IFA quarantine line	No action	3	1		**4**
McDowell	10-mile strip from the NC IFA quarantine line	Expand 2021	2	1	5	**8**
Person	10-mile strip from the NC IFA quarantine line	No action			1	**1**
Swain	5-mile strip from the NC IFA quarantine line	No action	1			**1**
Transylvania	10-mile strip from the NC IFA quarantine line	No action	2	1		**3**
Total			**88**	**16**	**26**	**130**

[1]"No action" when numbers are not enough to justify a regulatory action. "Expand" when partially quarantined counties have shown significant numbers of IFA mounds above the quarantine line. "Add" when there is conclusive evidence that a significant number of IFA mounds are detected in a county where no previous mounds have been reported.
[2]For the purposes of this table new observations are only recorded for presence of mounds. If a new observation was recorded but there were no mounds present that is not recorded on this table.

Regulatory

As part of the IFA program's regulatory activities, blitzes were also conducted in three locations across the state to enforce that operations moving regulated articles outside the quarantine area in NC are in compliance with federal and state regulations. A total of 10 blitzes were conducted during Spring 2019 from March 4 to March 26 at the weigh stations in Halifax (I-95 corridor in Halifax County), Mt. Airy (I-77 Corridor in Surry County), and Hendersonville (I-26 corridor in Henderson County) (Table 2). Halifax County blitzes are usually the busiest, though inclement

weather slowed things down during the first week and the weigh station was not operating the second week forcing us to cancel the scheduled blitzes. One soil sample was collected during the Halifax blitzes. Of the 10 trucks we stopped during the Surry County blitzes all but one were carrying B&B material; the other truck was carrying baled hay. However, none of the trucks were traveling from the IFA quarantine so no samples were taken. We did speak with the farmer moving baled hay about setting him up under compliance if the IFA quarantine expands to his area in the future. We stopped three trucks during the Henderson Co. blitzes. In total 16 trucks were stopped for the purposes of assessing their load and reviewing/recording their paperwork.

A total of 12 blitzes were conducted during Fall 2019 from October 1 to October 23 in three locations across North Carolina for a total of 6 days—two each in Halifax County (I-95 Northbound Weight Station), Surry County (I-77 Northbound Weigh Station), and Henderson County (I-26 Westbound Weigh Station) (Table 2). Normally we would hold four days of blitzes in Halifax County but NC Plant Protection Section (NCDA&CS-PID) hosted the Horticultural Inspection Society-Southern Chapter Annual Meeting in October so we didn't hold blitzes that week so all our staff could attend the meeting.

As is typical, Halifax County blitzes were the busiest with eight trucks stopped and six soil samples collected. We only stopped two trucks over the two days in Surry County—one truck was not actually coming from the NC IFA quarantine area, so no sample was collected and the other was hauling dirty equipment. We inspected the equipment for presence of IFA and found none, then educated the driver on the importance of removing all loose soil from any equipment prior to exiting the NC IFA quarantine. In Henderson County, we stopped three trucks; however, we collected no samples because all the plant material was either greenhouse grown or cut flowers.

In total, 13 trucks were stopped for the purposes of assessing their load and reviewing/recording their paperwork. Based on this year and other Fall IFA blitzes in recent years, we suspect there is simply less plant material moving in late October, especially in western NC, as the weather begins to grow colder. For 2020 we will aim to hold the Fall blitzes slightly earlier to hopefully account for this.

Soil samples from seven (Spring = 1; Fall = 6) vehicles were collected and processed from regulated articles such as potted plant containers and B&B trees and all samples were sent for chemical analysis (NCDA&CS Food and Drug Protection Division Laboratory) to determine the levels of bifenthrin or any other approved pesticides as required by the federal and state regulations. All samples showed detectable levels of bifenthrin, chlorpyrifos, diazinon, fenoxycarb, fipronil, hydramethylnon, methoprene, pyriproxyfen and/or tefluthrin in compliance with the levels required by state and/or federal regulations.

TABLE 2. NC IMPORTED FIRE ANT BLITZES SUMMARY (2019)			
Date	**Location**	**Trucks Stopped**	**Trucks Sampled**
03/04/19	Halifax Co. (I-95 Northbound)	0	0
03/05/19		3	1
03/11/19		CANCELLED[2]	
03/12/19		CANCELLED[2]	
03/18/19	Surry Co. (I-77 Northbound)	3	0
03/19/19		7	0
03/25/19	Henderson Co. (I-26 Westbound)[3]	0	0
03/26/19		3	0
10/01/19	Halifax Co. (I-95 Northbound)	3	2
10/02/19		5	4
10/15/19	Surry Co. (I-77 Northbound)	0	0
10/16/19		2	0
10/22/19	Henderson Co. (I-26 Westbound)	3	0
10/23/19		0	0
TOTALS:	**22 Blitzes[1]**	**29**	**7**

[1]Corresponds to 6 days and two blitzes per day (with the exception of the Spring Henderson blitzes which only occurred during the morning).

[2]Despite getting prior approval from NC State Highway Patrol to hold IFA Blitzes on March 18 & 19, the weigh station was not operating on either of these days meaning we were unable to conduct the scheduled blitzes.

[3]The weigh station person scheduled to operate the Henderson County weigh station each afternoon was sick and the weigh station unfortunately closed at 1pm on both days limiting the time we were able to spend conducting these Henderson Co. blitzes.

BLUEBERRY CERTIFICATION PROGRAM

The blueberry maggot (*Rhagoletis mendax*; BBM; Figure 1) is a serious pest of both lowbush and highbush blueberries. Infestations of this pest lead to unmarketable berries, reductions in yield, and increased production costs. The maggot is native to eastern North America and is found in the eastern United States, including North Carolina. While native to Nova Scotia, New Brunswick, and Prince Edward Island, the pest was detected in Ontario and Quebec in the mid-1990s—two regions where the maggot had not previously been known to exist. As a result, Canada regulates *R. mendax* to prevent spread of BBM into provinces that are currently free of this pest. The Blueberry Certification Program (BCP) was initiated by the Canadian Food Inspection Agency (CFIA) in 1999 to facilitate the movement of fresh blueberries while managing the risk of further spread of the blueberry maggot into non-infested areas of Canada.

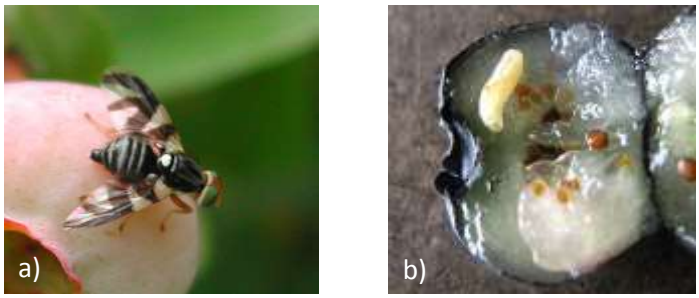


Figure 1. Blueberry maggot (*Rhagoletis mendax*): a) adult; b) larva inside blueberry (Photos by Rufus Isaacs, MSU)

In North Carolina, we currently have 51 blueberry farms located in four southeastern NC counties (Bladen, Duplin, Pender, and Sampson) participating in the Blueberry Certification Program. In May 2019, we mailed out the annual blueberry maggot flight letter informing all growers in the program that they should begin their internal audits. All growers are required to perform a brown sugar or salt flotation test on their berries every three days starting from when they receive their flight letter until they are done packing and shipping for the season. The flotation test involves soaking two pints of gently crushed berries in either a sugar or salt solution for 10 minutes to observe whether any maggots float to the surface (Figure 2; the complete method can be found at http://www.ncagr.gov/plantindustry/Plant/entomology/BlueberryCertificationProgram.htm).

Figure 2. Salt flotation test: a) blueberries soaking in salt water solution for 10 minutes; b) close-up of flotation test showing potato masher used to gently crush berries. (Photos by Whitney Swink, NCDA&CS)

In late May, NCDA&CS Plant Protection personnel began traveling to each farm to perform the annual regulatory audit. The NCDA&CS audit consists of performing the flotation test and checking the calendar spray treatment and/or trapping records (if utilizing IPM) to ensure the growers are following the CFIA BCP regulations. Every single grower in the program elected to use the salt solution (as opposed to the brown sugar solution). The results were negative for all audits performed (both internal and regulatory).

In 2017, we began using Survey 123 to record data collected during the audits which fine-tuned the data collection process through use of a "smart form" (a form that modifies the input fields based on the data being collected; e.g. if a grower is using the calendar spray program the form will not ask you questions about IPM trapping results). We continued using Survey 123 in 2019 and plan to continue its use in 2020.

COTTON BOLL WEEVIL PROGRAM

Field surveys for the cotton boll weevil (*Anthonomus grandis*) were coordinated and carried out by the NC Cotton Boll Weevil Eradication Foundation. In 2019, a total of 493,798 acres were reported in 50 counties (Table 1). Plant Industry Division personnel surveyed cotton gins, cotton processing facilities, and ornamental cotton (n=48) in 31 counties using conventional cotton boll weevil traps, similar to those used for sweetpotato weevil field surveys (Table 2). Traps were baited with a male specific sex pheromone and checked once a month.

TABLE 1. COTTON ACREAGE BY COUNTY (2019)

Anson	1,863.4300	Gates	15,623.5697	Pasquotank	757.1928
Beaufort	15,578.25	Greene	10,377.4658	Perquimans	13,218.3741
Bertie	30,995.552	Halifax	63,115.7515	Pitt	16,183.8166
Bladen	11,390.8675	Harnett	8,558.6600	Richmond	4,092.5110
Cabarrus	905.3540	Hertford	14,620.5000	Robeson	17,831.0165
Camden	524.6400	Hoke	7,992.0760	Rowan	533.1900
Carteret	400.4400	Hyde	9,550.9959	Sampson	19,794.2130
Chowan	10,609.5100	Johnston	5,891.6870	Scotland	4,871.1600
Cleveland	104.0300	Jones	12,589.3900	Stanly	13,379.7160
Columbus	1,902.4800	Lenoir	12,592.6100	Tyrrell	4,143.3640
Craven	9,419.2500	Lincoln	111.1200	Union	1,994.1300
Cumberland	6,520.4000	Martin	33,665.6608	Wake	378.5100
Currituck	55.2600	Montgomery	435.64900	Warren	184.3300
Davidson	1,129.2300	Moore	564.5300	Washington	6,019.8532
Duplin	8,371.1877	Nash	9,085.7600	Wayne	9,457.8039
Edgecombe	26,782.4151	Northampton	38,665.4487	Wilson	6,599.2906
Franklin	488.3700	Onslow	3,878.0000	**Total**	**493,798.02**

TABLE 2. NUMBER OF COTTON GINS/SITES SURVEYED BY COUNTY (2019)

Anson	1	Edgecombe	1	Jones	2	Pitt	2
Beaufort	1	Forsyth	1	Lenoir	1	Robeson	4
Bertie	2	Gates	1	Martin	1	Rowan	1
Bladen	1	Greene	1	Mecklenburg	3	Sampson	3
Chowan	1	Halifax	5	Montgomery	1	Stanly	1
Craven	1	Hertford	1	Nash	1	Wake	1
Cumberland	1	Hyde	1	Northampton	4	Wilson	1
Currituck	1	Johnston	1	Perquimans	1		

SPOTTED LANTERNFLY PROGRAM

Spotted lanternfly (*Lycorma delicatula*) is a relatively new invasive insect from Asia that was first detected in the United States in Berks County, Pennsylvania in 2014. The pest has spread into and become established in portions of Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia. In 2019, North Carolina received Farm Bill funding (AP19PPQFO000C170) to begin a statewide survey for spotted lanternfly via finding and mapping host material (in this case *Ailanthus altissima*; tree-of-heaven) throughout the state.

To date, well over 14,000 tree-of-heaven (TOH) have been identified throughout North Carolina with roughly 30,000 miles driven while conducting this survey (Figures 1 & 2). An additional 1200+ TOH were identified within and around nurseries while field specialists conducted their inspections. Surveillance for this major host began in June and ended shortly after leaf fall. In conducting this survey, we noted that a clear line may be drawn going north and south breaking the state into thirds for TOH density; east, central and west. The eastern third of NC is described here as the I-95 corridor and points east which has sparsely populated TOH. Of those locations most are often associated with smaller towns usually near railroad tracks or dilapidated and abandoned buildings. Large, dense stands of this species are rare within this area. The central region has much more abundance of TOH and can readily be found growing in large clumps along roadsides, farms, rail tracks, industrial and residential areas and metropolitan areas. The central region goes from I-77 to I-95 and holds all major metropolitan areas for the state which include Charlotte, Winston-Salem, Greensboro and Raleigh. The western third of NC has very large stands of TOH and the tree is readily found almost anywhere. Depending on where the survey is being conducted common lookalikes are sumac, chinaberry and black walnut saplings.

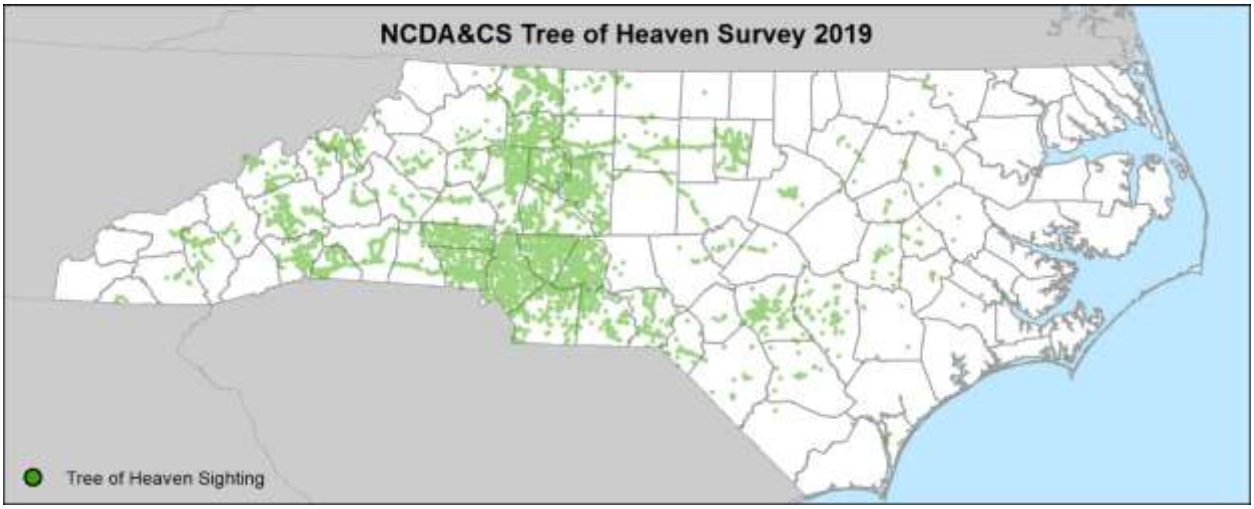


Figure 1. Tree of Heaven sightings in North Carolina in 2019. Each sighting may represent between 1-100+ individual TOHs.

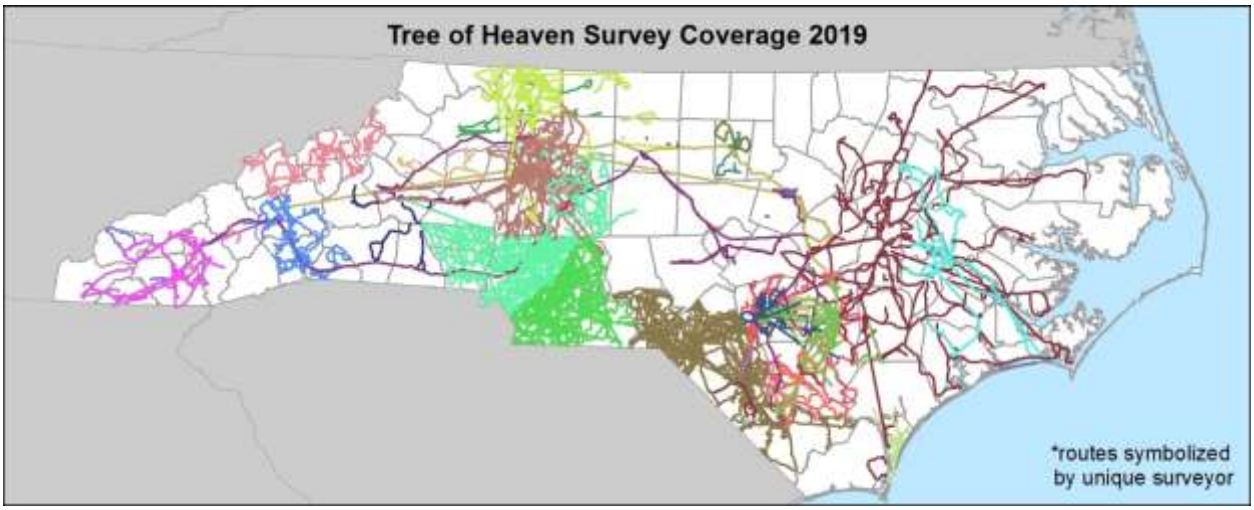


Figure 2. Surveying paths for the 2019 North Carolina Tree of Heaven survey. Each color represents a different surveyor.

Nine full-time temporary employees helped to conduct this first half of our survey effort, combined with all nineteen full-time field staff at nursery locations while conducting their annual certifications. The program managers who are overseeing this survey were also active participants in identifying TOH locations. These program managers provided the educational guidance to all field staff and full-time temporary help to get this work accomplished by holding numerous meetings within our group and working one on one with field staff to properly identify TOH and record it using iPads. Other program managers and their field staff were also active in helping with our survey efforts.

In addition to our statewide survey we have made great effort to prepare our staff and the citizens of North Carolina for the likely future spread of spotted lanternfly into our state. Our staff made two trips to the SLF quarantine area in Pennsylvania to work with Pennsylvania Department of Agriculture (PDA) staff to see first-hand how property assessments are completed and what the SLF ground treatments (both the herbicide and insecticide applications) look like. The first trip occurred in early June when first instars were beginning to emerge, and the second trip was in late August when adults were active. Both trips were invaluable to our staff and we appreciate PDA for taking the time to work with us.

In late June, NCDA&CS and USDA-APHIS-PPQ staff completed a joint tabletop exercise to simulate an emergency response to a spotted lanternfly detection in North Carolina. This exercise served as an excellent tool in planning for an eventual detection of this pest in our state. We recognize that one of the most important aspects of early detection and rapid response is outreach and education, so we focused a great amount of time on spotted lanternfly education. We developed a spotted lanternfly presentation that covers life cycle of the pest, biology, signs & symptoms, regulatory status, and planned response in North Carolina and have presented across the state to students, educators, foresters, extension specialists, master gardeners, landscape & turf professionals, and many others. We plan to continue our outreach efforts in 2020.

In early October 2019 we had our first detection of spotted lanternfly in North Carolina; a dead adult was found by a business owner in Asheville, NC which is in the western third of our state. We sent a small team to investigate the report and determined it arrived on a shipment from the Pennsylvania SLF quarantine area. We are confident only one dead hitchhiker traveled on that shipment but scouted the surrounding area for host material and further signs of the pest just in case.

BROWN GARDEN SNAIL SURVEY

The brown garden snail (*Cornu aspersum*; BGS) was intentionally and illegally introduced into a small area in Kill Devil Hills (Dare County), North Carolina in the mid-1980s as part of a project intended to raise and sell these mollusks to restaurants and businesses (heliculture farming, which is prohibited in North Carolina). BGSs are a non-native species of mollusk that can be a potentially destructive pest for agriculture, and specifically the nursery industry.
Since BGS was reported in North Carolina, and a small population was established in the Kill Devil Hills area, NCDA&CS has been monitoring and containing its spread with periodic applications of molluscicides (Sluggo®) and by manually killing snails.

WALNUT TWIG BEETLE PROGRAM (THOUSAND CANKERS DISEASE)

The walnut twig beetle (*Pityopthorus juglandis*) is a vector of a serious disease of forest trees affecting primarily black walnuts (*Juglans nigra*) and butternuts (*Juglans cinerea*) called thousand cankers disease (*Geosmithia morbida*; TCD). Our plant pathologist currently runs the TCD program and the work done on the program is covered in the plant pathology section of the NCDACS-PID-PPS annual report.

FOREST PEST OUTREACH PROGRAM

The Forest Pest Outreach Program (funded by USDA Farm Bill Agreement AP19PPQFO000C210) supports public outreach centered on invasive forest pests. An ongoing central goal of this program is to help prevent the spread of forest pests throughout North Carolina. The impacts and benefits from conducting statewide invasive pest outreach will result in quicker detection of incipient populations of pests, lead to a greater number of individuals reporting pests, and cause positive behavioral changes from the public that reduce the negative impacts of invasive pests and aid with slowing their spread. This in turn will help protect million-to-billion dollar nursery, forest, and agricultural industries.

Events & Trade Shows

A major component of our outreach program was giving oral and poster presentations at events such as extension field days, commodity meetings, industry professional days, and university classes across the entire state. We covered a wide range of invasive pest topics such as gypsy moth, imported fire ant, and spotted lanternfly. A highlight of our outreach in 2019 was conducting a webinar for Master Gardeners covering a relatively new invasive pest, the spotted lanternfly. During the webinar we covered the life cycle, behavior, signs & symptoms, and regulatory concerns of the pest. In addition to the webinar, the spotted lanternfly presentation was given 13 times over the course of the year to a wide range of audiences. The presentation is available online at: https://gardening.ces.ncsu.edu/spotted-lanternfly-resource-page/

In addition to the above we also participated in two major annual outreach events in North Carolina—Bugfest and the North Carolina State Fair. In September, we staffed tables highlighting important forest pests at the NC Museum of Natural Science's "Bugfest", which has a total attendance of greater than 30,000 people. For 10-days during mid-October, we teamed with NC Forest Service Forest Health personnel to man a booth featuring the "Don't Move Firewood" message at the NC State Fair (total attendance of roughly 1 million people). An estimated 1000+ people were directly impacted by our presence at both events.

We will also staff a booth at the upcoming *Green & Growin'* nursery industry trade show, the NC SweetPotato Commission Annual Meeting, the NC Christmas Tree Association Annual Meeting, and the NC Blueberry Open House & Trade Show thereby reaching both the general public and agricultural industry professionals with our invasive pests message.

Educational Materials

In addition to conducting outreach every day at the North Carolina State Fair we also developed a large banner to raise awareness of spotted lanternfly with a "See it. Snap it. Report it." message (Figure 1). We had nine of these banners produced and set them up near entrances and major thoroughfares at the NC State Fairgrounds.

Figure 1. Spotted lanternfly banner for NC State Fair

We wrote pest awareness articles for two North Carolina industry magazines which were published in the summer and fall. The first was an article on spotted lanternfly written for the NC Nursery & Landscape Association magazine, *Nursery & Landscape Notes*, a quarterly magazine distributed to approximately 1,200 green industry professionals. The second was an article on spotted lanternfly and elongate hemlock scale written for the NC Christmas Tree Association (NCCTA) magazine, *Limbs & Needles*, a quarterly publication distributed to all members of the NCCTA. We also wrote a press release highlighting the importance of checking vehicles, campers, and outdoor equipment for anyone traveling to and from the spotted lanternfly quarantine over the summer. We timed the release to coincide with many people's summer vacations to attempt to draw greater attention to the issue as travel increased (https://www.ncagr.gov/paffairs/LookoutforSpottedLanternflythisSummer.htm).

We continually update our outreach materials with the current scientific and geographic pest information and have been providing handouts (e.g. pest alerts, pest information brochures, etc.) and educational giveaways at all outreach events we attend. We have produced materials covering invasive pests such as gypsy moth, imported fire ant, spotted lanternfly, and crape myrtle bark scale. Our major focus right now is educating as many people as possible about the threat of spotted lanternfly to our forests, agricultural commodities, and green industry and we have designed numerous materials to help spread our message far and wide.

Movement of Live Insects for Research, Commercial or Education Purposes

The Entomological Programs Manager evaluated 137 federal applications for PPQ 526 e-Permits in 2019. The large number of applications to move insects into North Carolina reflects the continued strong market in entomological research, commerce, and education in the state conducted by our public and private institutions.

Current Insect Quarantines in North Carolina

Regulatory Species	Quarantines as of December 2019
Emerald Ash Borer (*Agrilus planipennis*)	The e**ntire state** of North Carolina was placed under quarantine in 2015.
Gypsy Moth (*Lymantria dispar*)	**Currituck County** and a small portion of **Dare County.** Quarantine area remained unchanged relative to 2017.
Imported Fire Ant (*Solenopsis invicta*)	No changes were made to the IFA quarantine in 2019. A total of **75 counties** are under entire or partial quarantine in NC.
Sweetpotato weevil (*Cylas formicarius*)	Coastal areas of **Brunswick** (Caswell Beach) and **New Hanover** (Carolina Beach and Kure Beach) counties.
Walnut Twig Beetle (*Pityopthorus juglandis*)	**Haywood County.** Quarantine area remained unchanged relative to 2017.

Nursery Certification Program

NCDA&CS' Plant Protection Specialists inspected 2,803 nursery dealers and nurseries during the 2019 season.

A license issued by the NCDA&CS is required by any person selling nursery stock in North Carolina. Nursery stock is defined as "all wild or cultivated plants or parts thereof, trees, shrubs, vines, bulbous plants and roots, grafts, scions and buds." Excluded in North Carolina's definition of nursery stock are "annual plants; cut flowers; tree, field, vegetable, flower or other true seeds; decorative plants or plant parts without roots not intended for propagation; and perennial plants intended for indoor use that are produced in North Carolina." A *nursery license* is required for any person growing and selling nursery stock whereas a *nursery dealer license* is required for any person obtaining and re-selling nursery stock. These licenses certify that plant material has been inspected for and is apparently free from potentially harmful quarantine pests and must be renewed yearly.

The NCDA&CS Plant Protection Section licensed 1,106 nurseries and 1,697 nursery dealers during the 2019 calendar year (Table 1). Of the 1,106 nurseries, 504 were registered nurseries and 602 were certified nurseries. A *registered nursery* has less than one acre of nursery stock and does not sell outside the state. A *certified nursery* has one or more acre of nursery stock and/or sells outside the state.

The data show a slight decrease in the number of nurseries and the number of acres that were certified. Nursery dealer licensure decreased more dramatically due to the loss of nearly 400 locations of a statewide retailer who sold seasonal regulated material. Despite these decreases, the stability in nursery production as well as nursery dealer locations indicates the strength and staying power of North Carolina's nursery industry.

Table 1. Number of NC nursery and nursery dealer licenses by year[1]

Calendar Year	Number of Licenses by Category				Total Number of Licenses	
	Registered Nursery[2]	Certified Nursery[3]	Nursery Dealer[4]		Nurseries (Registered & Certified)	Nurseries & Dealers
2014	590	654	2,782		1,244	4,026
2015	594	612	3,188		1,206	4,394
2016	642	651	2,957		1,293	4,250
2017	620	646	2,858		1,266	4,124
2018	515	610	2,043		1,125	3,168
2019	504	602	1,697		1,106	2,803

[1] Data based on receipt of license fees.
[2] Registered nursery – a location with less than once acre of nursery stock with no sales outside the state.
[3] Certified nursery – a location with one or more acre of nursery stock and/or sales outside the state.
[4] Nursery dealer – a location where nursery stock is sold, usually to the end user, but not actually grown.

The primary objective of Plant Industry's Nursery Program is to facilitate the movement of nursery stock while preventing the introduction and spread of quarantine plant pests into and within North Carolina. The movement of infested nursery stock represents one of the ways plant pests may be moved from one location to another and has the potential to directly impact both wholesale and retail nursery operations. North Carolina works to prevent such outbreaks by coordinating with other states and nursery industry to bring awareness of threats to the state.

Stop sale/movement notices are issued when high levels of pests and/or prohibited plants are noted. Plants can either be treated and/or destroyed when a stop sale/movement notice is issued. Plants can be released for sale/movement if testing of the material confirms they are free of the suspected pest(s). In 2019 stop sale/movement notices were issued for box blight (*Calonectria pseudonaviculata*) on cut greenery, sweet potatoes and sweet potato vines originating from a state or region quarantined for Sweet Potato Weevil (*Cylas formicarius*), bailed hay harvested from fields infested with Broomrape (*Orobanche minor)*, aquatic plants for sale infested with Hydrilla (*Hydrilla verticillata*), Crepe Myrtles for sale infested with Crepe Myrtle Bark Scale (*Eriococcus lagerstroemiae*) and Ruscus for sale infested with *Phaeosphaeriopsis glaucopunctata*.

Phytosanitary and Export Certification Program

Within the Phytosanitary and Export Certification Program, Plant Protection Specialists issue phytosanitary certificates to growers and/or brokers to facilitate movement of agricultural commodities to other states and to other countries. Phytosanitary certificates indicate that inspections and other specific requirements of the importing states or countries have been met. State certificates are used for movement within the U.S., and federal certificates are required for movement to another country. Countries and states vary greatly in what they require for various types of commodities such that careful research and interpretation of requirements are needed for each request for phytosanitary certification.

A phytosanitary certificate provides documentation that a plant, plant part, or plant-based product has been inspected and is apparently free of harmful pests. Each state and country has very specific import phytosanitary requirements that are tailored to protect their agricultural industries and natural environment from potentially harmful pests.

The NCDA&CS Plant Protection and Export Certification Specialists facilitate interstate and international movement of plants, plant parts, and plant-based products by issuing both state and federal phytosanitary certificates to NC growers and brokers. State and federal phytosanitary certificates are issued for interstate and international movement, respectively. The NCDA&CS is responsible for implementing the state export program while the USDA is responsible for implementing the federal export program. However, the NCDA&CS works in collaboration with the USDA to issue federal phytosanitary certificates to support international export of plant-based products from NC.

Primary use of the USDA PCIT (Phytosanitary Certificate Issuance and Tracking) System to issue federal certificates began in October 2009. The number of federal and state phytosanitary certificates issued using the PCIT system is included in Table 2. In 2019, NCDA&CS staff issued 9,209 federal phytosanitary certificates and 3,191 state phytosanitary certificates. The number of federal phytosanitary certificates issued in 2019 represented an increase of 18.95% over 2018 figures while the number of state phytosanitary certificates issued represented an increase of

235.54% from the previous year. The significant increase in state phytosanitary certificates was primarily due to shipping requirements for sweet potato seeds and cuttings to meet the NC Guava Root Knot Nematode (*Meloidogyne enterolobii*) internal quarantine. On December 14, 2019 the European Union enacted phytosanitary regulations requiring all US agricultural commodities to ship with a federal phytosanitary certificate. In the month of December alone, NCDA&CS Plant Pest Specialists issued more than 300 federal phytosanitary certificates for sweet potatoes destined for the European Union. North Carolina is number 1 in the nation in sweet potato production and sweet potato exports. To support the increased demand for federal phytosanitary certificates generated by sweet potato exports to the European Union, Plant Industry Division hired 5 temporary, full-time employees to complete inspections for the issuance of federal phytosanitary certificates. Federal certificates were issued for the movement of commodities to 93 countries, while state certificates were issued for all 50 states, Puerto Rico, and the US Virgin Islands. Most phytosanitary certificates issued were for lumber, logs, tobacco, cotton, cotton seed, Christmas trees, peanuts, nursery and greenhouse plants, sweet potatoes, and sweet potato cuttings.

Table 2. Number of phytosanitary certificates issued through the PCIT[1] system

Fiscal Year	Federal					State
	Plant or Plant Part	Re-export	Processed Plant Product	Total		Total
2010/2011	2,781	21	0	2,808		323
2011/2012	4,221	13	18	4,252		206
2013 (Calendar Year)	5,830	15	134	6,658		412
2014 (Calendar Year)	6,980	32	172	7,184		348
2015 (Calendar Year)	6,560	21	162	6,743		561
2016 (Calendar Year)	7,140	17	199	7,356		703
2017 (Calendar Year)	7,932	15	91	8,038		580
2018 (Calendar Year)	7,729	15	18	7,762		951
2019 (Calendar Year)	9,179	24	30	9,233		3,191

[1] PCIT = Phytosanitary Certificate Issuance and Tracking (USDA web-based application)

Plant Conservation Program

NORTH CAROLINA PLANT CONSERVATION BOARD

The Plant Conservation Program meets quarterly with members of the NC Plant Conservation Board (the Board) whose seven members are appointed by either the Governor or the Commissioner of Agriculture. Members in 2019 included: Damon Waitt (chair) Les Hunter, Julie Moore, Alexander Krings (vice-chair), David Hyatt, Jonathan Lanier, and Bruce Williams. In September, the Governor appointed James Slye to replace Les Hunter as representative of the NC Forest Service and Dr. Gary Walker to replace Alexander Krings as representative of the botanical community.

In 2019, the Board sent letters to the multiple Clerks of Court across North Carolina requesting notification of convictions related to illegal taking of plants as it pertains to NCGS §14-79 and §14-129. In December, they received the first notification from McDowell County for the illegal taking of American ginseng.

NORTH CAROLINA PLANT CONSERVATION SCIENTIFIC COMMITTEE

PCP meets regularly with members of the NC Plant Conservation Scientific Committee. This seven-member committee consists, primarily, of positions designated to the committee by law. Members include Alan Weakley (chair), Dennis Niemeyer, Richard Braham, Johnny Randall, Hervey McIver, Laura Robinson, and Jerry Reynolds. In late 2019 Laura Robinson resigned from her position at the Natural Heritage Program. Misty Buchanan participated as the NHP representative until the position was rehired in the first week of January 2020.

The Committee continued work on updating the NC protected plant list following procedures and protocols established during the last update in 2008. The Committee sent a final recommendation to the Board for additions, deletions, and technical changes to the Board in October. Final review of the recommended changes is expected in early 2020.

PLANT CONSERVATION PRESERVE SYSTEM

PCP and the Board have the regulatory authority to establish Plant Conservation Preserves to protect imperiled plant species. These Preserves are the only state-managed lands selected and designed specifically for plant conservation purposes. Due to concerns about resource damage and plant poaching, access is limited to guided tours or by permit issued from PCP. To help engage the public about rare plants and their conservation, PCP conducts guided preserve tours for the public through 10 months of the year. The Preserve system now consists of 26 Preserves distributed across North Carolina (Figure 1). One new preserve was added in 2019, the McIntosh Bays Preserve in Scotland County along with additional acres added to the Paddy Mountain Preserve in Ashe County, the Butner Cedar Glade Preserve in Granville County, and the Eastwood Preserve in Moore County.

PCP's newest property is McIntosh Bays in Scotland County. This acquisition was a collaborative project between The Nature Conservancy (TNC) and PCP. This site is home to nine protected plant species plus an extirpated record of federally endangered Canby's dropwort (*Oxypolis canbyi*). This project closed in September 2019.

In partnership with Three Rivers Land Trust, approximately 15 acres were added to Eastwood PCP Preserve in Moore County in June 2019. This adds exceptional habitat to better protect the state endangered Sandhills lily (*Lilium pyrophilum*) within the imperiled Sandhills seepage slope natural communities. In July, in partnership with the Blue Ridge Conservancy, approximately 65 acres were added to Paddy Mountain PCP Preserve in Ashe County. This addition adds exceptional habitat and improves the boundary of the preserve to better protect the rock outcrop which is home to two federally listed plant species, Heller's blazing star (*Liatris helleri*) and Roan mountain bluet (*Houstonia montana*), along the existing western preserve boundary. Also in 2019, approximately 1 acre was added to the Butner Cedar Glade PCP Preserve in Granville County. This is PCP's smallest Preserve and this new acre brings the total acreage up to 6.5 acres; however, this Preserve is home to 10 listed plant species. The new acre expands protection of these plants and provides protection to one new state endangered species, veined skull-cap (*Scutellaria nervosa*), not previously documented within the Preserve.

Figure 1. PCP Preserve System

PARTNERSHIP & OUTREACH PROJECTS

The Plant Conservation Program's closest partner is the Friends of Plant Conservation (FOPC), a non-profit organization dedicated to supporting the mission of PCP. FOPC helps with fundraising, supporting education and outreach opportunities on behalf of PCP. Due to concerns about resource damage and plant poaching, PCP conducts guided preserve tours open to the public with help from FOPC. Twelve such guided tours were offered at Dulany Bog, Caraway, Redlair, Eastwood, Eno River Diabase Sill, Paddy Mountain, Bat Fork Bog, Ochlawaha Bog, and Cedar Mountain Bog reaching citizens across the state. Each trip provides participants the opportunity to observe rare plants while also learning more about land management and ecological stewardship.

In partnership with the NC Botanical Garden Foundation, FOPC initiated a campaign to create a new NC vehicle license plate to support rare plant conservation. The plate design highlights Venus flytrap and uses the slogan, "Home of the Venus Flytrap" (Figure 2). These two organizations, with extra support from PCP staff, have been calling for the minimum 500 applications by early 2020 to meet the annual legislative deadline for new plate submissions. If this plate is successful,

annual revenue would be shared by NC Botanical Garden Foundation and FOPC to support rare plant conservation, including that conducted by PCP.

Figure 2. Home of the Venus Flytrap license plate design.

The Plant Conservation Program is a member of several statewide or regional conservation partnerships and staff participates in these partnerships as time allows. The PCP has also continued to work closely in partnership with conservation organizations and land trusts across the state in land acquisition and management as well as regional consortiums such as the Bog Learning Network, the Southern Blue Ridge Fire Learning Network, the Greater Uwharrie Conservation Partnership and Cape Fear Arch. Also of note, PCP has expanded its partnerships with the NC Museum of Natural Science, the NCDA Research Stations, and the NC Forest Service.

In addition, PCP staff's outreach to the public includes special presentations and by filling information requests. In 2019, staff gave presentations across the state for festivals such as Bug Fest and Darwin Day both at the NC Museum of Natural Sciences as well as for annual meetings of the NC Invasive Plant Council, the Southern Chapter of the Horticultural Inspector Society, the Society of Ecological Engineers, and for the Friends of Plant Conservation.

PCP staff supported, helped plan, and presented at the Rare Plant Conservation Discussion Meeting in February, cohosted by the NC Botanical Garden and the NC Zoo. These annual meetings provide a venue for presentation of new research as well as to hold discussions and pose questions regarding rare plants. These meetings are attended by faculty and students of multiple universities as well as staff from numerous state and federal agencies and provides a good opportunity for PCP to keep current and possible partners abreast of important news related to PCP.

CLEAN WATER MANAGEMENT TRUST FUND

PCP staff did not prepare grant applications to the Clean Water Management Trust Fund (CWMTF) in 2019. However, we were represented in partner applications for fee simple purchases that would be transferred to PCP as new Preserves or additions to Preserves.

UNITED STATES FISH & WILDLIFE SERVICE (USFWS) PARTNERSHIP

PCP and USFWS continued a long-standing cooperative agreement related to the recovery of endangered and threatened plant species in North Carolina. Grant funds obtained under this cooperative agreement provide critical funds to North Carolina each year. This funding covers the program's research specialist position. A portion of the remaining funds support PCP temporary employees for part of the year. The funding from this partnership supports imperiled plant monitoring, preserve management targeted towards federally-listed, candidate, and at-risk plant species, and regulatory programs including protected plant permit evaluation and issuance.

USFWS REVERTED FUNDS GRANTS

Intermittently, USFWS offers grant opportunities for reverted Section 6 funds to cooperating states. This regional and national competition awards funds to high priority conservation projects. In May this year, PCP submitted a proposal to develop nine management plans for protected populations in the PCP preserve system. In September we learned that we were awarded full funding for this project through 2024.

PCP previously received funding for two additional reverted funds grants, one to reintroduce two wetland species which have been extirpated from NC and the other to support imperiled plant conservation efforts in non-PCP state-owned lands. The first of these two grants is titled "*Reintroducing Two Federally Listed Wetland Species (White fringeless orchid, Platanthera integrilabia & Canby's dropwort, Oxypolis canbyi)".* PCP has developed a propagation for reintroduction plan for *P. integrilabia* at the Bat Fork Bog Preserve. Seeds were collected by partners from the Atlanta Botanical Garden and the US Forest Service and are being grown at Atlanta Botanical Garden for eventual outplanting at the PCP Preserve.

The other species listed on this grant is Canby's dropwort. This plant is also extirpated in NC, with the only known pop last observed in 2004 at McIntosh Bays in Scotland County. There is no known safeguarded material from this population. So, PCP proposed to develop a management plan at this site and reinitiate annual monitoring for this species for 5 years. We're hoping this monitoring will allow us to see it reemerge in response to already ongoing restoration. If it does not, PCP has identified a donor population in South Carolina for propagation and augmentation. If this species does reemerge naturally, then propagated individuals would be returned to their parent populations. PCP Staff has worked on burn plan writing and site monitoring during 2019. The burn complexity at this site is very high requiring several meetings with The Nature Conservancy, NC Forest Service, and other stakeholders to devise a plan for future management efforts including burning. This grant has been extended until December 2021, in part due to the exceptionally slow growth rate of the orchids to be reintroduced.

The second grant is titled "Rare species management to support recovery and potential downlisting (smooth coneflower, *Echinacea laevigata*; swamp pink *Helonias bullata*; and mountain purple pitcher-plant, *Sarracenia purpurea* var. *montana*). Funds from this grant have helped PCP offer assistance and planning advice to two NC Department of Agriculture and Consumer Services divisions to manage rare plant species on their lands. First the NC Forest Service recently acquired additional acres for their DuPont State Forest which has mountain bog habitat and several rare species. PCP Staff have helped monitor and update records of these habitats and plant populations as well as devise a series of management suggestions for their consideration. In the process of this field work, two new imperiled plant populations were discovered, one a federally listed pitcher-

plant and the other so rare this find represents the third of three known extant populations world-wide. The second project supports the NC Research Stations with management and augmentation of smooth coneflower and several other state-listed species at the Picture Creek Diabase Barrens Nature Preserve. PCP is collaborating with the NC Botanical Garden to grow several of these species from seeds collected on site to later outplant into recently restored areas.

REGULATORY PROGRAMS

PCP is responsible for the protection and conservation of 419 plant species across NC, of which 27 are also federally listed. Staff convenes quarterly meetings with an interagency panel to review permit requests for projects affecting these protected plant species. PCP staff continues to review requests for permits from individuals or institutions requesting to move or collect protected plants, including all state and federally listed plant species in North Carolina. This permit requirement applies to transplant and rescue projects, nurseries which propagate and sell protected species, as well as many scientific research projects. The review process incorporates input from the US Fish and Wildlife Service, NC Natural Heritage Program, and advisory capacity from NC Botanical Garden. Twenty-four protected plant permits were issued and several additional requests were evaluated during 2019. PCP works with the Plant Protection Section to issue Certificates of Origin for protected plant species being propagated for sale as part of the nursery inspection process carried out by inspection specialists.

Venus Flytrap

No new projects involving Venus flytraps (*Dionaea muscipula*) were begun in 2019 by PCP Staff directly; however, our partners at NC Natural Heritage Program initiated a species status update survey which PCP staff helped advise. In January, NHP hosted a meeting to gather updated knowledge about flytrap populations to inform their monitoring season. PCP provided population data, burn history, and guidance for site visits to Boiling Spring Lakes and Hog Branch Ponds Preserves. For 2019, NHP focused monitoring efforts on public lands and will continue the survey on private lands in 2020. PCP will be attending future meetings to continue to help with this process, as needed.

American ginseng

American ginseng (*Panax quinquefolius*) harvest and exports from North Carolina continued under regulations adopted by the NC Plant Conservation Board. Without monitoring by PCP, harvest and export from North Carolina will not be allowed by federal authorities who have listed this plant under the Convention on International Trade in Endangered Species (CITES). The harvest season for American ginseng is September 1st through December 31st. The buying season for wild or wild-simulated green ginseng is September 1st through March 31st. The buying season for wild or wild-simulated dry ginseng is September 15th through March 31st.

NCDA&CS certified over 6,146 pounds of calculated dry wild collected and wild simulated ginseng during the 2018 - 2019 season representing 28 North Carolina counties. A total of 43 ginseng dealer license permits were issued during the 2018 - 2019 season.

Galax

The sale of wild-collected Galax (*Galax urceolata*) is regulated in North Carolina within a regulated buying season which prohibits harvest during the early growing season to allow for new leaves to emerge and grow. In North Carolina, Galax (*Galax urceolata*) may only be legally bought or sold during the buying season of June 15th through April 15th.

PRESERVE MANAGEMENT

The Program continues to strive to manage Preserves for the benefit of the rare plant species and habitats present and to conduct sufficiently detailed monitoring to determine the status of rare species at these sites. Some examples are as follows:

Controlled Burning Program

Prescribed burning is one the most pressing management needs across the Preserve system and around NC to enhance rare species populations and improve habitats for these species. With assistance and support from NC Forest Service and other partners, PCP staff were able to conduct 20 prescribed burns totaling 1,550 acres across 8 preserves this past year, which is a record high number of acres. This burn unit acreage represents a stunning ~11% of the total acreage within the PCP Preserve system. PCP continues to be responsible for all phases of burn planning and preparation as well as mop-up after the burns were conducted. Staff have been in contact with numerous NCFS District and County offices around the state to begin or expand further collaboration for the upcoming year.

Preserve Management Highlights:

Bat Fork Bog (Henderson Co.): Staff continued efforts to implement a treatment plan for optimal herbicide control methods for the highly invasive reed canary grass (*Phalaris arundinacea*). The long-term goal for this preserve is to restore the artificial meadow to a swamp forest like the adjacent areas of the preserve and to restore habitat for the existing and extirpated protected plant species known to this site.

Boiling Spring Lakes & Hog Branch Ponds (Brunswick Co.): The use of mechanical mulching and midstory removal continued in 2019 to restore longleaf pine savannas and pond pine flatwoods across these Preserves which have become heavily overgrown with shrubs. In many cases, the mulching machine is used to prepare burn units to allow for a safer controlled burn by removing ladder fuels and thus reducing the flame intensity. With significant help from NC Forest Service staff and grant funds they obtained, 864 acres were burned at these two preserves this year.

Butner Cedar Glade (Granville Co.): PCP staff worked to refresh and maintain control lines as well as control invasive species such waxyleaf privet (*Ligustrum quihoui*), nandina (*Nandina domestica*), and Japanese stilt grass (*Microstegium vimineum*). Monitoring data were collected for several rare plant species and submitted to the Natural Heritage Program.

Cedar Mountain Bog (Transylvania County): PCP Staff held two very effective workdays to clear overgrown *Rhododendron* and mountain laurel brush from around bog habitat. This effort will have an immediate benefit to several rare plant species, including recently reintroduced swamp pink, but will also allow for the restoration of some of the bog habitat edges by improving water flow and sunlight. Additional volunteer and staff time was devoted to controlling roadside weeds like sericea lespedeza.

Eno River Diabase Sill (Durham Co.): Staff spent time thinning the midstory here to open the canopy and facilitate effective prescribed burns. Staff and volunteers worked to reduce and control invasive species populations such as Japanese stilt grass, sericea lespedeza (*Lespedeza cuneata*), and Queen Anne's lace (*Daucus carota*) as well as numerous other invasive plants. More than a mile of fire line was refreshed in preparation for burning the site. One controlled burn was conducted on one of the larger, more difficult units at this site with help from NC Forest Service.

Dulany Bog (Jackson Co.): PCP staff and partners from the Friends of Plant Conservation, US Forest Service, and Highlands Biological Foundation, held a collaborative workday to remove midstory brush from around rare bog plants including mountain purple pitcher plants (*Sarracenia purpurea* var. *montana*) and swamp pink. Additional plants were discovered in this process which was very encouraging.

Hebron Road (Durham Co.): Management efforts were focused on control of invasive exotic species, focusing primarily on Japanese stilt grass and hairy jointgrass (*Arthraxon hispidus*). Additionally, control lines were also refreshed for upcoming prescribed burns.

Pondberry Bay Preserve (Sampson Co.): Prescribed burning was a focus at this preserve this year. With tremendous help from the NC Forest Service, Staff were able to conduct six burns for a total of 366 acres for the year, supporting several rare plant communities within the Preserve.

Redlair (Gaston Co.): The Redlair Preserve Management Plan was completed in 2019. PCP Staff and volunteer steward Haywood Rankin worked to control invasive species such as wisteria (*Wisteria sinensis*), Chinese privet, autumn olive (*Elaeagnus umbellata*), Japanese stilt grass, and hairy jointgrass across the Preserve. The Redlair Preserve is unique within the preserve network for having its own stewardship committee devoted to advising PCP staff on management of this Preserve. This committee developed a plan to use native woody plants to restore areas of the Preserve which have had infestations of invasive plants removed. A new controlled burn unit was established, and a successful controlled burn was conducted in the spring with the help of the NC Forest Service.

The Redlair Observatory, a research collaborative with UNC-Charlotte, the Redlair Foundation, and PCP was officially begun with the installation of monitoring wells and other field equipment. The data collected from these instruments will provide useful information not only for the management of this site, but also for regional management of similar Piedmont natural areas.

RARE SPECIES MONITORING

Understanding the current status and trends of the populations we protect is very important. To that end, we have been collecting flowering data on several species across the state. In 2019, census and/or population monitoring work was conducted for the following federally listed species:

- Bunched arrowhead (*Sagittaria fasciculata*) - Henderson Co. (2 sites)
- Canby's dropwort (*Oxypolis canbyi*) - Scotland Co. (1 site)
- Swamp pink (*Helonias bullata)* - Henderson, Transylvania Cos. (2 sites)
- Schweinitz's sunflower (*Helianthus schweinitzii*) - Randolph, Montgomery, Union, Gaston Cos. (4 sites)
- Smooth coneflower (*Echinacea laevigata*) - Durham, Granville Cos. (5 sites)
- Mountain sweet pitcher plant (*Sarracenia jonesii*) - Transylvania Co. (1 site)
- Heller's blazing star (*Liatris helleri*) - Ashe Co. (1 site)
- Michaux's sumac (*Rhus michauxii*) - Durham Co. (1 site)

Additional state-listed and rare plant surveys/monitoring conducted this year:

- Gray's lily (*Lilium grayi*) - Watauga Co. (1 site)
- Northern Oconee bells (*Shortia brevistyla*) - McDowell Co. (1 site)
- Montane purple pitcher plant (*Sarracenia purpurea* var. *montana*) - Transylvania Co. and Jackson Co. (3 sites)
- Canada lily (*Lilium canadense* ssp. *editorum*) - Henderson and Cabarrus Cos. (2 sites)
- Sandhills Lily (*Lilium pyrophilum*) - Moore Co. (1 site)

STEWARD ACTIVITY

Many of the management projects at the Durham Preserves (Hebron Road and Eno Diabase Sill) have been enhanced with the reliable help from two volunteer stewards who participate in a variety of activities including prescribed burn preparations, trash pick-up, invasive species control, seed plot establishment, seed collection, and leading guided tours. Herb and Pat Amyx are heading up augmentation efforts for smooth coneflower, state Endangered tall larkspur (*Delphinium exaltatum*), and state Threatened smooth aster (*Symphyotrichum concinnum*) at our Durham County preserves. For several years they have helped collect seed and propagate seedlings to return to the appropriate Preserves. These efforts have significantly increased the size of several of our smallest smooth coneflower subpopulations, and our only known population of smooth aster.

The Redlair Preserve (Gaston Co.) volunteer steward and prior landowner, Haywood Rankin, continues to contribute an extraordinary amount of time to the management of the preserve (on average 80+ hours per month). Haywood divides his time at the preserve between invasive plant control, monitoring for invasive species, as well as boundary checks and addressing trespass issues. Haywood also helps coordinate the deer hunting permit holders and leads tour groups and permitted researchers at this large preserve on behalf of the PCP Staff, increasing our capacity for engaging the public at this site.

The Cedar Mountain Bog (Transylvania Co.) volunteer steward, Torry Nergart, Conservation Easement Manager with Conserving Carolina (CC), a long-time partner of PCP, was a tremendous help to PCP staff this year. He recruited and led volunteers on management workdays to remove

invasive plants. Torry also helped provide updates on imperiled plant fruit ripening at the preserve to facilitate in a seed collecting project with the NC Botanical Garden for long term ex situ conservation. PCP hopes to deepen the collaboration between our office and CC for advertising volunteer stewardship activities.

The Tater Hill Preserve (Watauga Co.) volunteer steward, Dr. Matt Estep who is a professor at Appalachian State University researching evolution and population genetics of rare plants, was again an enormous help to PCP staff this year. He and several of his graduate students are undertaking monitoring and management projects and facilitating property boundary marking at the preserve. Of note, Matt is helping PCP to investigate the flower production and fruit set among Gray's lilies at the Preserve to better understand the impact of Lily Leafspot Disease which has been confirmed at this population. Matt is also an invaluable resource for connecting with other neighbors in the small community who live along Replogle Drive.

The Eastwood Preserve (Moore Co.) volunteer steward, Jeff Marcus, NC Longleaf Pine Restoration Director for The Nature Conservancy, was again very helpful this year. Jeff has been instrumental in facilitating burn planning meetings between NC Forest Service and PCP staff and to perform onsite preparations such as clearing flammable vegetation from around wooden fences and other structures to facilitate prescribed burned this winter. Jeff also assisted with a guided tour and Sandhills lily count at the Eastwood Preserve which had a large turnout and was a great success.

The Suther Prairie (Cabarrus Co.) volunteer steward, Dennis Testerman, retired from Cabarrus County Soil and Water Conservation District, began stewarding at this site this year. Dennis brings tremendous site and history knowledge to this role as he was heavily involved with the land acquisition process and the previous land management at the site. Dennis strengthened PCP's capacity by facilitating site visits for researchers and other permit holders.

Plant Pathology Program

Boxwood Blight Statement Program
In February 2012, NCDA&CS developed an optional "Boxwood blight Statement Program". Under the program, a NC nursery receives a statement to accompany shipments into other states. The participating nurseries are signees to a compliance agreement and follow best management practices. To facilitate this program, the NCSU Plant Disease and Insect Clinic assays samples collected during this process at no charge. As of December 2019, there are 81 participants in the program. Currently, States with established external quarantine against the boxwood blight pathogen include Tennessee and Pennsylvania.

Sudden Oak Death (SOD)
Survey – see CAPS section

Recurring positive location
Ornamental plants at a nursery dealer in Mecklenburg County have tested positive for the plant pathogen, *Phytophthora ramorum*, at various times since the first detection in 2008. The NCFS continues to conduct water sampling in the stream directly outside of the nursery as part of a USFS regional stream-baiting project.

Trace-forward/trace-back notifications
USDA-APHIS-PPQ notifies NCDA&CS when a nursery in another state has plants test positive for *Phytophthora ramorum* infection. If the positive nursery has recently sent host plants to NC, a trace-forward event occurs, the plants in question are inspected, and possible regulatory action is taken. Four trace-forward notifications occurred in 2019 (July, November, December). All trace-forward events are related to plant materials shipped from the State of Washington, plants include kalmia, azalea, pieris, rhododendron, knockout rose, and lilac. Plants with suspicious symptoms were collected and screened by State Pathologist. As of December 2019, no additional positive *P. ramorum* cases were found in the state of North Carolina.

Miscellaneous
The Plant Pathologist participates in monthly, national conference calls pertaining to the Sudden Oak Death program and provides summaries to the Plant Pest Administrator. Monthly conference call participants routinely discuss issues such as: changes to national regulations, current trace-forward/trace-back investigations, updates from regulated states, on-going research, and workshop/training announcements.

Guava Root Knot Nematode (*Meloidogyne enterolobii*)
Guava Root Knot Nematode (GRKN) is a nematode first found in China. The first US find of GRKN was in Puerto Rico in 1988, then in southern Florida in 2002 on ornamental plants. The first identification of GRKN in North Carolina was on cotton in Wayne County in 2011. This pest was not of regulatory concern at the time as it was not associated with crop movement that could spread the nematode. In 2014 GRKN was identified on NC sweet potatoes and in 2018 a shipment of uncertified sweet potato seed sent out of state transferred the nematode and sparked regulatory action. On October 1, 2018, NC issued an internal quarantine for the entire state on GRKN to

prevent the spread of this pest through sweet potato seed, sweet potato plants with roots and soil, used equipment, and any other article that could spread GRKN.
November 5, 2018 NCDA&CS began an official statewide survey for GRKN. The survey concluded in March 2019. Official survey results documented 12 counties where GRKN was found intermittently. Only 4.2% of 2,014 samples taken from 916 randomly selected fields across 50 sweet potato producing counties were GRKN positive.
The GRKN Internal Quarantine was revised on April 4, 2019 to strengthen regulations.

Thousand Cankers Disease (TCD)
Thousand Cankers Disease (TCD) threatens eastern black walnut (*Juglans nigra*), a high value ecologically, and culturally important tree species in North Carolina. The disease is caused by a fungus, *Geosmithia morbida*, spread by the walnut twig beetle (*Pityophtorus juglandis* Blackman (Coleoptera: Scolytidae)) and can kill trees in as few as three years once symptoms appear. TCD may also infect butternut trees (*Juglans cinerea*).
In 2019, NCDA&CS received federal Farm Bill funding to conduct surveys for the walnut twig beetle and TCD. Surveys spanned across 17 counties in North Carolina (Figure 1). Trapping occurred predominately in western and central areas of the state where black walnut occurs in greater numbers. Special focus was placed around Haywood County, the only location in the state where TCD is known to occur and a quarantine is in place. A total of 32 Lindgren multi-funnel traps were set in June 2019. Samples were collected every two weeks for eight weeks. No walnut twig beetles were detected to date.

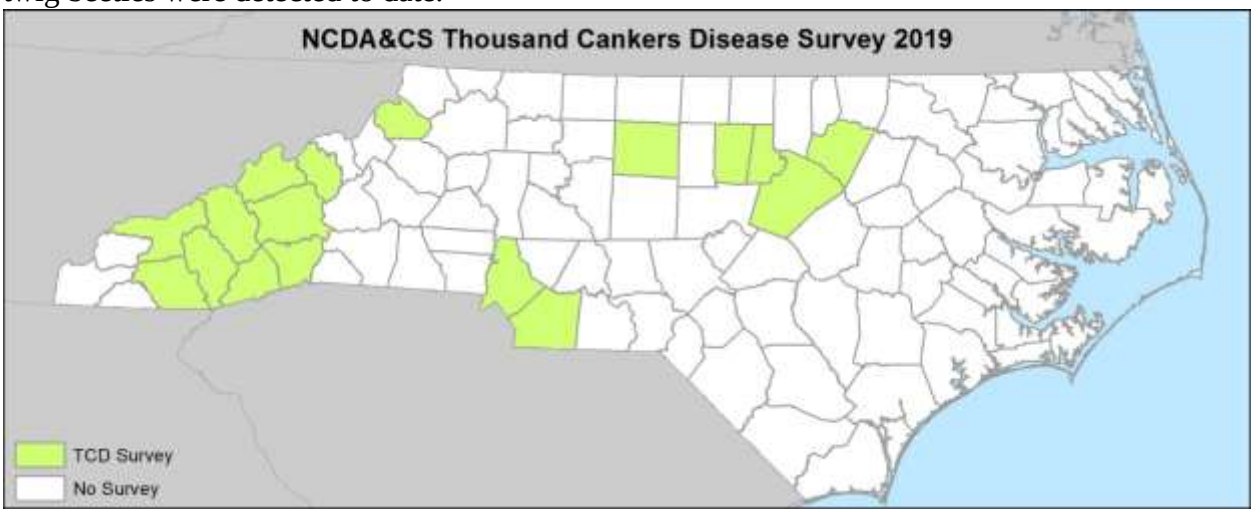


Figure 1. 2019 Thousand canker disease survey counties for North Carolina.

2019 Newly Reported Plant Pathogens

Fungus Report on *Ruscus*
USDA identified the first report of the fungus *Phaeosphaeriopsis glaucopunctata* in *Ruscus* in the United States found in a nursery in North Carolina in late 2018. An immediate Stop Sale/Movement was issued for all *Ruscus* at the nursery while an investigation was completed by NCDA&CS- Plant Industry Division and USDA-APHIS-PPQ. USDA-APHIS-PPQ completed a risk analysis and determined the pathogen is not of actionable concern and in Great Britain and Ireland *P. glaucopunctata* is "almost always present where the host plant is located" (Cannon 2019). Additional surveys for the presence of the pathogen were done in Spring 2019. *Ruscus* and

potentially Asparagus are the only reported host plants for this fungus. All *Ruscus* at the originating nursery were Stop Saled and are pending in-house research trials for treatment. These plants are inspected regularly by NCDA&CS – Plant Protection and none can be sold until the plants have cleared the regulatory screening process.

Fungus Report on Hellebores

In May 2019, Plant Disease and Insect Clinic (PDIC) at North Carolina State University identified the first report of the fungus *Peronospora pulveracea*, a species of downy mildew pathogen in *Helleborus sp*. The fungus was found on home grounds which has low risk of spreading through business activities. The fungus has been reported in Georgia (2007), California (2008), and South Carolina (2018). There is not a good account of the disease's current distribution. Infected foliage had angular, vein-delimited, dark brown-to-black speckled lesions on adaxial leaf surfaces turning dry and necrotic with age. Young leaves were small and distorted. Affected flowers were spotted and brown (Warfield et al. 2009).

Fungus Repost on Maple and Little leaf linden

In October 2018, Plant Disease and Insect Clinic (PDIC) at North Carolina State University identified the first report of the fungus *Erythricium salmonicolor* in *Acer rubrum* and *Tilia cordate*. The findings were later confirmed by USDA in November 2019. The pathogen has been described to cause pink disease or pink limb blight, and has been reported in Florida, Louisiana, and Mississippi. Trees are most susceptible in areas with high levels of rainfall. Initial symptom of the disease is tip dieback, as the fungal pathogen girdles the water conductive tissue in twigs and stems. The point of infection appears pinkish orange, and the fungus can be observed as a thin mantle of hyphae along declining shoots. Below the bark, the sapwood is discolored and brown. Leaves on affected plant parts turn brown and desiccated and eventually drop from the plant (Jones & Benson, 2001). Spores of the fungus are spread by wind and rain, spores require water to germinate, and can infect through healthy bark. NCDA&CS- Plant Industry Division is currently monitoring the distribution of the disease within the State, and collaborating with regional Extension specialists to develop plans for preventing further spread of the pathogen.

References:

Warfield, C.Y., Blomquist, C.L., and Lovig, E.E. 2009. First report of downy mildew on nursery-grown Hellebore caused by *Peronospora pulveracea* in California. Plant Disease 93:319-319.
Jones R.K., and Benson, D.M. 2001. Disease of woody ornamentals and trees in nurseries. APS Press, St. Paul, Minnesota.

Export: Disease certification requirements and pathogen distribution information

Most agricultural commodities exported to foreign countries and to some U.S. states must meet certain requirements with regard to plant pests. Countries and states differ as to what is perceived as a plant pest risk. The Plant Pathologist received and handled requests from Field Specialists for assistance with interpretation of plant disease and nematode certification requirements and determination of pathogen distribution.

Nematode certification
California has import requirements concerning burrowing and reniform nematodes. To assist nurseries that wish to send plants to California, Field Specialists collect soil samples and submit them to the NCDA&CS Nematode Assay lab according to procedures developed by the Plant Pathologist, who also provides oversight for this program. A sampling table based on numbers of plants or area sampled was developed by the Plant Pathologist. Using this table enables growers to pre-determine costs prior to sample collection and submission. [Note: Burrowing and reniform nematodes have not been found in any NC nursery. Reniform nematode was found in eight NC counties under agronomic field conditions, but burrowing nematode has never been found at any location.]

Permits: Movement of plant pathogens for research and other purposes
USDA-APHIS-PPQ Form 526 ("Application and Permit to Move Live Plant Pests or Noxious Weeds") permits the movement of plant pathogens and other pests into NC for research, diagnostic identifications, or commercial uses. The Plant Pathologist has the responsibility of adding comments to address state-specific concerns regarding each application. USDA-APHIS-PPQ issues final approval or denial of each application. All plant pathogenic organisms are subject to this requirement. The risk associated with each organism is evaluated to ensure that adequate safeguards are listed in the conditions of the permits. During 2019, pathogenic species permit applications were evaluated which included fungi/oomycetes, bacteria, nematodes, and viruses.

Tobacco Plant Inspections
The NC Tobacco Plant Certification Regulation requires anyone who moves tobacco plants into NC from another state to do so under an import permit system. There were no import permit applications received during this reporting period. Another aspect of the regulation requires that plants grown in NC and sold for planting in a location more than seventy-five (75) miles away from the place of production must be inspected and certified. A major reason for this requirement is to prevent the artificial movement of blue-mold or virus-infected plants from one growing region into another, which could initiate a premature disease epidemic. There were no certified tobacco plant nurseries during this reporting period.

Vegetable Plant Inspections
The Vegetable Plant Certification regulation requires weekly inspections and certification of vegetable plants grown in NC for sale to commercial growers. There were no vegetable plant nurseries certified under this regulation during this reporting period. The NC Crop Improvement Association (NCCIA) certifies a large number of sweet potato cuttings and "seed" under its certification program. Because NCCIA certification requirements meet or exceed the standards of the vegetable plant regulation, NCDA&CS accepts inspections and certification tags of NCCIA in lieu of its own.

Regulatory Weed Program

Program Objective: The North Carolina Regulatory Weed Program protects North Carolina agriculture, public health, and native plants from the harmful impacts of noxious weeds. The regulation of noxious weeds is authorized by the North Carolina Plant Pest Law and the Aquatic Weed Control Act of 1991. Program activities include inspections, issuance of Phytosanitary Certificates and Scientific Permits for movement of regulated articles, education of the public, and the survey, control, and eradication of Federal and State listed noxious weeds. The Witchweed Eradication Project, funded by USDA, APHIS, PPQ, is one vital part of the Regulatory Weed Program.

Public Relations & Outreach: The Weed Specialist serves in an advisory role for a number of Technical Advisory Committees. Tasks include attending meetings across the state and weighing in or reporting upon the status of weed control programs, writing management plans, coordinating outreach, and weighing-in on budgetary concerns regarding the control programs. The groups include:

Committee or board member:

- North Carolina Aquatic Weed Council (Vice-Chair), Eno River Hydrilla Technical Advisory Committee (Outreach & Scientific Committee), Lake Waccamaw Technical Advisory Group for Hydrilla Management, Aquatic Nuisance Species Workgroup, and the White Lake Technical Advisory Committee for Hydrilla Management.

Regional Weed Science Groups:

- North Carolina Weed Science Society, North Carolina Invasive Plant Council, South Carolina Aquatic Plant Management Society

The Weed Specialist was engaged with the public in the following ways in 2019:

Educational talks:

Date	Group	Location	Title of Talk	People Reached
Feb 27	NC Assoc. of Soil & Water Conservation District, Area 7 Spring Meeting	Lumberton	Invasive Weeds in NC	100
Feb 28	NC Assoc. of Soil & Water Conservation District, Area 4 Spring Meeting	Louisburg	Invasive Weeds in NC	100
March 14	Piedmont Area Foresters Workshop	New London	Invasive Weeds in NC	120
April 11	Consulting Foresters	Dunn	Invasive Weeds in NC	90
Jun 6	NC Society of American Foresters	Charlotte	Invasive Weeds in NC	90
Jun 8	Extension Master Gardeners College	Raleigh	Invasive Weeds in NC	20
Jun 18	NC Ag Agents Meeting	Southern Pines	Invasive Weeds in NC	60
July 16	Vocational Ag Teachers Conference	Greensboro	Invasive Weeds in NC	120
July 23	Webinar - Plants, Pests, Pathogens - Master Gardeners	Raleigh	Invasive Weeds in NC	110
Aug 13	Aquatic Plant and Small Impoundments Workshop - NCSU	Raleigh	Noxious Weed Regulations	100
Oct 6	Horticultural Inspection Society - SC	Wrightsville Beach	From the Mountains to the Coast: A Guide to NC Invasive Weeds	100
Nov 5	Johnston County Master Gardeners	Smithfield	Invasive Weeds in NC	50
Dec 11	EDDMaps Workshop with NC State Parks Employees	Haw River State Park, Browns Summit	A Behind-the Scenes Look at EDDMaps	25

Research Presentations:

Date	Group	Location	Title of Talk	People Reached
Jan 15	Green N Growin' Show	Greensboro	Noxious Weeds in NC - How to Avoid Promoting the Next "Kudzu" of the Southeast	100
March 18	Invasive Plant Council	Charlotte	*Ficaria verna* in NC	110
Oct 5	SC Aquatic Plant Management Society	Myrtle Beach, SC	The Continued Spread of Yellow Floating Heart and Wooly Frogsmouth in NC.	90

Guest Lectures:

Date	Group	Location	Title of Talk	People Reached	Contact Person
Feb 19	CS 415 - IPM Course	NCSU - Raleigh, NC	Invasive Weed Program & Regulatory Issues in NC	50	Dr. David Jordan

Publications:

Date	Publication	Title of Article	Web Location
Fall 2019	Nursery and Landscape Notes	Be on the Lookout for Purple Loosestrife & Floating Heart	www.ncnla.com/nln-blog/2019/10/29/be-on-the-lookout-for-purple-loosestrife-and-floating-heart

Other Activities:

- Served as the official EDDMaps verifier for invasive plant reports in North Carolina. Approved over 100 entries.
- Served as a reviewer for the Grantees in the Bioenergy Research Initiative in December 2019.
- Aided numerous individuals for images of invasive weeds for publications and signage, as well as to provide help identifying weeds through photos and live specimens, as well as providing weed control recommendations in crop, turf, aquatic and non-crop sites.
- Approved 32 USDA ePermits, and wrote 5 PPS-1 State Scientific Permits for the movement of state or federal noxious weeds.
- Accompanied a scientist from the US Army Corps of Engineers, and a graduate student from the University of Florida to numerous *Nymphoides* sites in central NC for data collection to aid in research projects attempting to characterize the genome.
- Collected data for a graduate student at Mississippi State University for a collaborative research project on *Baccaris halmnifolia* genetics and distribution.
- Collected data for a graduate student at the University of Minnesota on *Humulus japonicus* to evaluate its resistance to Hop Powdery Mildew.
- Participated in a certification workshop to become a SePRO Certified Specialist for the application of ProcellaCOR (a new aquatic herbicide).

Aquatic Dealer Inspections: Aquatic dealer inspections are an important activity as they help to screen unwanted invasive plants from entering the trade through aquariums and water gardens. The current database of Aquatic Dealers was updated in March of 2018, and inspection sheets given to Plant Pest Specialists for completion each year. In 2019, 10 Plant Pest Specialists completed inspections at 146 retailers across the state, an increase from 72 in 2018. No regulated plants were found during those inspections.

RESULTS OF ACTIVE WEED CONTROL PROGRAMS

Beach Vitex *(Vitex rotundifolia):* A Class B State Noxious Weed since 2007. A large effort was undertaken by the Beach Vitex Taskforce to eradicate known populations of the invasive plant from 2000-2010. In 2018, a large infestation was found in Morehead City. Plant Pest Specialist, David Pearce has been working with the homeowners in the neighborhood to apply herbicide selectively to the known plants. Permission was obtained from each homeowner in the neighborhood before treatment began. Herbicide was applied using a scrape-and-paint method on July 10th, 2019. The treatment was very successful, and subsequent treatments will be made in 2020.

Broomrape (*Orobanche minor*): A Federal Noxious Weed (FNW), has been growing in NC since the late 1990's. It was first discovered growing in DOT rights of ways in Mitchell County. It is believed that it was a seed contaminant on tomato seeds imported from Hungary. Several new sites of Orobanche were discovered in 2018 and 2019 as a result of outreach. An update for each of those sites is provided below.

- Western NC Livestock Center, Canton. Hundreds of plants were found by Sarah Scott (Plant Pest Inspector) at the site in 2018. Many were hand removed, and also spot sprayed using a 2% solution of glyphosate. The infestation does not appear to be moving or growing in size. Subsequent years of scouting and treatment will be needed to eliminate the plant from this site. Sarah also worked with the extension agents and extension specialist in the county to ensure the treatment plan is acceptable for the site, since the area is being used as a demonstration forage plot.
- Large Hay Field, small roadside site, Mitchell County. These are the oldest orobanche sites known in NC. Plant Pest Specialist, Tim Hartley, has worked on eradicating the plant from both sites. In 2019, about 600 plants were rogued and discarded. No pesticide treatments were made and monitoring of the sites will continue in 2020.
- Mountain Research Station, Waynesville. As a result of outreach, Dr. Deidre Hermon, Livestock Extension Specialist at the station, discovered a new infestation of Orobanche in May of 2018. The site is less than ¼ acre. Station staff sprayed GrazonNext herbicide on the site in the summer of 2018, with excellent results (clover control). A site visit was made in May of 2019 to check on progress of the weed control. Monitoring, and control will continue into 2020.
- Private horse pasture, Waynesville. A fourth site was discovered on a private farm in Waynesville in 2018. No treatments were made in 2018 because horses were on the pasture, and the plants were nearing senescence by the time that they were discovered (June 2018). Contact was made with the homeowners in 2019, and herbicide treatments were made to

half of the pasture in August 2019, and the other half of the pasture was treated in September of 2019. Additional plants were found across the road from this site, which lead to the next discovery of plants.

- Private Hay Pasture, Waynesville. A fifth site was discovered after interviewing the homeowners in the area and finding a local farmer who had been cutting hay in the area. He has approximately 15 acres infested with Orobanche. Herbicide treatments were made to his pastures in September of 2019. Site visits 3 weeks later showed excellent control of the legumes in the pasture. Monitoring of this site will continue into 2020, with additional herbicide treatments made as deemed necessary.

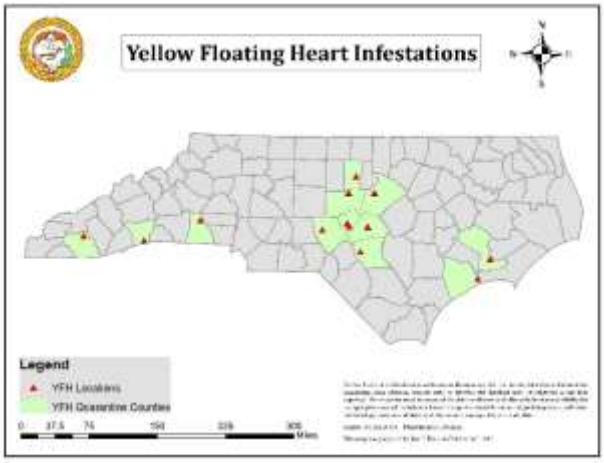
Cogongrass (*Imperata cylindrica*): A FNW that continues to invade thousands of acres across the Southeastern U.S. The first NC infestation was discovered in 2012 in Pender Counties. A total of 14 sites (both active and eradicated) are now known in NC. Plant Pest Specialist, Scott Cannady, treated 8 sites in Pender and Sampson counties with glyphosate in September of 2019. These sites will be revisited in 2020 for monitoring and follow-up herbicide applications.

Crested Floating Heart (*Nymphoides cristata*) **Yellow Floating Heart** (*Nymphoides peltata*) & **Water Snowflake** (*Nymphoides indica*): Three Class A state noxious weeds since 2012. *N. peltata* is the most insidious of the 3 species in NC. Figure 1. Shows a map of all known Yellow Floating Heart sites in the state that are being treated.

Details for specific 2019 treatments for some of the sites can be found below:

- New Bern: Plant Pest Specialist, David Pearce, has worked to create an eradication plan for the pond. Herbicide treatments began in May 2016. A total of 4 herbicide sprays were applied to the entire lake during 2019 in cooperation with the DEQ Aquatic Weed Control Program. The infestation is controlled by 95%. Herbicide treatments will continue in 2020.

Figure 1. Yellow Floating Heart Infestations in NC that are being monitored and treated with herbicides by NCDA&CS.



- Hillsborough: Yellow floating heart was reported in 2017, and herbicide treatments were made in 2017, 2018 and 2019. Only a few small plants were treated in 2019, and eradication is likely in 2020.
- Lee, Moore Counties: Several infested farm ponds were discovered in 2018. These ponds were located on private property in Lee and Moore Counties. Plant Pest Specialists, Mike Massey and April Bauder ensured that several sites were treated in 2018, and the remaining sites were treated in 2019 (total of 6 ponds). Follow-up treatments will be made in 2020 as needed.

- Lake James**:** First reported sighting in 2017. A working group consisting of Lake James Park Staff, NC Parks Staff, NCDEQ, Duke Energy, and the Lake James Environmental Group were involved with survey and outreach plans. Plant Pest Specialist, Amanda Cook oversaw an herbicide treatment on July 30th, and follow-up trips showed 100% control of the plant. Plans have been made to post signs about the plant at boat ramps around the lake. A whole-lake survey was conducted by Duke Energy, and it was confirmed that YFH is not growing in any other part of the 6,800-acre lake. Survey and spray efforts will continue as needed in 2020.
- Koi Pond, Johnston County: Reported in 2019. A very small Koi pond located inside of a wedding venue was reported in Johnston County. Herbicide treatments were made to the pond in August, and control was excellent. Ongoing monitoring of the site will continue in 2020.

Giant Hogweed *(Heracleum mantegazzianum***):** A FNW, and plants first reported in NC in 2011. As a result of media coverage in 2018 media coverage, two new sites of GH were discovered in Watauga County in 2018, and one new site in 2019. Plant Pest Specialist, Chad Taylor, immediately responded to the sites and began treatments. Seventeen plants were present in the new site, all located at the base of a power pole. Approximately 280 plants were found across the 4 active sites in Watauga County, and all were treated with a 2% solution of glyphosate.

Hydrilla (*Hydrilla verticillata*): A FNW, and found across the state of NC. Several populations have been receiving large treatments.

- **Lake Waccama:** Hydrilla was found in 2012. An estimated 698 acres were infested. There are 28 rare mollusk, fish and plant species in the lake –making treatment efforts complex. Multiple state agencies form a Technical Advisory Committee (of which the weed specialist is a member) to design a treatment plant. Herbicide treatments have been applied each year from 2014 to 2019. The treatment area was decreased from 960 acres to 600 acres in 2018 and continued to be that size in 2019. The treatments have been very successful at controlling the existing vegetation and reducing the tuber bank in the soil. Vegetation studies by NCSU in October of 2019 indicated that there were no discernable fragments or tubers of hydrilla to be found in the lake. Monitoring efforts will continue in 2020, but herbicide applications will likely cease in 2020.
- **Eno River:** A technical committee was formed in 2013 to form a strategy for managing the Eno hydrilla infestation, and the State Weed Specialist is a member of that committee. Hydrilla was completely infesting several sections of the river in Eno River State Park. Seven funding partners are part of the Eno River Hydrilla Management Task Force, and each partner contributes money to the effort. The contract is approximately $60,000 a year. Herbicides have been applied to the river each year since 2015. In the first pilot study 17 miles of the river were treated with herbicide via two separate drip applicators installed on the river through a contract with SePRO Company. The treatments were highly successful. In 2017, 2018 and 2019, the treatment area was increased to encompass 21 miles of the river. Treatment plans for 2020 are unknown at this time, as the decision is pending some data collection of tubers from the river.

Itchgrass *(Rottboellia cochinchinensis)*: A FNW, and efforts to control this weed in Robeson County have been ongoing since 1983. There are at least 6 separate areas located around the town of Rowland that are being monitored and treated. Pre-emergence herbicides were made by the NC DOT, with help from Plant Pest Specialist Michelle Shooter throughout the growing season. In addition, two NCDA&CS temporary employees worked the area during the growing season (June through October), applying post-emergence glyphosate treatments to areas where plants had escaped the pre-herbicide treatments. The infested areas are largely improved from past years, and scouting efforts will continue in 2020.

Mile-a-minute vine (*Persicaria perfoliata*): A Class A State Noxious weed, is documented in the following NC counties NC: Alleghany, Gates, Guilford, Pasquotank, Perquimans, Rockingham, Watauga and Yancey counties. The original population was found along the Mayo River in Mayo River State Park (Rockingham County).

Since 2011, biological control of MAM weed has been underway in NC under the supervision of Dr. Steven Turner. Weevils obtained from the New Jersey Department of Agriculture were released in Allegheny county in an area where they were previously released. Existing populations of the weevils were found, showing that the populations is established in those areas. New weevil populations were released where there were no signs of feeding. Efforts to scientifically quantify weevil feeding is ongoing under Dr. Turner's oversight using plants propagated at the BioLab in Cary, NC.

Purple Loosestrife (*Lythrum salicaria*): A Class B State Noxious Weed, and eradication efforts have been ongoing since 1997. There are two main geographical areas of the state that are in the process of being eradicated.

- Guilford County: Sixteen sites located near Winston/Salem. The first three sites are the most heavily infested, but eradication efforts have greatly reduced the number of plants present in recent years. All known sites were visited by Plant Pest Specialist, Andrew Allen, 3 times during the growing season. A total of 170 plants were found and treated – most plants were found on the June 25th visit due to an exceedingly rainy spring. Site visits were also made on July 31st and September 17th. The flower heads were clipped and placed in garbage bags for incineration, and the remaining plants were treated with a 1.5% solution of Element 3A (triclopyr). The sites will continue to be monitored in 2020, with herbicide treatments made as necessary.
- Henderson County: Discovered in 2011, and is being monitored by Plant Pest Specialist, Sue Dial. Several separate sites are being treated around the Henderson County airport. Herbicide treatments were made on June 3rd, July 24th and September 24th using 4-wheelers. Additional plants were discovered in nearby Jackson Park in 2019, so the area was surveyed using an Unmanned Aerial Vehicle by the Henderson County Extension Agent, and then herbicide treatments were made on foot as well as by boat by NCDA&CS employees. Survey and herbicide treatments will be ongoing in 2020.

Tropical Soda Apple (*Solanum viarum*): A FNW, present in NC since 1995. There is one active site being managed by Plant Pest Specialist Jensen McLamb.

- Faircloth Farm - Whole Farm surveys using ATV's and UTV's were completed in June, September, and October (six survey days). A total of 165 plants were found, which is a significant decrease from the number of plants found in 2018. The farm is very large (7,000 acres), so only half the farm can be surveyed in one workday. A total of 288 people-hours were spent surveying for TSA in 2019. Many of the large plants did have fruit on them. All plants were pulled, placed in paper bags and incinerated. Survey efforts at Faircloth Farm will continue in 2020.

Tropical Spiderwort (*Commelina benghalensis*): A FNW, present in NC since 2001. The quarantine area is currently confined to the Cherry Research Farm in Wayne County.

- Cherry Research Farm: Richard Banner of NCSU continues to monitor the infested fields located inside of the Farming Systems Unit. The first Tropical Spiderwort plant of the season was dug on September 3rd. It was in plot 12 at a previously marked location. Total plants found in found in 2018 totaled 19.

When equipment is moved out of the quarantine area, it is washed/or fumigated and inspected prior to transport to ensure that no soil or propagules of TSW remain on the equipment. The following inspections (Table 2) were performed by Plant Pest Specialist, Scott Cannady in 2019.

Figure 15: Tropical Spiderwort plants found in September 2019 in plot #12 at Cherry Research Farm, Goldsboro NC.

Table 1: Equipment Inspections at Cherry Farm, 2019.

1/31/19: Meeting with Andy Meyer to discuss ditch cleaning /soil movement project. Project was cancelled due to hurricane.
2/7/19: Equipment inspection of 1 ripper and 1 bedder.
3/15/19: Equipment inspection of 1 tractor.
6/15/19: Equipment inspection of 1 combine.
9/23/19: Equipment inspection of 1 tractor and 1 grain drill.
10/2/19: Equipment inspection of 1 tractor,1 seeder, and 1 litter spreader.
11/13/19: Equipment inspection of 1 tractor and 1 combine.

All visitors to the Cherry Research Station are asked to sign in at the office, and the Station keeps a log of visits to the wash station. Ivy Lanier and Scott Cannady reported the following visitor numbers, as well as visits to the Wash Station in 2019.

Table 2. Wash station logs at Cherry Farms, 2019		
Month	**Visitors Sign-In**	**Wash Station Log**
Jan	39	7
Feb	77	39
Mar	54	41
Apr	91	112
May	104	146
June	212	163
July	173	133
Aug	203	154
Sept	138	128
Oct	76	77
Nov	54	21
Dec	3	3
Total Sign-Ins	**1,224**	**1,024**

Wooly Frog's Mouth (*Philydrum lanuginosum*): A first-find in the US, this plant was reported to the NCDA&CS on August 8, 2016. It was growing around a "Barrow Pit" located near the Holly Shelter and reported by the Wildlife Resources Commission (WRC) while they were surveying the pond for the rare Gopher Frog. After a risk assessment was conducted by the USDA, NCDA&CS decided to eradicate the plant from the site, with the approval of the homeowner. Rodeo (aquatic glyphosate) was applied to the plants growing around the pond's perimeter in October 2016. Good control was achieved to the plants growing above the water, but poor control was observed in the submerged plants. Plants collected in April 2017 were screened for herbicide tolerance in the NCSU greenhouse, and it was determined that a solution of imazapyr and glyphosate would provide better control to the submerged plants. Due to the growth of the frogs, herbicide treatment was delayed until October 2017. No additional treatments were made in 2018, due to the fact that no plants could be found by either the homeowner or Plant Pest Specialist, Scott Cannady. In 2019, additional plants were found in the original pond, as well as a neighboring pond. Herbicide treatments were made to all known populations of the plant in August 2019, with good control results. Scouting and control efforts will be ongoing in 2020 in cooperation with the WRC and the two landowners.

Witchweed (*Striga asiatica*): A FNW that has existed in the state of NC since at least 1954. It is an obligate parasite, and needs a grassy hosts such as corn, sorghum, millet, rice and several other warm season grasses. Heavy infestations of witchweed can eliminate yield from these crops, resulting in devastating economic losses. The presence of this quarantined pest also imposes a regulatory burden on crop production and on the movement of farm commodities, equipment, and other regulated articles. The witchweed eradication program includes an organized and effective set of survey, control and regulatory procedures developed through early USDA, APHIS research.

2019 Witchweed Program Discussion

2019 was one of the warmest years on record in NC. The spring season started early and was accompanied by adequate rain. In July and August, the rain ceased, and it wasn't until September

that the rain started back in earnest. Employees reported seeing very little Witchweed germinating during the droughty summer months, but the weed flushed again after the late summer rains. The first killing frost occurred during the 2nd week of November, and the last field surveys for Witchweed were completed during that time. During the field season (May through November), infested fields were visited and treated every 14 days, thereby eliminating much of the risk that Witchweed would flower and produce more seed. Released fields were visited 3 times during the season (Early, Mid and Late).

Several fields (equaling 84 acres), previously released or terminated fields were discovered to be newly or re-infested with Witchweed. One of these fields was reported by the homeowner, highlighting the need for ongoing outreach and education to citizens residing in counties where active witchweed infestations are still found. There are several ways that the fields could have been re-infested (contamination from equipment on the farm, movement of contaminated articles, or a long-lived seed bank), and we attribute the very astute actions of the plant pest inspectors in finding the new and re-infested fields. In many cases, the inspectors stop to look at fields that have been released from the program (therefore not requiring a formal inspection) when they happen to be in the area inspecting other active fields. This situation emphasizes that this eradication program takes many years to be successful due to the very long seed viability (>15 years), and that prematurely ending the program could result in many new re-infested fields.

2019 Witchweed Eradication Program Summary of Results

Table 3 summarizes acreage status for fields managed in the Witchweed Eradication Program in North Carolina. The number of infested acres decreased slightly in 2019, as compared to 2018 due to termination, which is a positive move forward in the eradication program. A total of 84 new or re-infested acres were added to the infested category. These new or re-infested acres were fields adjacent to currently infested farms, or fields that had been infested in the past.

Table 3. Total Acreage Status for the Witchweed Eradication Program

	2018	**2019**
Total Acres in Infested Category	1,119	1,174
Total Acres in Released Category	1,901	1,593
Total Acres Managed by Program	3,020	2,767
Total Acres Treated	1,735	1,357
Total Acres Surveyed	43,700	48,722
Acres Transferred from Infested to Release Category	138	33
Acres New or Re-Infested	20	84
Net Gain in Eradicated Acres	118	-55

Other pertinent program data is summarized in Table 4. Zero witchweed bounty payments were requested by temporary inspectors in 2019. Phytosanitary certificates (a total of 38) were issued for movement of regulated articles moving out of the quarantine areas such as straw mulch used by the NC Department of Transportation.

Table 4. Additional Statistics for the Witchweed Eradication Program

	2018	2019
Acres Treated by Contract	0	0
Counties now Infested in NC	5	5
Number of Witchweed Bounty Payments	0	0
Associated Witchweed Bounty Acreage	0	0
Number of Phytosanitary Certificates Issued	78	38

In addition to infested acreage, another measure of the size of the Witchweed program is the number of infested farms and fields that are currently being managed with scheduled surveys and treatments. Table 5 shows the number of infested farms and fields by county for 2018 and 2019. There are currently 69 farms and 102 fields classified as infested (i.e. fields with fewer than 5.0 points) in the program. Sampson County is still included in this table because there are no infested fields in Sampson County, but there are still released fields in Sampson County. Including released fields for which surveys are still scheduled, there are a total of 154 fields (1,593 acres) still managed by the program, for a total of 2,767 acres.

Table 5. Number of Infested Farms and Fields by County for 2018 and 2019.				
County		**No. of Farms**	**No. of Fields**	**Infested Acres**
Bladen	2018	31	57	**563**
	2019	33	59	**595**
Cumberland	2018	23	26	**209**
	2019	19	22	**186**
Pender	2018	3	3	**32**
	2019	4	4	**37**
Robeson	2018	12	16	**315**
	2019	13	17	**356**
Sampson	2018	0	0	**0**
	2019	0	0	**0**
Total	**2018**	**68**	**101**	**1,119**
	2019	**69**	**102**	**1,174**

Table 6 summarizes treatment acreage by crop type. Treated acreage is recorded for each treatment event and fields may get treated more than once during the season, so totals are cumulative. The type of crop planted into infested fields is an important indication of whether or not Witchweed is likely to emerge and be detected during the growing season. Host crops such as Corn, and non-host crops like Soybean and Idle land (usually pastures or abandoned garden plots) can easily be treated with herbicides, ethylene and disking, but garden spots are harder to manage because of proximity to residences and power poles. The reduction in acreage treated in 2019 from 2018 is a reflection of the fact that there are less acres overall in our program to treat due to acres being terminated in 2018.

Table 6. Summary of Treated Acreage by Crop Type for 2018 and 2019.

Crop Name		**No. of Acres Treated**
Corn	2018	1,096
	2019	879
Soybean	2018	85
	2019	4
Idle	2018	454
	2019	347
Other	2018	101
	2019	127
Total Crop Acres Treated	**2018**	**1,736**
	2019	**1,357**

Table 7 describes treatments that are applied to prevent Witchweed from flowering and producing new seed, as well as those used to deplete reserves of seed still present in the soil. Ethylene applications are the main early-season control method. They help to hasten depletion of seed reserves by artificially stimulating Witchweed germination. In the absence of host plants, germinating Witchweed is unable to complete its life cycle and produce new seed (suicide germination). Disking (also early-season) helps to remove grassy weed hosts and therefore also deny opportunities for additional Witchweed seed production. Hand pulling of emerged Witchweed plants before seed set also eliminates additional seed production, and is the main control method used in mid-late season.

Table 7. Summary of Acres by Treatment Type for 2018 and 2019.

Treatment Type		No. of Acres Treated	No. of Treatments
Disking	2018 2019	480 319	67 65
Ethylene (Tractor and Hand)	2018 2019	36 137	14 32
Hand Pulled	2018 2019	773 616	207 176
Herbicide to Host	2018 2019	407 259	34 19
Herbicide to Witchweed	2018 2019	13 26	2 5
Herbicide (Survey Aid)	2018 2019	27 0	2 0
Total Acres Treated	2018 2019	**1,735** **1,357**	**326** **297**

The success of the Witchweed eradication program is largely dependent on the quality and quantity of field inspections completed during the growing season. Over 48,000 acres were surveyed during 2019 (Table 3). Some of those additional acres were completed in Sampson County by the Plant Pest Aide. He completed surveys in 249 fields that were terminated 20 years or more ago. He did not find Witchweed growing in any of those fields. Surveys and treatments will continue in 2020.

Seed and Fertilizer Section

The mission of the Seed and Fertilizer Section is to improve the profitability and sustainability of agriculture in the state by ensuring the seed, fertilizer, lime, and other soil additives offered for sale in North Carolina meet prescribed standards and are properly labeled.

The mission of this section is accomplished by:

- Ensuring that all locations that offer seed, commercial fertilizers, agricultural liming materials, landplaster, and soil additives for sale in the state are registered.
- Implementing a sound regulatory compliance program by conducting inspections and sampling of seed and fertilizer offered for sale in the state.
- Implementing seed purity, germination, and other specialized laboratory tests in support of the seed regulatory and service programs.
- Implementing a joint federal/state administered biotechnology permitting and inspection program.
- Conducting the fertilizer bioassay and endophyte testing programs.
- Coordinating activities of the N.C. Seed Board such that complaints regarding the failure of agricultural or vegetable seed to produce or perform as labeled or warranted are heard and responses are provided.

The Seed and Fertilizer Section includes 25 staff members with responsibilities and accountability for administration, field services and North Carolina Seed Lab functions. The total budget for the Seed and Fertilizer Program for 2017-18 was $1,694,555 including a state appropriation of $727,227 and receipts of $967,328. Revenues included receipts from licenses, registration fees, and tonnage fees.

N.C. Seed Laboratory

The North Carolina Seed Laboratory is responsible for providing laboratory support for both the regulatory and service areas including the state's seed dealers, producers, university researchers and consumers. The work of this laboratory provides critical seed testing data needed to make management decisions regarding seed stock and for labeling purposes. For 2018-19, the North Carolina Seed Laboratory conducted 2,294 regulatory seed tests and 10,783 service seed tests. These tests involve required testing for purity and germination. Multiple tests are generally conducted on each of the samples submitted with 13,077 individual tests carried out. Additional special tests included tetrazolium, accelerated aging, cool test of cotton, cold test of hybrid corn, phenol, Round-up Ready™ tolerance, sand, and moisture testing. There were 670 special tests conducted during the fiscal year. All official regulatory samples taken during the fiscal year 2018-19 represent testing for a total of 29,299,008 pounds of seed offered for sale in North Carolina. See Figure 36 and Figure 37 for more information on the various seed tests performed in the laboratory.

The Seed and Fertilizer Section continued to implement the endophyte testing service. A number of grasses, including tall fescue and perennial ryegrass, contain a fungal endophyte which has a beneficial relationship with the grass host. The tall fescue endophyte, *Neotyphodium coenophialum* (previously *Acremonium coenophialum*), lives exclusively inside plants, and can only be detected through laboratory analysis. This endophyte has been proven to give the plant

insect, disease and drought resistance, as well as enabling the plant to be more tolerant of overgrazing. Though very beneficial to tall fescue plants, this endophyte produces chemicals which are toxic to a variety of animals. In North Carolina, fescue toxicosis is especially a problem in horses and cattle. A total of 18 Endophyte pasture samples were processed for producers, both in-state and out-of-state.

The staff of the North Carolina Seed Laboratory remains active in the Association of Official Seed Analysts and the Association of American Seed Control Officials. At the state level, program staff remains active in the North Carolina Seedsmen's Association and the North Carolina Crop Improvement Association.

Joint Collaboration with USDA Biotechnology Regulatory

Seed and Fertilizer Section staff worked with USDA, Biotechnology and Regulatory Services (BRS) to jointly administer a federal/state biotechnology and permitting program. Primary responsibilities included reviewing permits and acknowledgements provided through USDA-BRS for laboratory, greenhouse, and field tests of genetically engineered crops. For this period, NCDA&CS staff reviewed a total of 144 notifications and permits. A joint project with USDA-BRS continued during this period involving NCDA&CS staff conducting field inspections of *Notification and Permit Release Sites*, including pharmaceutical/industrial trials. During this time period there were 1 field inspections conducted by NCDA&CS field staff. As a prerequisite for participation in the project, all field staff were required to participate in training conducted by USDA-BRS focusing on work flow, confidential business information, and steps in effectively completing a field inspection.

North Carolina Seed Board

The responsibility of the North Carolina Seed Board is to review complaints from individuals who may have suffered damage from the failure of agricultural or vegetable seed to perform as labeled or warranted, or as a result of negligence. Performance issues related to seed purity, seed germination, varietal purity, percent weeds, inert material, other crop seed and test date are potential issues to be addressed by the Seed Board.

North Carolina Tobacco Variety Evaluation Program

The Tobacco Variety Evaluation Program continued in joint cooperation with N.C. State University. Samples from 31 flue-cured tobacco seed lots were obtained for planting grow-outs in the variety testing program. The Tobacco Seed Company approved for sale in North Carolina a total of 65 different varieties from four different seed companies.

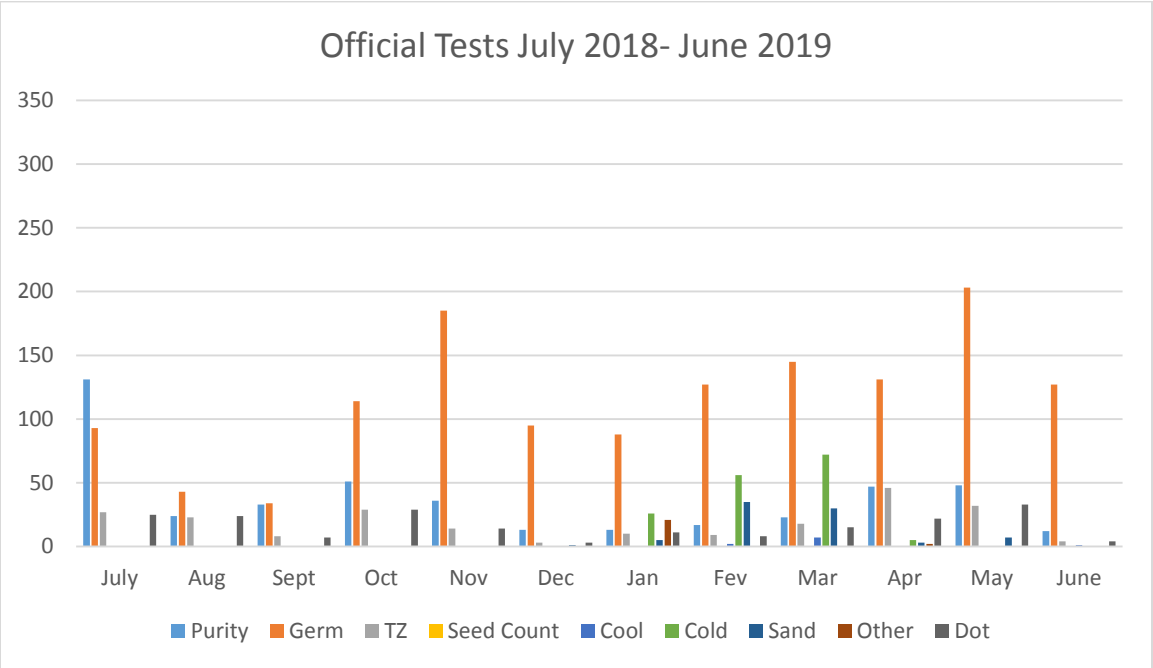


Figure 36 Seed Laboratory Official Tests

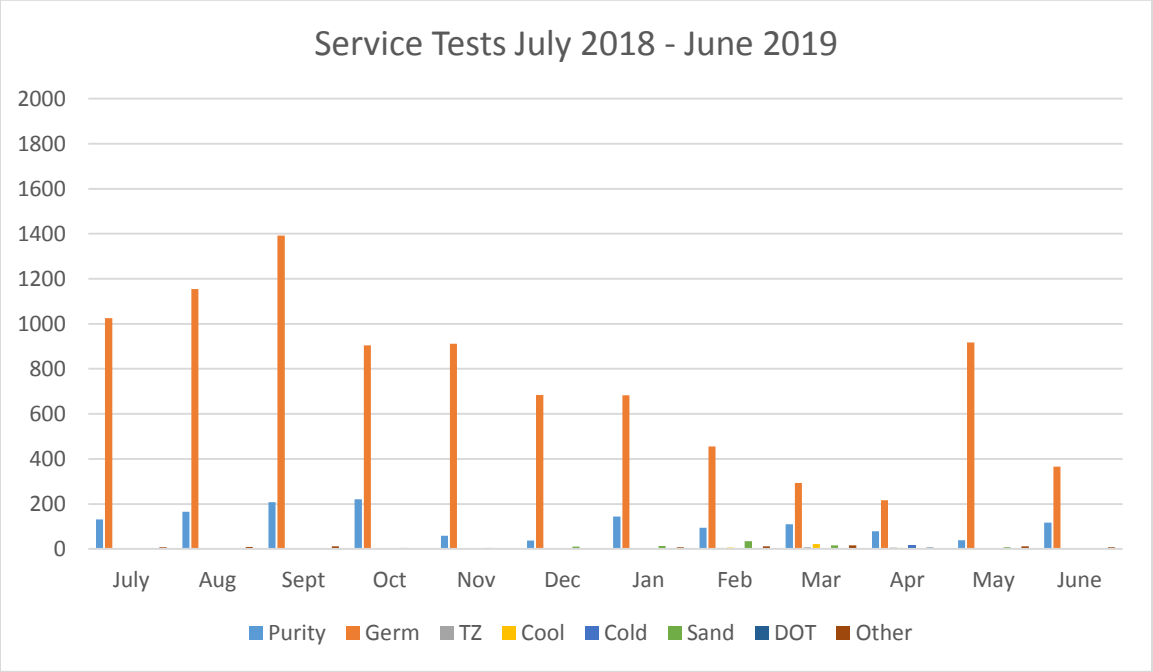


Figure 37 Seed Laboratory Service Tests