NCDA&CS
Plant Industry Division
Annual Report
2020

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.

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North Carolina Board of Agriculture

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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

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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. Congress, in a continuing resolution extended the pilot programs to September 30th, 2021 initially. This presented a problem as this is in the middle of the outdoor growing/harvest season. It has since been extended to January 1st, 2022

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, the rate of increase in new license holders has dropped precipitously. At the end of 2020 we had 1,525 licensed growers. This is an addition of 132 licenses amounting to about an increase of 9%. We also lost a fair number of growers who had lost interest in hemp due to low market prices, an inability to sell material, and unstable regulations.

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, there has been a marked decrease in the rate of growth for program acreage and greenhouse sq. ft. in the year 2020. Acreage actually decreased to 14,459.64 which is approximately a 17.5% of last years acreage. Greenhouse sq. ft. on the other hand increased by about 3.5% up to 7,069,430.59 sq. ft. licensed.

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. In 2020, we took approximately 1,374 tests of which 94 failed resulting in an overall pass rate just over 93%. This is a reduction in our failure rate of approximately 64% which is significant. We believe that increases in grower competence and the presence of low THC CBG varieties contributed to this change. Our workforce was significantly more able to handle the amount of samples taken this year and no additional staff were coopted or hired to handle sampling this year. COVID-19 did contribute significantly to our decreased numbers.

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 tests 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 license holders license. It also seems that no retesting will be allowed. This all amounts to greater fail rates for farmers and more substantial and widespread losses for program participants.

However, conversations with USDA representatives have indicated a desire of USDA to make changes to the interim final rule such that it may be more appealing and easier to implement and "friendlier" to existing and future growers and regulatory groups. New rule revisions are anticipated spring of 2021.

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. At the end of 2020 we had approximately 1,223 processors which is an increase of about 20% over last years numbers.

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 gotten well ahead of the law and the market in this case and this remains 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, nucleus colonies (nucs), or hives. One hundred and forty-one permits to sell were issued for 2020. To obtain a permit, bees must be inspected, and the producers must 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. The list of permitted dealers authorized to sell bees in NC is updated weekly and can be found on the Plant Industry Division – Apiary website.

One of our inspectors, Greg Fariss, retired in 2020. Greg covered 15 counties in the western part of the piedmont. His position is to be filled by Ms. Bridget Gross in March of 2021 with no changes to the work region.

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.

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. In order to reduce the improper use of antibiotics, we again coordinated with the Veterinary Consortium to facilitate further education of veterinarians in honey bee disease diagnostics.

Beekeepers are expressing concern about pesticides, particularly the neonicotinoids, but the evidence of pesticide misuse has not been commensurate with the concern. Bee yards can be registered through the Plant Industry Division. The list of registered apiaries 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. 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 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.

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 2020 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, Daniel Russell and John Banask. Glenn Hackney is a Research Specialist in the Apiary Inspection Program and maintains a lab at the BIL. Other Apiary staff operate from home-based offices across the state. During 2020, the inspectors were: Greg Farris (retired 09/01/2020), western Piedmont, Nancy Ruppert,

Sandhills, John Harris, southeastern 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 posed staffing challenges as Steven Turner left NCDA&CS in August and the Biological Control Administrator position remained vacant until March 2021. In addition, starting March of 2020, COVID-19 concerns eliminated all overnight travel and limited activities at the biolab facility when we were fully staffed. Progress on our dedicated programs continued to decrease when all three of the temporary staff charged with project management resigned to focus on their education or pursue permanent employment. Christine Nalepa and Nancy Oderkirk remained dedicated to the current biocontrol programs throughout the pandemic. Greg Wiggins, PhD, will fill the Biological Control Administrator position in March 2021 and COVID restrictions are expected to lessen which will allow all biocontrol work to resume to full capacity.

The following report is a summary of activities from NCDA&CS beneficial insect programs.

Apiary Inspection Program

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Implementation of *Cerceris fumipennis* as a Biosurveillance Tool for Pest Buprestidae in North Carolina during 2020

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 2020 studies of the wasp in North Carolina were continued by conducting biosurveillance at established sites and by surveying for new *Cerceris* aggregation sites.

The primary goal of the *Cerceris* surveys in 2020 was to find aggregations of the wasp large enough ($\geq$ 15 nests) to allow us to conduct biosurveillance for detection of emerald ash borer (EAB) in counties where this pest had not yet been detected. The counties surveyed for *Cerceris* aggregations were therefore primarily in the southern and southeastern part of the state. An additional goal was for the wasps to collect beetles in the genus *Chrysobothris*, to send to cooperator Dr. William Klingeman, The University of Tennessee, for use in his studies.

Surveys and biosurveillance began on 25 May and were completed on 1 July 2020. *Cerceris* aggregations were found in few of the new counties we surveyed. Of the 60 new sites in 14 counties surveyed, 17 had *Cerceris* nests (28%), but in all but 2 cases (Harnett 5 and Lee 3) nests were too few in number to conduct biosurveillance. It appears to have been a dismal year in general for *Cerceris* aggregations, for example, in

one site in Franklin Co. (Franklin #6) that had 86 nests in on 5 June 2019, none were to be found on 5 June 2020.

The most beetles by far were collected from two sites previously known to have *Cerceris* aggregations and in one new site. One was a *Cerceris* aggregation first detected in 2019 (Lee 1). A second was from a long-established site in Wayne Co., where we attempted to collect beetles in the genus *Chrysobothris* for cooperators. The third was a uniquely positioned newly detected site in Wake Co. (Wake 62, discussed below).

Overall, a total of 258 buprestids were collected (Table 1); five of these were in the genus *Chrysobothris*, identified by W. Klingeman as two *Chrysobothris cribraria*, one *C. quadriimpressa*, one *C. rugosiceps*, and one *C. viridiceps* (Table 2).

The remaining beetles were pinned, labelled, and most identified by NCDA State Entomologist Whitney Swink. The majority were species that were commonly collected by *Cerceris* in previous field seasons. Seven difficult to determine beetles were sent to cooperator Joshua Basham (USDA-APHIS), who identified them as *Actenodes acornis, Agrilus quadriguttatus quadriguttatus, Agrilus quadriimpressus*, and *Buprestis apricans*.

EAB was not detected in any of the *Cerceris* positive sites where new biosurveillance was conducted; neither was it collected in our Wayne Co. site where EAB has been collected in the past. The only site where *Cerceris* brought back EAB was in a Wake Co site strategically positioned near a known infested ash stand and part of a separate study conducted there (see below).

Table 1. Summary of biosurveillance using *Cerceris fumipennis* during 2020.

County	**# Sites surveyed**	**# Sites with *Cerceris* nests**	**# Sites where biosurveillance was conducted**	**# Buprestid beetles collected**
Bladen	10	4	0	0
Craven	2	0	0	0
Franklin	1	1	0	0
Greene	3	1	0	0
Harnett	2	2	1	18
Hoke	3	0	0	0
Lee	7	3	2	32 (10 + 22)
Lenoir	1	1	0	0
Montgomery	9	1	0	0
Moore	6	1	0	0
Pitt	1	0	0	0
Robeson	1	1	0	0
Sampson	5	0	0	0
Scotland	4	2	0	0
Stanley	7	2	0	0
Wake	1	1	1	176
Wayne	1	1	1	32
Total: 16 counties	**64**	**21**	**5**	258

We received identifications of the *Agrilus* specimens collected by *Cerceris* in 2019 and sent to J. Basham for examination. Of note was that ten specimens of *Agrilus subrobustus* were collected by *Cerceris* at a site in Nash county (Spring Hope Elementary School: 35°57'0.86"N, 78° 6'38.99"W), on the other side of the state from where this *Agrilus* species was first detected by *Cerceris* in North Carolina (Asheville - Swink et al. 2015). This finding indicates that this pest of mimosa (*Albizia julibrissin* Durazzini) should be considered widespread in the state.

Table 2. Summary of beetles in the genus *Chrysobothris* collected by *Cerceris fumipennis*.

Date	Species	Site	City	County
3-Jun-20	*Chrysobothris rugosiceps*	Faith Christian Academy	Goldsboro, NC	Wayne Co.
3-Jun-20	*Chrysobothris cribraria*	Erwin Parks & Rec	Erwin, NC	Harnett Co.
4-Jun-20	*Chrysobothris quadriimpressa*	Faith Christian Academy	Goldsboro, NC	Wayne Co.
8-Jun-20	*Chrysobothris viridiceps*	Lee Christian School	Sanford, NC	Lee Co.
13-Jun-20	*Chrysobothris cribraria*	S Garner High School	Garner, NC	Wake Co.

Biology of the Emerald Ash Borer (EAB) and its Parasitoids in North Carolina 2020

We continued our cooperative research with Dr. Kelly Oten (formerly North Carolina Forest Service, currently with North Carolina State University, Department of Forestry and Environmental Resources) on the biology of emerald ash borer, with an emphasis on their phenology and natural enemies in NC.

The study site\ was the Wrenn Road Water Reclamation Facility for the City of Raleigh in Garner, NC, where. ~40 acres total of green ash (*Fraxinus pennsylvanica*) was planted in three plots about 20 years ago for the purpose of treating municipal wastewater. These plots are surrounded by stands of pine, sycamore, sweetgum and bald cypress.

Fig. 1. A) Adult emerald ash borer emergence at Wrenn Road Research site (14 April 2020). Note chewed edges of ash leaves. B) Log sections of ash in emergence cages for collection of adult EAB and parasitoids.

The research was conducted in three parts, allowing for a comparative analysis.

1) On 20 March 2020, six EAB infested ash trees (Fig. 1A) at the Wrenn Road research site were cut down and sectioned into logs, two trees from each of three plots (Fig. 2A). These were brought back to the Beneficial Insects Laboratory (BIL), placed into emergence cages (Fig. 1B) and monitored daily for emergence of adult EAB and its native parasitoids. A total of 1,298 EAB emerged from these logs; these are being sexed and the length of females measured. Females measured to date are a mean of 11.8 $\pm$ 0.79 mm in length (n=261). Forty-three possible parasitoids were collected and submitted to cooperators at NCSU for identification.

2) *Cerceris* biosurveillance was conducted intensely at a newly detected Wake county site (South Garner High School) located about 550 meters north of our Wrenn Road research site (Fig. 2A). Biosurveillance was conducted at the aggregation (Fig. 2B) on 14 days, between the dates of 5 June and 1 July. A total of 176 beetles were collected by *Cerceris* at that site, 92 of which were EAB (52.3%). The first EAB was taken from the wasps on 7 June, and the last on 1 July, at which point the wasps in this aggregation were at the end of their life cycle. The collected EAB were sexed, measured and weighed, and the data are being analyzed.

3) Adult EAB collected biweekly from purple prism traps at the Garner site were preserved in alcohol and brought to the BIL. These are currently being measured, dissected and sexed; data will then be compared to EAB collected by *Cerceris* and to those emerged from logs cut at the site.

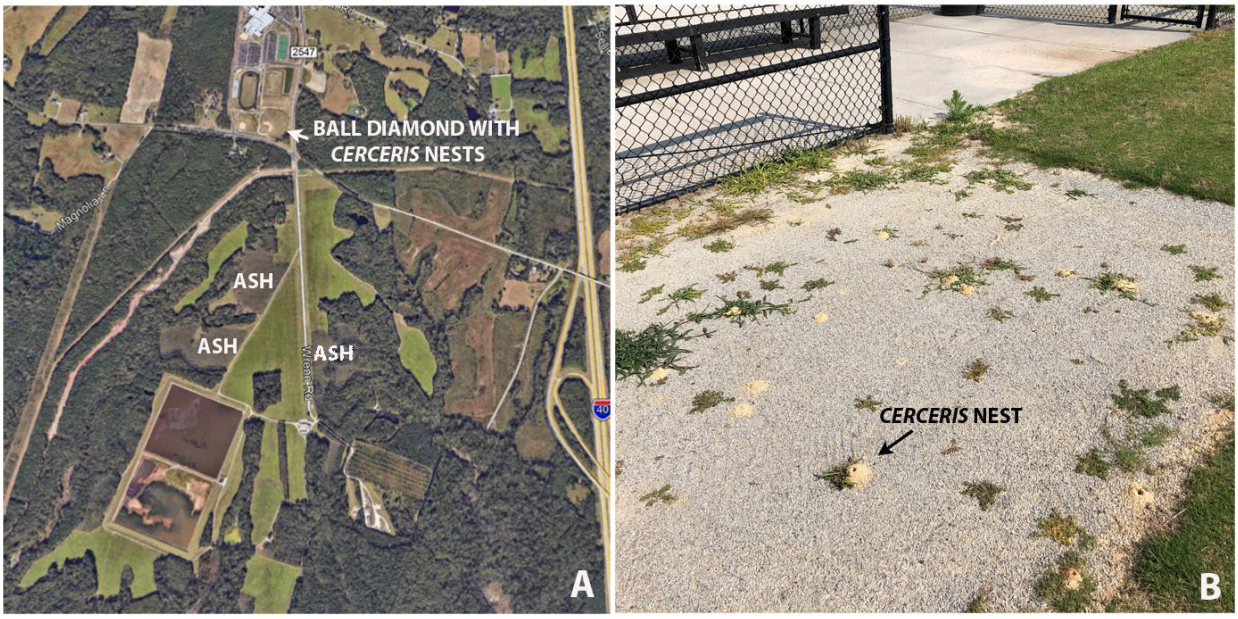


Fig. 2. A) Map showing location of *Cerceris* aggregation on a ball diamond at South Garner High School (SGHS) in relation to three pure stands of EAB infested ash at the Wrenn Road Research site. B) *Cerceris* nests along the backstop at SGHS.

Analysis of these data allows for comparison among the three collection techniques and will provide information on the efficacy of the three methods employed. Preliminary results indicate that *Cerceris* was able to collect EAB for at least three weeks after the last EAB was found on the purple traps.

Reference Cited

Swink,W.G, C.A. Nalepa, and J.P. Basham. 2015. *Agrilus subrobustus* Saunders (Coleoptera: Buprestidae) first detected in North Carolina as prey of the wasp, *Cerceris fumipennis* Say (Hymenoptera: Crabronidae). Coleopterists Bulletin 69(2): 274. DOI: http://dx.doi.org/10.1649/0010-065X-69.2.274

Biological Control of Mile-A-Minute Vine with the weevil, *Rhinoncomimus latipes* in North Carolina

Mile-a-Minute vine (MAM), *Persicaria perfoliata*, is a fast-growing annual invasive weed found in riparian areas and along forest edges in the Northeastern and mid-Atlantic United States. It was first discovered in North Carolina in 2010 (Poindexter 2010). This plant is easily identified by triangular leaves, spines on the stems and leaf petioles, and a modified leaf (ochrea) that surrounds each node. Its small white flowers develop into bright metallic blue, berry-like fruit in late summer. Seeds can remain viable in the soil for up to six years. They disperse by floating and by seed-feeding birds, mammals, and ants. Patches of MAM also drift along waterways during major flooding events.

Rapid growth, prolific flowering, long-lived seeds, location along waterways, and ability to overtop herbaceous and shrubby plants and even small trees (Fig. 1), make chemical control of MAM difficult. Cultivation is not very effective, because seeds can be released during the process, and plant remnants root at the nodes and re-grow. Biological control has therefore proven to be a valuable tool for an integrated management plan for dealing with this weed.

Surveys for natural enemies in its native Asia revealed the weevil *Rhinoncomimus latipes* Korotyaev (MAM weevil) as the most promising species, with MAM as its sole hostplant. Adult weevils feed on the leaves (Figs. 2 and 3) and larvae bore into the stems, weakening the plant and reducing seed production. MAM weevil has 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.

Extensive surveys have determined the range of MAM to be restricted to six counties in North Carolina (Fig. 4.) We recently discovered one new site in Watauga County, where a previous population of MAM was thought to have been eradicated. We plan to conduct weevil releases at that site in 2021.

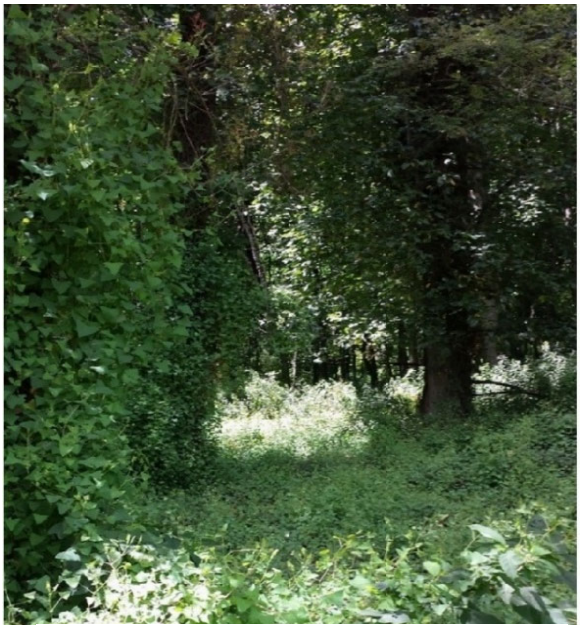


Figure 1. Mile-a-Minute vine overgrowing other vegetation at the forest edge.

Figure 2. Typical early-season damage by MAM weevil. Alleghany County, 2016.

Figure 3. Mile-a-Minute Weevil *Rhinoncomimus latipes* on its host plant.

Photo credit: Matthew Bertone, NCSU Plant Disease and Insect Clinic.

Weevils have been released in multiple years at sites with dense MAM populations (Table 1). The weevils have persisted at each site, and dispersal has been documented almost 5km from release sites. The Yancey County MAM population has been kept in check by means of mechanical removal in addition to biological control. In Guilford County, only a small MAM stand has remained, and has been kept in balance by the weevils. In all other locations, as observed during annual surveys, plant density has consistently outgrown that of the weevil, in the absence of consistent mechanical control. This has resulted in partial suppression of the weed via previously documented reduction of plant growth and seed production.

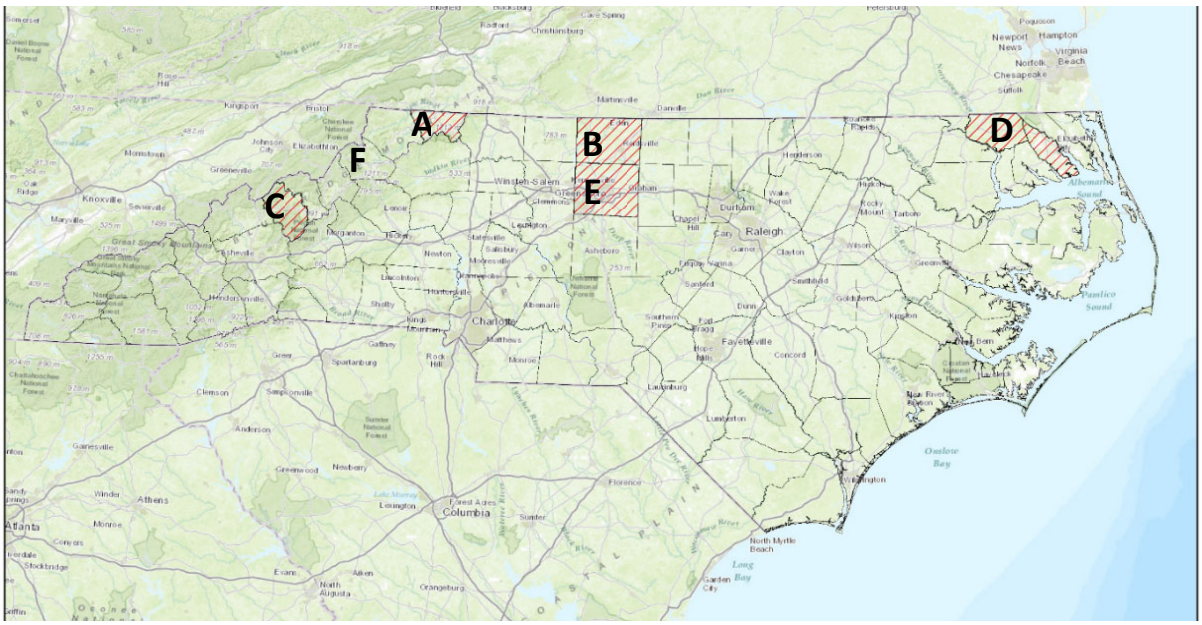
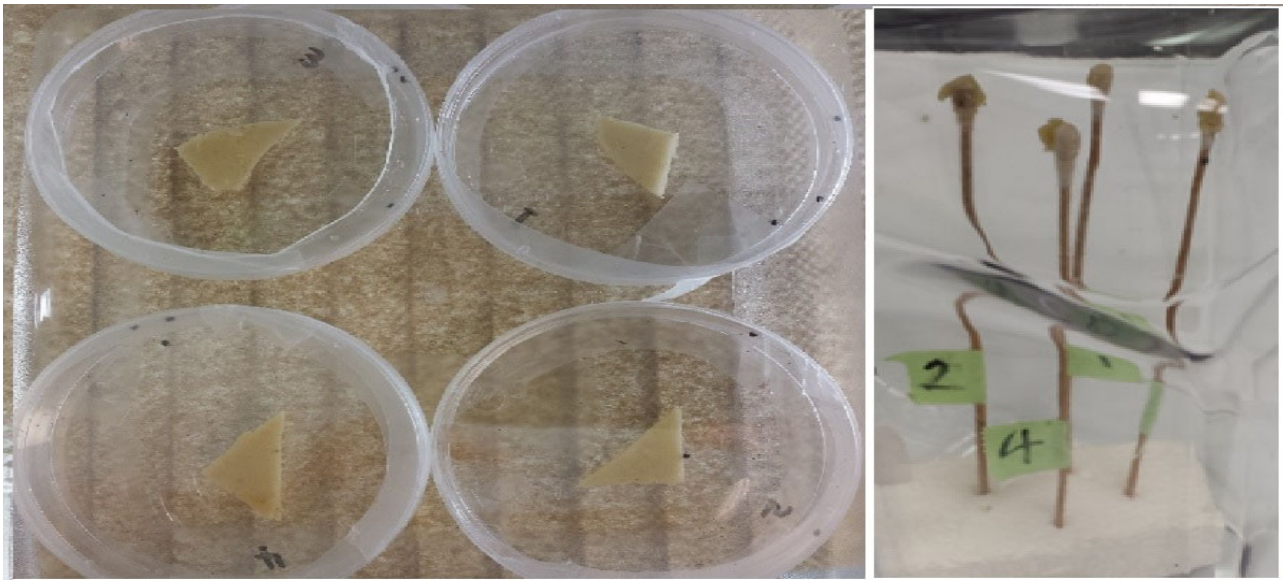


Figure 4. Mile-a-Minute detections in North Carolina Counties. Letters correspond with the order in which detections were reported. **A** = Alleghany, **B** = Rockingham, **C** = Yancey, **D** = Pasquotank and Gates, **E** = Guilford, **F** = Watauga.

Table 1. Releases of *Rhinoncomimus latipes* in North Carolina by year.

Year	County	# Weevils
2011	Alleghany	2200
	Yancey	200
2012	Alleghany	4800
2013	Alleghany	2500
2014	Alleghany	300
	Guilford	200
	Pasquotank	4000
2015	Gates	3000
	Rockingham	1350
2016	Pasquotank	300
	Rockingham	300
2017	Alleghany	2000
	Gates & Pasquatank	500
2018	Alleghany	2000
	Guilford	1000
	Gates & Pasquotank	3000
Total		27,650

Plant growth in our region can outpace weevil activity in Spring, especially during periods of high rainfall (Berg et al. 2015). We therefore endeavored to build up an overwintering weevil population under artificial conditions, for early release as the plants emerge in Spring. MAM plants, however, do not adapt well to extended laboratory containment, despite controlled environmental factors. To facilitate this work, therefore, we tested four laboratory-developed insect diets that were in the early development stage. In multiple replicates, with two different presentation formats, the weevils failed to thrive on these diets. We observed



only occasional feeding on any formulation (Fig. 5).

Figure 5. Presentation of laboratory-developed diet for overwintering *R. latipes* weevils.

Despite variable results in terms of biological control of MAM in North Carolina, we have observed consistently that MAM weevils have reliably persisted, dispersed, and produced noticeable suppression of Mile-a-Minute vine at every site where they have been released. For these reasons, we believe that the weevil will remain a viable tool, in concert with early-season mechanical controls, within an IPM program for this weed.

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Acknowledgements

This work has been supported by USDA-APHIS and the USFS under Biological Control Cooperative Agreements with the initial generous support of Ron Weeks. NCDA&CS collaborators from 2019-2020 have included Andrew Allen, John Banask, Joe Davenport, Jarred Driscoll, Tim Hartley, Samantha Larsen, Bridgett Lassiter, Nancy Oderkirk, Chad Taylor, and Steven Turner. Cooperators included Kent Luton and Nate Cartwright of Jones Lumber Company, Bill Castelloe of Weyerhaeuser, and private landowners. Allen Cohen of North Carolina State University developed and provided weevil diets. Whitney Swink designed the original maps. Cynthia Detweiler of the New Jersey Department of Agriculture Philip Alampi Beneficial Insect Laboratory provided weevils for release.

NCDA&CS Knotweed Biocontrol Annual Report 2020

The Beneficial Insects Lab (BIL) of the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Plant Industry Division houses the Biological Control working group for the study, maintenance, and distribution of biological agents for invasive weed and pest control in North Carolina. Nonindigenous plant species that are now invasive were often originally imported as ornamental or otherwise benign or even useful purposes. Knotweeds were initially introduced as ornamentals throughout Europe and in the United States in the late 1800's and early 1900's, but are now known to spread beyond control via underground rhizomes, forming stands that outcompete native plants and create ecological imbalance. In addition, the rhizomes have been known to grow so vigorously as to undermine pavement and foundations, causing structural collapse. To prevent drastic measures that must be employed in such cases, control initiatives have been undertaken to locate and remove small patches of knotweeds and to instigate biocontrol for larger knotweed stands.

Members of the BIL are collaborating in a national effort led by Dr. Fritzi Grevstad of Oregon State University to control this weed. In August 2019, we received shipments of two biotypes of the Knotweed psyllid, *Aphalara itadori*: the Hokkaido biotype from Northern Japan, specific to Giant Knotweed, *Fallopia sachalinensis*, and the Kyushu biotype from Southern Japan, specific to Japanese Knotweed, *F. japonica* and the hybrid Bohemian Knotweed, *F. X bohemica.* These psyllids have since been maintained continuously at the BIL on their respective host plants. Colonies were housed initially strictly in our Quarantine facility. Since permits for release were granted by federal granting agencies in the Spring of 2020, our psyllid colonies have been expanded and held also in additional lab space outside of the Quarantine lab. Protocols for knotweed and psyllid colony establishment and expansion have been established with adaptations to meet our available equipment and specific environmental conditions, largely following those of Grevstad et al. (2018).

This year, with cooperation from property owners, local and state governmental officials, business owners, and additional stakeholders, we identified and obtained permissions for knotweed control and release activities at six sites within five Counties (Table 1). Standardized protocols were followed, and more than three thousand psyllids were released (Fig. 1). Establishment of post-release psyllid populations at each site is being determined, with initial observations confirming successful survival of the released adult psyllids, and initiation of a second psyllid generation. Long-term viability and overwintering survivorship will be determined in the Spring of 2021. We are also preparing to release psyllids for Giant Knotweed biocontrol at one site in Henderson County in early 2021.

Table 1. North Carolina Knotweed site descriptions and psyllid release information for 2020.

Site Description	County	Knotweed species	Psyllid biotype released	# Released	Date (2020)
Evergreen Cemetery & Preserve	Mecklenburg	*Fallopia X bohemica*	Hokkaido	800	10 May
NC DOT, Raeford	Hoke	*Fallopia X bohemica*	Kyushu	780	26 June
Private property adjacent to NCDOT mitigation site	Lee	*Fallopia japonica*	Kyushu	835	6 July
Private property	Henderson	*Fallopia sachalinensis*	Hokkaido, planned release Spring 2021		
Walnut Creek Wetland Center	Wake	*Fallopia japonica*	Kyushu	500	6 May
Walnut Creek near Farmers Market	Wake	*Fallopia japonica*	Kyushu	500	6 May
			Total # Psyllids released	3415	

Three sets of psyllid colonies are now housed at the BIL: Indoor colonies held under long-day summer conditions for scaling up in early Spring, outdoor colonies within a newly-established field cage to determine the overwintering capabilities of the psyllids, and indoor colonies held under short-day winter conditions to replenish the outdoor colonies in the event of a weather event that damages those cages. Determinations of psyllid survival at release sites and in field cages will instruct our release and control plans for the future.

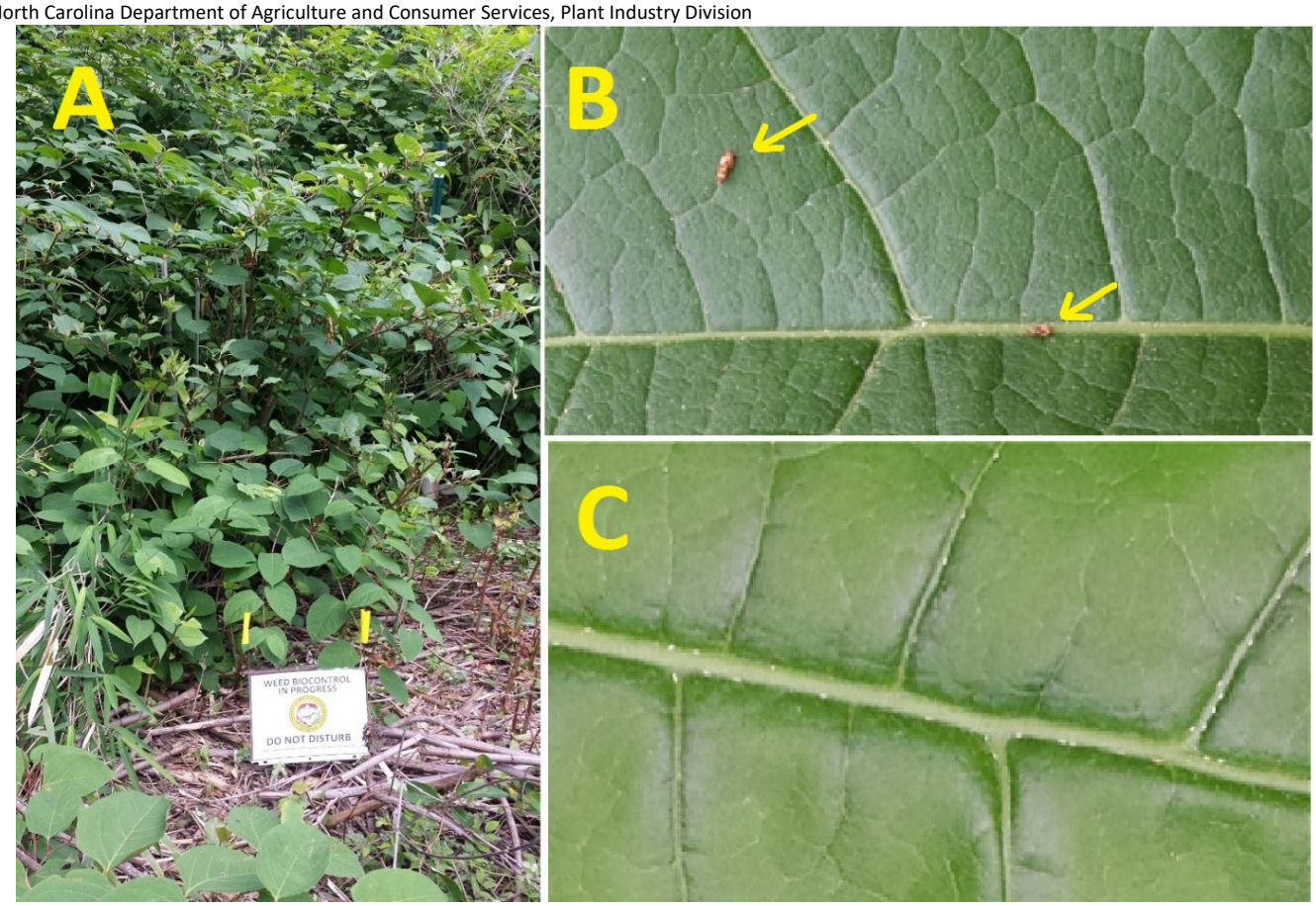


Figure 1. Typical Knotweed site in North Carolina (A), psyllids on a knotweed leaf (B), and psyllid eggs along leaf veins (C).

Reference

Grevstad, F., J.E. Andreas, R.S. Bouchier, R. Shaw, R.L. Winston, and C.B. Randall. 2018. Biology and Biological Control of Knotweeds. USDA Forest Service, Forest Heath Assessment and Applied Sciences Team, Morganton, West Virginia. FHTET-2017-03.

Acknowledgements

This work has been supported by USFS Agreement #18-CA-1142004-021. Psyllids were initially supplied by Fritzi Grevstad of Oregon State University. Property permissions and collaborative efforts were provided by Leigh Bragassa, Owen Cass, Stacie Hagwood, and Julian Watson of the City of Raleigh Parks, Recreation, and Cultural Resources Department; Stefanie Hedrick, Lenny Lampel, and Christa Rogers of the Mecklenburg County Park and Recreation Department; William Bibby and Erin Shanaberger of the City of Charlotte; Rex Badget and Cheryl Knepp of the North Carolina Department of Transportation; Bruce Paitt of Duke Energy; and private property owners.

The 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. Jarred Driscoll who served as the North Carolina State Survey Coordinator (SSC) for seven years transitions to the North Carolina Regulatory Weed Program Manager on April 1, 2020. Amy Michael started her role as North Carolina CAPS SSC on June 1, 2020. Ms. Michael formerly served as the Arkansas CAPS SSC. 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. Data collected from these surveys are entered into the National Agricultural Pest Information System (NAPIS) before December 31st for inclusion into the Nation Plant Board's annual report.

Executive Summary

The 2020 North Carolina CAPS program was successful in procuring funding for CAPS and Farm Bill surveys for early detection of exotic plant pests. Eight independent surveys were conducted throughout the state, covering 53 counties. Surveys included; mollusk, forest pests, oak commodity, Asian defoliators, grape commodity, solanaceous commodity, a *Phytophthora* spp. state-specific survey, and spotted lanternfly. Five temporary employees were hired to assist with survey efforts, including four plant pest aides and one taxonomic specialist. A total of thirty-three different exotic plant pests were surveyed from April through late October. All surveys were completed following the 2020 CAPS guidelines, so that negative data were reportable. One positive detection of a target pest occurred during this survey season: *Phytophthora ramorum* was found in a private Ashe County nursery on plant material originating from an Oregon nursery that was not known to be infested with the pathogen. Destruction and quarantine protocols were enacted. Follow-up inspections did not detect additional *Phytophthora* spp. in the plants or in a nearby stream, and the 90-day quarantine was lifted. Otherwise, there were no positive detections for any of the targeted plant pests during the 2020 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.), *Phytophthora* spp. (important plant pathogens affecting nursery and natural areas), grape commodity, Asian defoliators (largely surveyed at ports of entry), and spotted lanternfly (early detection/ host mapping). Many of these surveys follow CAPS guidelines for how they are conducted. Survey priorities for 2020 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 2020 surveys, while proposals for the 2021 survey season were successfully submitted in August, 2020.

CAPS Surveys

Three CAPS surveys were selected for the 2020 season in North Carolina; mollusk, forest pests and oak (Figure 1).

Mollusk Survey

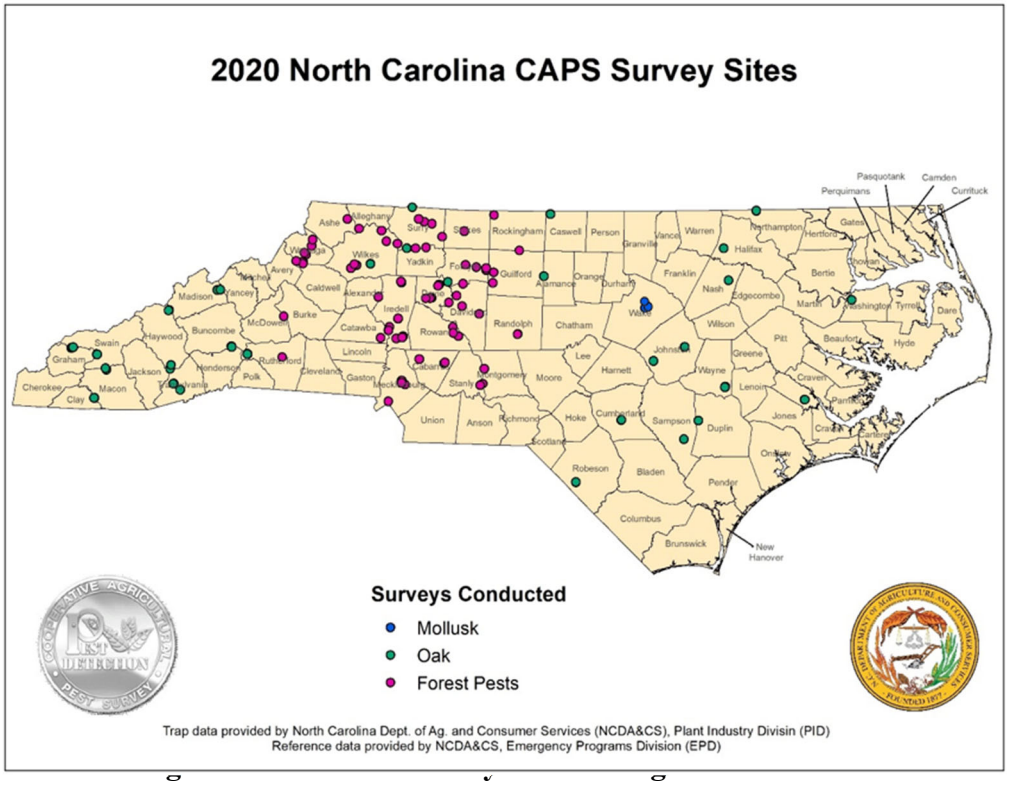
The mollusk survey was completed in June at three locations (Figure 1), meeting our survey goal. Eight exotic taxa of mollusk were surveyed: giant African snail (*Lissachatina fulica*), Hygromiid snails (*Cernuella spp.*) and Leatherleaf slug spp. (*Veronicella spp., Belocaulus spp., Celosias spp., Laevicaulis 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 three stone and tile importing locations within the state. No target pests for this survey were recovered.

Oak Commodity Survey

North Carolina completed the 2020 oak commodity survey at 29 locations (Figure 1), surpassing the goal of 20. This survey included the following species: false codling moth (*Thaumatotibia leucotreta)*, oak processionary moth (*Thaumetopoea processionea)*, green oak tortrix moth *(Tortrix viridana)*, oak ambrosia beetle (*Platypus quercivorus*), and Japanese oak wilt (*Raffaelea quercivora)*. Trapping for the insects included in this survey began in April 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. Visual surveys for *R. quercivora* – the pathogen spread by oak ambrosia beetle – were conducted at all sites. No target pests for this survey were recovered.

Forest Pests Survey

The Forest Pest survey throughout the state concentrated on Asian Longhorned beetle (*Anoplophora glabripennis*; ALB), beginning in April and concluded in early October. The initial goal to conduct monthly inspections of declining maple at 20 industrial parks was met. However, following the detection of an ALB population in Hollywood, South Carolina in June, sites were added in order to investigate potential pathways and educate a greater number of stakeholders. New sites were primarily campgrounds operated by state parks or private landowners. Ultimately, 82



visual surveys were conducted across 37 sites by the end of the survey (Figure 1). No evidence of ALB infestation was observed.

Farm Bill (PPA 7721) Surveys

The SSC annually applies for Federal assistance for the state to conduct exotic plant pest surveys. In 2020, money for five Farm Bill surveys were awarded to NC; Asian defoliators, grape commodity, solanaceous commodity, a *Phytophthora* spp. survey, and spotted lanternfly early detection/ host mapping.

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 rest areas, 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 17 trapping locations were placed at ports of entry over a four-month period from June to September (Figure 2), meeting our survey goal of 15-20 locations. Monthly site visits were used to replace sticky cards and/or lures. Typical survey sites include rest areas, 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. No target pests for this survey were recovered.

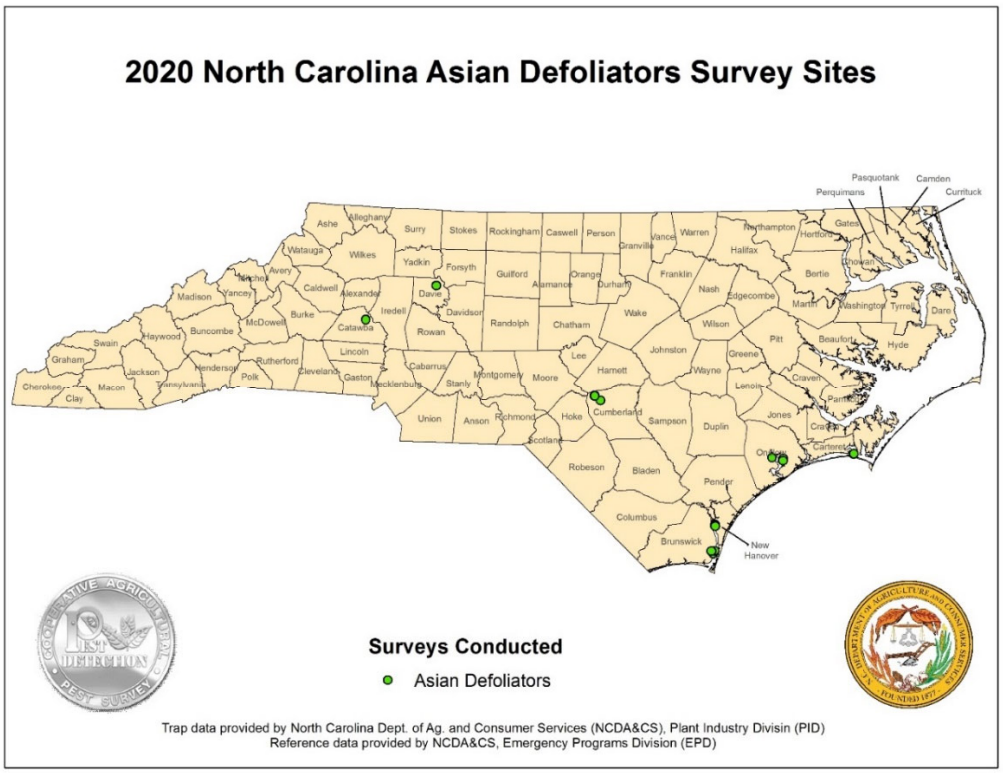


Figure 2. Asian Defoliator survey locations during the 2020 season.

Following the conclusion of the 2019 Asian defoliator survey and the arrival of a ship infested with Asian gypsy moth (AGM) eggs at the Sunny Point Military Ocean Terminal (MOTSU) in late 2019, NCDA&CS personnel participated in the rapid response effort and placed 56 additional traps throughout the base according to a risk-based grid (Figure 3). Additional traps (2-sided orange paper delta with disparlure, 56 total) were placed at MOTSU according to this grid again in 2020 to capture any potential AGM resulting from this incident. High-density traps were changed and lures replaced once in late July and pulled September 30th. While no AGM were recovered, a single European gypsy moth (*Lymantria dispar dispar*) adult male was intercepted in a trap.

Figure 3. Additional trap locations for *L. dispar asiatica* within MOTSU.

Grape Commodity

The Grape Commodity survey was completed at 35 locations (Figure 4), exceeding our goal of 20 locations. Vineyards surveyed included both European (*Vitis vinifera*) and native muscadine grapes (*Vitis rotundifolia*). We surveyed for four exotic species; Christmas berry webworm (*Cryptoblabes gnidiella*), spotted lanternfly (*Lycorma delicatula*), light brown apple moth (*Epiphyas postvittana*, LBAM), and European grapevine moth (*Lobesia botrana*). Additional traps for LBAM were placed at several vineyards that had imported nursery stock from an LBAM-infested area of California as additional "check" to any regulatory measures followed by the originating nursery. The survey was completed at twenty-nine locations using plastic delta and bucket traps that were set in June and pulled by October (Figure 4). Visual surveys for spotted lanternfly were conducted within vineyards at each visit in accordance with the approved guidelines. No target pests for this survey were recovered.

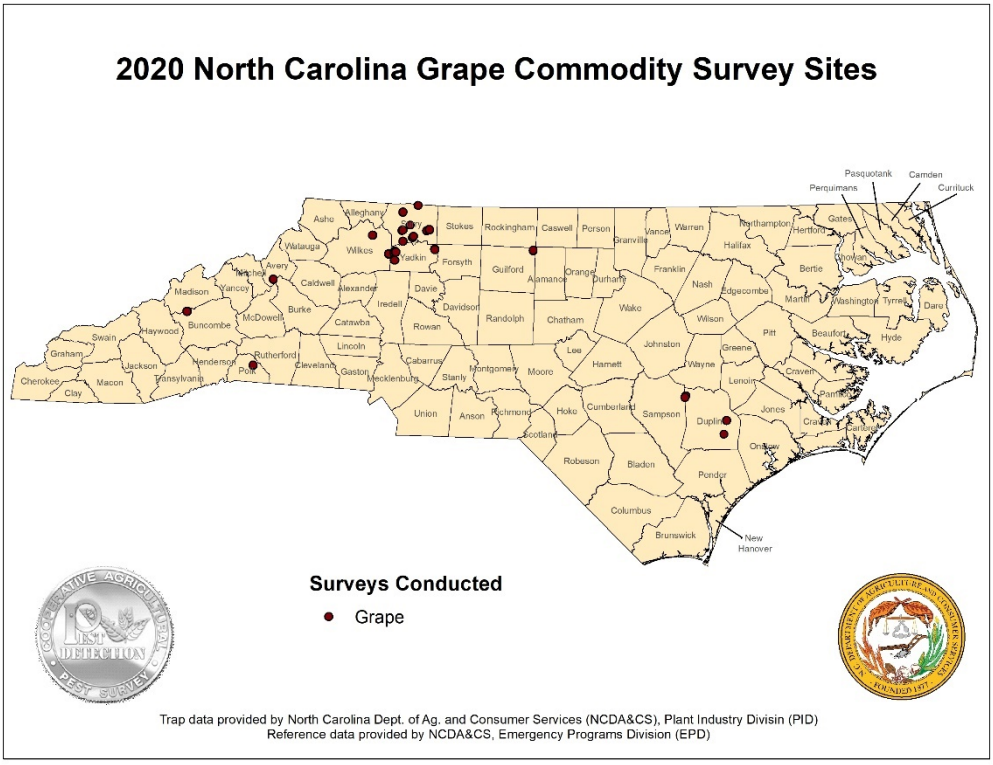


Figure 4. Grape commodity survey sites for the 2020 season.

Solanaceous Commodity

We surveyed 33 host sites that included commercial tomato, eggplant, tobacco and pepper production fields (Figure 5) for insect pests, exceeding our goal of 20 sites. Four exotic insect pests of solanaceous plants were surveyed from June-October 2020: tomato leaf miner (*Tuta absoluta*), old world bollworm (*Helicoverpa armigera*), tomato fruit borer (*Neoleucinodes elegantalis*), Egyptian cottonworm (*Spodoptera littoralis*), and cotton cutworm (*Spodoptera litura*). 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.

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. It has also shown a propensity to hybridize with native bollworm, *H. zea*, in South America. *H. zea* is already a leading pest in several NC commodity systems, and there would be potential for rapid sharing of resistant genes between these species if *H. armigera* becomes established. Early detection and identification of this pest will limit spread to the natural environment and aid in eradication. Invasive *Helicoverpa armigera* and native *H. zea* are impossible to distinguish by their external appearance. A taxonomic specialist was hired to conduct genitalic dissections on all *Helicoverpa* spp. collected in this survey to rule out positive identifications for *H. armigera*.

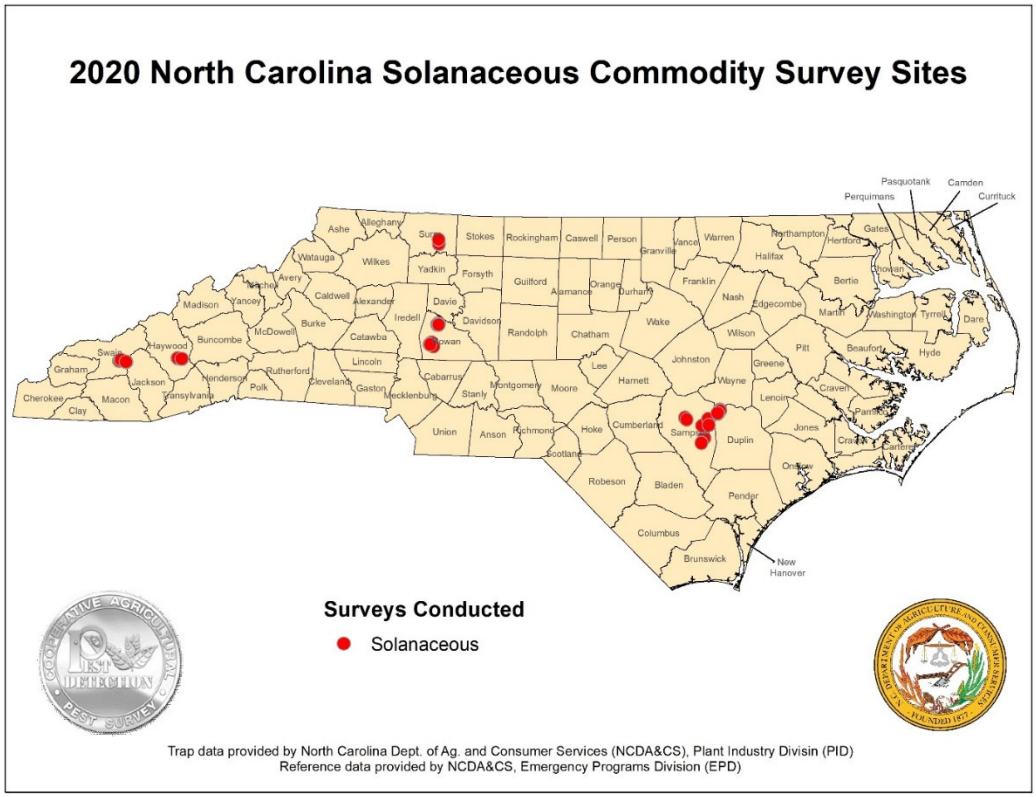


Figure 5. Solanaceous commodity survey sites for 2020 season (insect traps only).

After the survey period for these pests had begun, USDA issued a call for a new pest to be added to solanaceous surveys. Tomato Brown Rugose Fruit Virus (ToBRFV) is a tobamovirus that is fairly new to science, discovered in Israel in 2015. It has since been detected in several countries including Mexico and has been intercepted in several US states. This virus can affect several solanaceous crops. Symptoms tend to appear in foliage first, and lead to brown lesions on the fruit that can render the product unmarketable (Figure 6). While it can be seedborne, this virus spreads mechanically and can quickly contaminate entire production systems. Greenhouse-grown tomatoes appear to be the most susceptible. Following the announcement from USDA, an amendment and extension was requested to survey for this pathogen during peak greenhouse cultivation beginning in February 2021.

Figure 6. Symptoms of ToBRFV (photos by Neta Luria et al.).

Phytophthora spp.

North Carolina conducted a *Phytophthora ramorum* and *P. kernoviae* survey during 2020. 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 members of *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 2021. All suspect samples were screened for the presence of *Phytophthora spp*. using Enzyme Linked Immunosorbent Assay (ELISA) with positive samples forwarded to a USDA National Plant Diagnostic Network (NPDN) Lab for further diagnostics.

Positive Detection/ Eradication

On June 25th, a Regional Plant Pest Specialist observed suspect symptoms of *P. ramorum* on rhododendron that had come into a certified Ashe County nursery from the State of Oregon. They collected a sample that tested positive for *Phytophthora* spp. by the NCDA&CS Plant Pathologist, who then sent it to the NPDN-member University of Florida Diagnostic Laboratory for species-level identification. USDA-APHIS-PPQ confirmed the plant positive for *P. ramorum*. NCDA&CS took immediate regulatory action upon notification of the result on July 20th, including destruction of all plants within a 2-meter radius of the initial positive plant, placing all plants within 4 meters under a 90-day quarantine for further inspection, a complete inspection of all other plants included in that shipment, and a delimiting survey of all other host plants at the nursery. No additional *Phytophthora* spp. were detected in follow-up inspections of the plants or a nearby stream, and the 90-day quarantine was lifted.

This detection triggered a traceback to an Oregon nursery that was not known to be infested with the pathogen. The complimentary trace forward conducted by the Oregon Dept. of Agriculture revealed one additional shipment from this company to North Carolina. Plants from this shipment were destroyed and additional plants inspected showed no evidence of infestation. *For further details – see Plant Pathology section.*

Otherwise, there were no additional positive detections for these pathogens during the 2020 survey season.

Spotted Lanternfly Early Detection/ Host Mapping

See Entomology section.

Entomological Programs

Prepared by Whitney Swink, Entomological Programs Manager, Allison Ballantyne, Gypsy Moth Program Coordinator, and Casey Buddenbaum, GIS Analyst

The following report summarizes the primary activities and accomplishments of the NCDA&CS Entomological Programs in 2020.

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 September through mid-October 2020 in 49 counties, primarily in eastern North Carolina. 12,411 traps were set in 11,653 fields in approximately 93,521 reported acres (Table 1). 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 7.54 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 2020.**

TABLE 1. NC SWEETPOTATO WEEVIL FIELD TRAPPING SUMMARY (2020)

County	Mapped Fields	Reported Acres	Traps Set[1]	County	Mapped Fields	Reported Acres	Traps Set[1]
Anson	1	0.02	--	Lee	18	106.79	21
Beaufort	25	180.49	24	Lenoir	274	2960.94	362
Bertie	87	735.12	116	Martin	149	1609.93	191
Bladen	13	128.44	23	Moore	7	102.39	15
Brunswick	1	4.14	2	Nash	1695	11678.691	1723
Camden	1	4	--	Northampton	10	159.2	19
Carteret	6	54.9	14	Onslow	16	69.72	8
Chowan	55	451.27	81	Orange	4	6.39	4
Cleveland	1	1.5	2	Pasquotank	8	82.62	17
Columbus	129	996.77	110	Pender	65	542.77	10
Craven	154	937.84	146	Pitt	587	5405.44	528
Cumberland	161	1651.87	252	Polk	2	4.97	4
Duplin	176	1977.83	278	Robeson	14	499.04	25
Edgecombe	927	8587.18	1080	Rockingham	6	22.53	--
Forsyth	1	1	--	Rutherford	1	0.35	1
Franklin	67	344.12	48	Sampson	821	8851.87	1465
Graham	1	1	1	Scotland	9	263.5	29
Granville	76	275.89	45	Tyrrell	1	5.17	2
Greene	534	5419.61	586	Vance	2	5.25	2
Guilford	42	226.6	14	Wake	231	1141.83	156
Halifax	192	1325.18	191	Warren	27	127.5	27
Harnett	451	3050.702	497	Wayne	1237	9998.77	1229
Hertford	108	1103.59	163	Wilson	1624	10300.44	1352
Johnston	1633	11080.78	1544	Yadkin	2	1.5	4
Jones	1	33.65	--				
				Total	**11,653**	**92,521.09**	**12,411**

[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 accomplished using the same procedure detailed for the field surveys. A total of 192 regulatory sites (totaling 4,264 inspections) were surveyed and **no weevils were found in storage facilities during the 2020 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 2021).

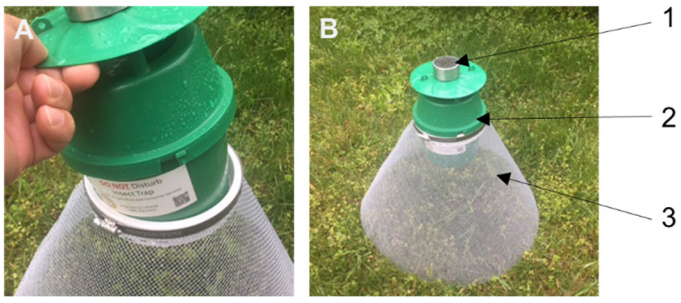


Figure 2. Details of the sweetpotato weevil trap to use in the MAT. The base of the trap is a funnel made with galvanized mesh (3). This allows weevils to walk to the bucket trap fitted within a PVC ring that holds the funnel (2). The bucket trap includes a solar cell (1) that charges an LED diode that 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 2020, 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 and regulatory 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 16,577 traps were set in 100 counties in NC from April to June 2020 and removed from July to September 2020 (Figure 1). 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. 1,037 adult gypsy moth males were captured in 371 positive traps in NC in 2020 (Table 1). An additional male European gypsy moth was found in a separate survey conducted by the Cooperative Agricultural Pest Survey program. The positive trap was located at the Military Ocean Terminal Sunny Point in Brunswick County. For more information on this survey please refer to the CAPS Program section of this annual report. Positive catches were entered into the gypsy moth trapping database at Virginia Tech.

Male moth captures in 2020 were slightly higher than last year. Higher captures were along the Virginia-North Carolina border as well as an area in the Western portion of the state. Four Mating Disruption (MD) treatments totaling 7,645 acres, one Larvacide (*Btk*) treatment of 450 acres, and multiple delimiting grids are proposed for 2021 to follow up in high-capture locations.

Per 2020 USDA-APHIS-PPQ protocol as stipulated in the cooperative agreement (AP20PPQFO000C100), 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 9 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, 6 contractors set traps in 28 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.

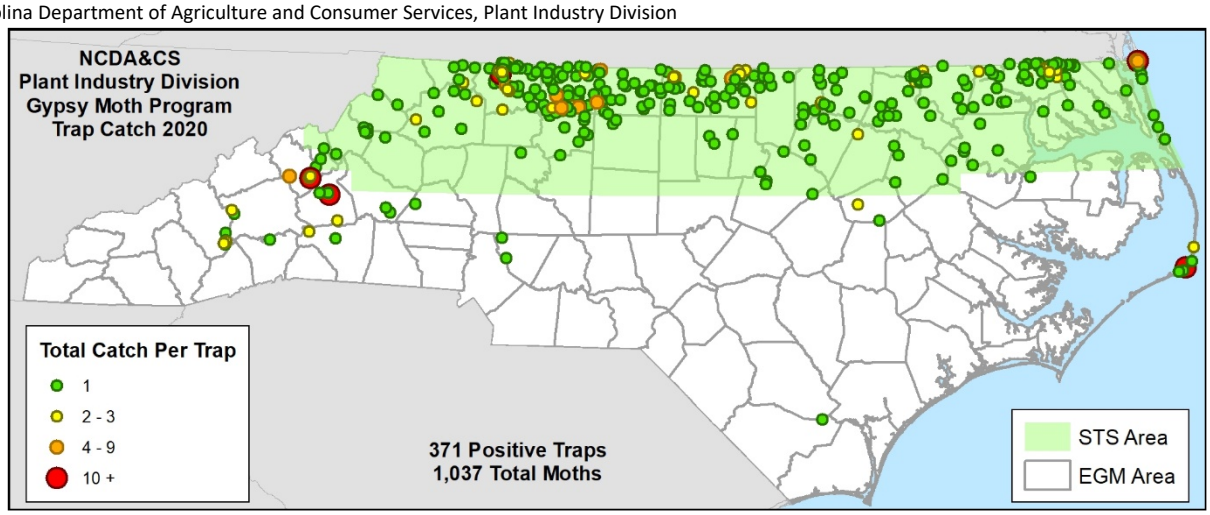


Figure 1. North Carolina gypsy moth trap catches in 2020.

Table 1. 2020 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	Traps	Positive Traps	Moths
Alamance	176	0	0
Alexander	78	0	0
Alleghany	157	5	6
Anson	147	0	0
Ashe	280	2	2
Avery	72	1	1
Beaufort	203	0	0
Bertie	299	3	3
Bladen	246	1	1
Brunswick	1	0	0
Buncombe	161	2	3
Burke	142	2	2
Cabarrus	106	2	2
Caldwell	148	4	4
Camden	137	9	9
Carteret	123	0	0
Caswell	289	19	28

Catawba	120	1	1
Chatham	199	0	0
Cherokee	97	0	0
Chowan	81	1	1
Clay	40	0	0
Cleveland	133	0	0
Columbus	199	0	0
Craven	178	0	0
Cumberland	171	0	0
Currituck	195	12	489
Dare	238	12	47
Davidson	164	0	0
Davie	85	1	1
Duplin	225	0	0
Durham	119	0	0
Edgecombe	147	3	3
Forsyth	206	9	9
Franklin	213	4	4
Gaston	111	0	0
Gates	232	21	32
Graham	33	0	0
Granville	328	6	6
Greene	76	0	0
Guilford	267	3	3
Halifax	446	8	8
Harnett	162	0	0
Haywood	107	7	12
Henderson	99	1	1
Hertford	224	8	8

Hoke	66	0	0
Hyde	137	0	0
Iredell	175	0	0
Jackson	106	0	0
Johnston	223	0	0
Jones	118	0	0
Lee	67	0	0
Lenoir	109	0	0
Lincoln	87	0	0
Macon	92	0	0
Madison	111	0	0
Martin	124	3	3
McDowell	104	7	37
Mecklenburg	171	0	0
Mitchell	60	2	2
Montgomery	126	0	0
Moore	199	0	0
Nash	170	2	3
New Hanover	56	0	0
Northampton	357	19	23
Onslow	169	0	0
Orange	178	3	3
Pamlico	92	0	0
Pasquotank	148	4	4
Pender	170	0	0
Perquimans	146	1	1
Person	247	17	24
Pitt	182	0	0
Polk	61	0	0

Randolph	222	0	0
Richmond	123	0	0
Robeson	260	0	0
Rockingham	387	27	38
Rowan	151	0	0
Rutherford	151	2	3
Sampson	267	0	0
Scotland	90	0	0
Stanly	114	0	0
Stokes	319	43	63
Surry	387	41	66
Swain	38	0	0
Transylvania	65	0	0
Tyrrell	74	0	0
Union	183	0	0
Vance	189	9	12
Wake	248	5	5
Warren	303	9	9
Washington	92	1	1
Watauga	175	4	4
Wayne	163	0	0
Wilkes	432	7	9
Wilson	115	2	3
Yadkin	189	0	0
Yancey	129	16	38
Total	**16577**	**371**	**1037**

Treatment

In June 2020, six treatments were performed within the STS area of North Carolina (Figure 2). The seventh and largest treatment was applied outside of the STS area. A total of 18,158 acres were treated with 6g dosage of SPLAT GM-O (Table 2). Evaluation of the efficacy of these treatments will take place in 2021 and 2022.

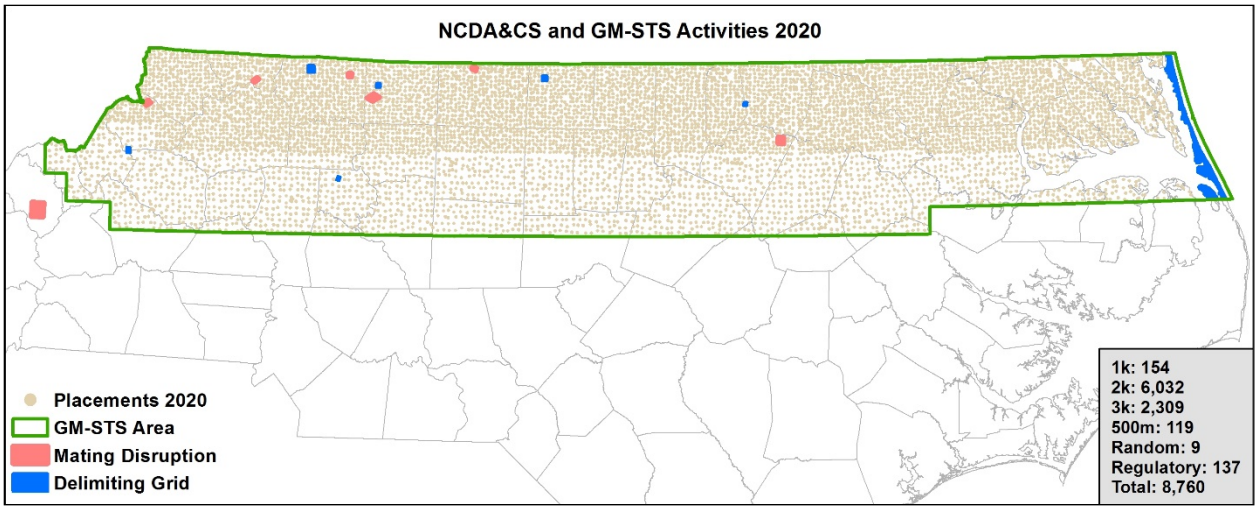


Figure 2. 2020 gypsy moth treatment site and delimiting grids.

Table 2. 2020 gypsy moth treatment, county, and acreage. For product, MD 6g = mating disruption at 6 grams per acre.

Block Name	County	Product	Dosage	Acres
Centerville	Franklin	SPLAT GM-O	6g	1,905
Glade Valley	Alleghany	SPLAT GM-O	6g	795
Mount Airy South	Surry	SPLAT GM-O	6g	700
Mount Mitchell	Yancey	SPLAT GM-O	6g	10,549
Northwest Eden	Rockingham	SPLAT GM-O	6g	655
Pilot Mountain	Stokes	SPLAT GM-O	6g	2,489
Zionville	Watauga	SPLAT GM-O	6g	1,065
			TOTAL	**18,158**

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.

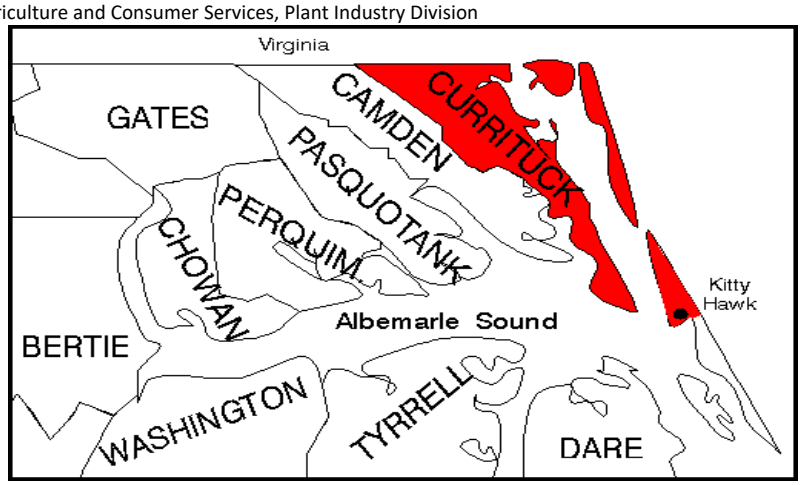


Figure 3. *Gypsy moth quarantine in North Carolina, shown in red.*

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, 77 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. This work is funded in cooperation with USDA-APHIS-PPQ under Cooperative Agreement AP20PPQFO000C211.

Survey

Drive-by surveys were conducted in eleven counties (Alexander, Caldwell, Caswell, Davie, Granville, Iredell, Madison, Person, Rockingham, 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 was one case where the surveyor returned to an established site (Madison County) 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 2020 IFA survey we recommend expanding our North Carolina IFA quarantine to include all or parts of Granville, Person, and Caswell Counties in 2022. Virginia has expanded their IFA quarantine along the North Carolina border extending beyond our current NC IFA quarantine boundaries. In 2021, we will continue to survey the NC-VA border along the newly expanded VA IFA quarantine line.

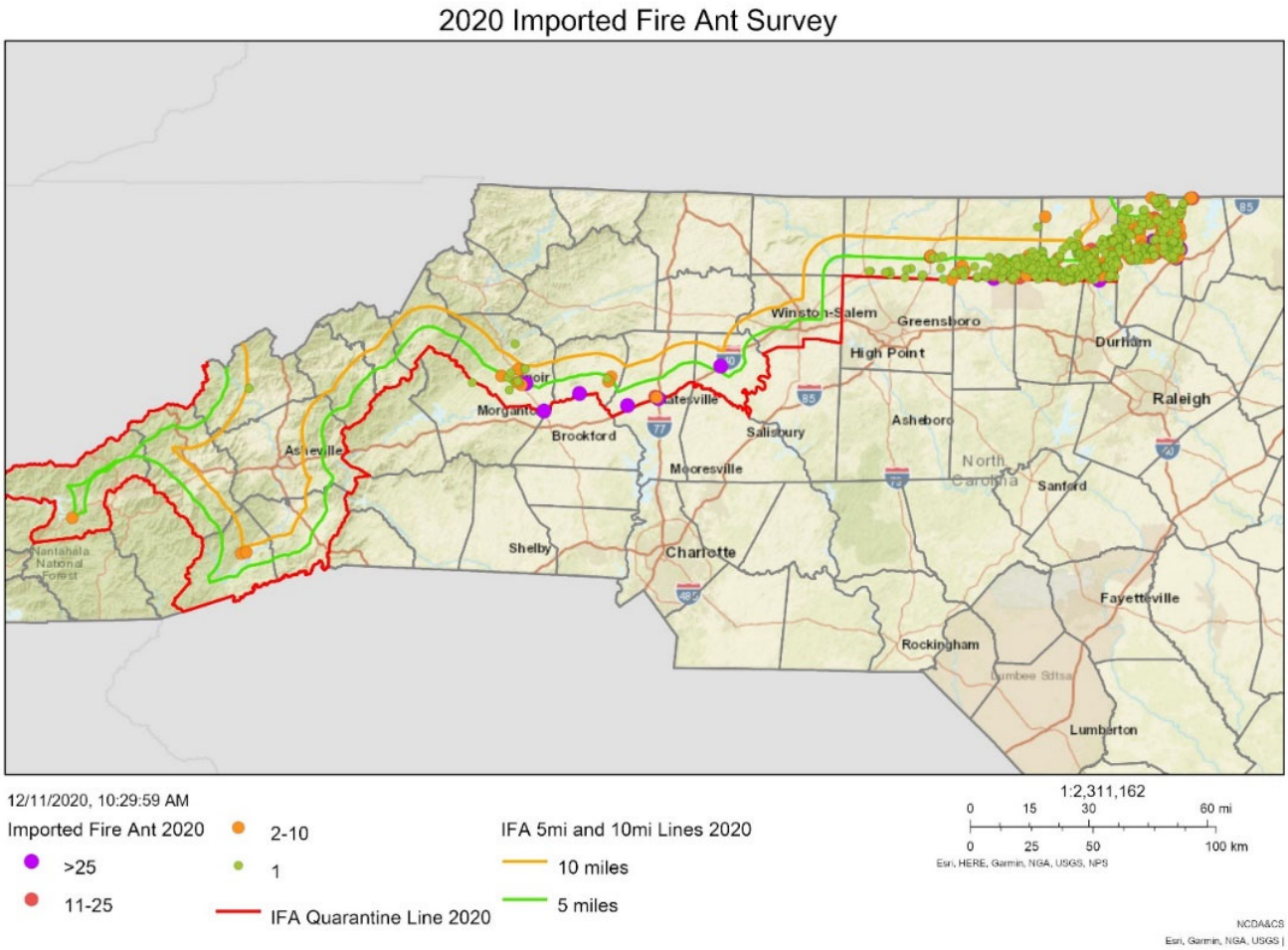


Figure 1. NC Imported Fire Ant survey results (March-October 2020). 1,607 data points were collected, 1,000 of which were reported as '0 mounds observed'; these data points are not displayed on this map

TABLE 1. NC IMPORTED FIRE ANT SURVEY SUMMARY (2020)

County	Areas Surveyed	Regulatory Action Recommended[1]	Absent	Established Sites	New Observation[2]	Total Sites
Alexander	5-mile strip from the 2020 quarantine line	No action		1	3	**4**
Caldwell	10-mile strip from the 2020 quarantine line	No action		1	14	**15**
Caswell	10-mile strip from the quarantine line	Add 2022	211		93	**304**
Davie	10-mile strip from the 2020 quarantine line	No action		1		**1**

Granville	Remaining non-quarantined portion of county	Expansion 2022	219		260	**479**
Iredell	5-mile strip from the 2020 quarantine line	No action		4		**4**
Madison	5-mile strip from the 2020 quarantine line	No action	1	1[3]	2	**3**
Person	10-mile strip from the 2020 quarantine line	Add 2022	318		199	**517**
Rockingham	5-mile strip from the 2020 quarantine line	No action	18		26	**277**
Swain	5-mile strip from the 2020 quarantine line	No action		1		**1**
Transylvania	5-mile strip from the 2020 quarantine line	No action		1	1	**2**
Total						**1,607**

[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 recorded on the 'Absent' column of this table.

[3]The mounds at the Madison County established site have been treated and upon survey this year could not be found.

Regulatory

As part of the IFA program's regulatory activities, 16 blitzes were scheduled to be 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. Due to lockdowns going into effect in March as a result of the COVID-19 pandemic, we made the decision to cancel the blitzes scheduled from March 17-April 1. A total of four blitzes were conducted during Spring 2020 on March 10th & 11th at the I-95 Northbound weigh station in Halifax County (Table 2). We stopped a total of 18 trucks to inspect their load and review/record their paperwork and we collected 10 soil samples during the Halifax blitzes. The soil samples collected were sent to the NCDA&CS Food & Drug Division for analysis and 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.

During the blitzes on March 11th we stopped a truck hauling baled hay, some of which had clearly been sitting on the ground which is in violation of IFA regulations pertaining to the movement of baled hay and pine straw (Figure 2). The driver had no paperwork and couldn't tell us where he was headed other than somewhere in Delaware. We placed bait around the bales of hay and after a short amount of time, live fire ants, including a queen, emerged from the bales.

We turned the truck around and sent him back to his start destination and had one of our Specialists meet the driver at the field where he picked up the bales. After an investigation we discovered a large multi-state operation that involved North Carolina and Virginia producers selling hay to a Pennsylvania business. As a result of our blitz, we were able to educate all involved parties and set the business up under compliance for imported fire ant and movement of baled hay.

Figure 2. Baled hay on truck stopped during Imported Fire Ant Blitz, March 2020. A number of the bales had 2-4" of soil caked in and live fire ants emerged from the bales upon being baited.

Table 2. IFA Blitz Spring 2020 Results

Date	Location	Trucks Stopped	Soil Samples Collected
03/10/20	Halifax Co. (I-95 Northbound)	5	5
03/11/20		13	5
03/17/20		CANCELLED[2]	
03/18/20		CANCELLED[2]	
03/24/20	Surry Co. (I-77 Northbound)	CANCELLED[2]	
03/25/20		CANCELLED[2]	
03/31/20	Henderson Co. (I-26 Westbound)[3]	CANCELLED[2]	
04/01/20		CANCELLED[2]	
TOTALS:	**4 Blitzes[1]**	**18**	**10**

[1]Corresponds to 2 days and two blitzes per day.

[2]Due to COVID-19 and lockdowns going into place in March, we made the decision to cancel the remaining Spring blitzes for safety.

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 54 blueberry farms located in four southeastern NC counties (Bladen, Duplin, Pender, and Sampson) participating in the Blueberry Certification Program. In May 2020, 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).

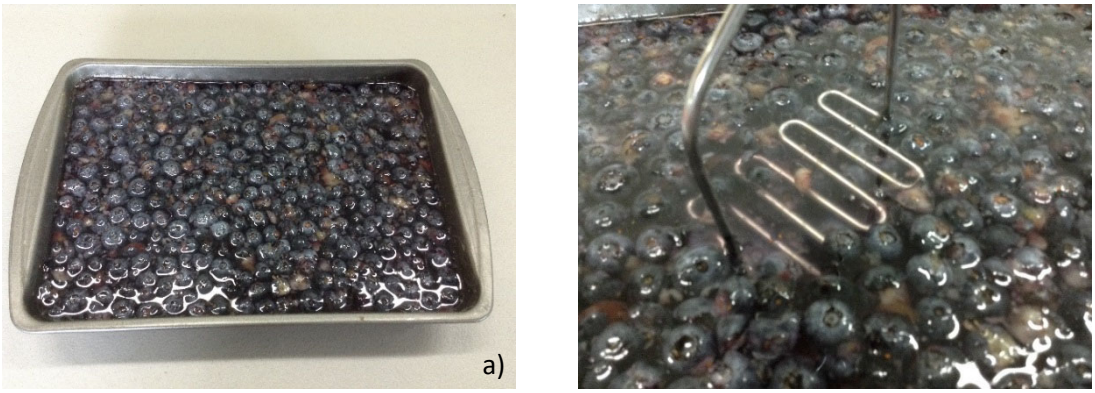


Figure 2. Salt flotation test: a) blueberries soaking in salt water solution for 10 minutes; b) close-up of flotation test showing potato masher used to gently crush berries. (Photos by Whitney Swink, NCDA&CS)

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 2020 and plan to continue its use in 2021.

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 2020, a total of 336,943 acres were reported in 46 counties (Table 1). Plant Industry Division personnel surveyed cotton gins, cotton processing facilities, and ornamental cotton (n=44) in 30 counties using conventional cotton boll weevil traps, like 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 (2020)

Anson	754.7100	Granville	0.0000	Pamlico	0.0000
Beaufort	9935.01	Greene	5,003.6506	Pasquotank	739.5064
Bertie	28703.975	Halifax	39,647.4800	Pender	0.0000
Bladen	10791.4200	Harnett	8,060.4450	Perquimans	3,013.6596
Brunswick	0.0000	Hertford	11,526.7500	Pitt	12,804.1731
Cabarrus	472.0400	Hoke	3,638.8180	Randolph	707.5900
Camden	206.6300	Hyde	10,239.8740	Richmond	0.0000
Carteret	0.0000	Iredell	1,136.7100	Robeson	6,098.4979
Chowan	7090.2150	Johnston	5,306.4311	Rowan	396.9100
Cleveland	0.0000	Jones	2,723.6300	Rutherford	0.0000
Columbus	630.8000	Lee	39.6400	Sampson	13,829.1570
Craven	2316.7100	Lenoir	8,107.8312	Scotland	6,218.0980
Cumberland	5156.4660	Lincoln	90.3700	Stanly	4,167.8149
Currituck	0.0000	Martin	32,886.1018	Tyrrell	3,861.2400
Davidson	0.0000	Mecklenburg	0.00000	Union	264.7900
Duplin	2979.8800	Montgomery	44.43000	Wake	0.0000
Durham	0.5000	Moore	0.0000	Warren	546.8800
Edgecombe	25915.5166	Nash	6,425.8800	Washington	3,859.2616
Franklin	0.0000	Northampton	32,131.7164	Wayne	3,859.2616
Gates	10201.7815	Onslow	857.8400	Wilson	3,520.2300
				Total	**336,943.43**

TABLE 2. NUMBER OF COTTON GINS/SITES SURVEYED BY COUNTY (2020)

Anson	1	Edgecombe	1	Lincoln	1	Randolph	1
Beaufort	1	Gates	1	Martin	1	Robeson	2
Bertie	2	Greene	1	Mecklenburg	2	Sampson	2
Bladen	1	Halifax	5	Montgomery	1	Stanly	1
Chowan	1	Hertford	1	Nash	2	Wake	2
Cumberland	1	Hyde	1	Northampton	4	Wilson	1
Currituck	1	Jones	1	Perquimans	1		
Duplin	1	Lenoir	1	Pitt	2		

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, New York, Ohio, Pennsylvania, Virginia, and West Virginia. In 2020, North Carolina received PPA7721 funding (AP20PPQFO000C195) to continue our statewide survey for spotted lanternfly via finding and mapping host material (in this case *Ailanthus altissima*; tree-of-heaven) throughout the state.

Since the beginning of this survey in 2019 over 21,000 tree of heaven (*Ailanthus altissima*; TOH) have been identified throughout North Carolina. Of those, roughly 7,074 tree of heaven (*Ailanthus altissima*; TOH) have been identified throughout North Carolina since June 1, 2020 (start of PPA7721 2020 funding) while conducting this survey (Figure 1). Rather than having our surveyors conduct a general road survey for TOH as in previous years, this year we included specific survey targets we've deemed higher risk for an introduction of spotted lanternfly into North Carolina. These high-risk targets include state parks, SLF-permitted businesses, forwarding addresses of people who moved to NC from an SLF quarantined area, and private campgrounds (Table 1). Each target was included as a separate layer on our ESRI Collector SLF/TOH survey map and could be toggled on/off depending on the surveyor's goal that day. An additional ~300 TOH were identified within and around nurseries while field specialists conducted their annual inspections. Surveillance for this major host will continue over winter as we've trained our field staff to identify TOH without leaves.

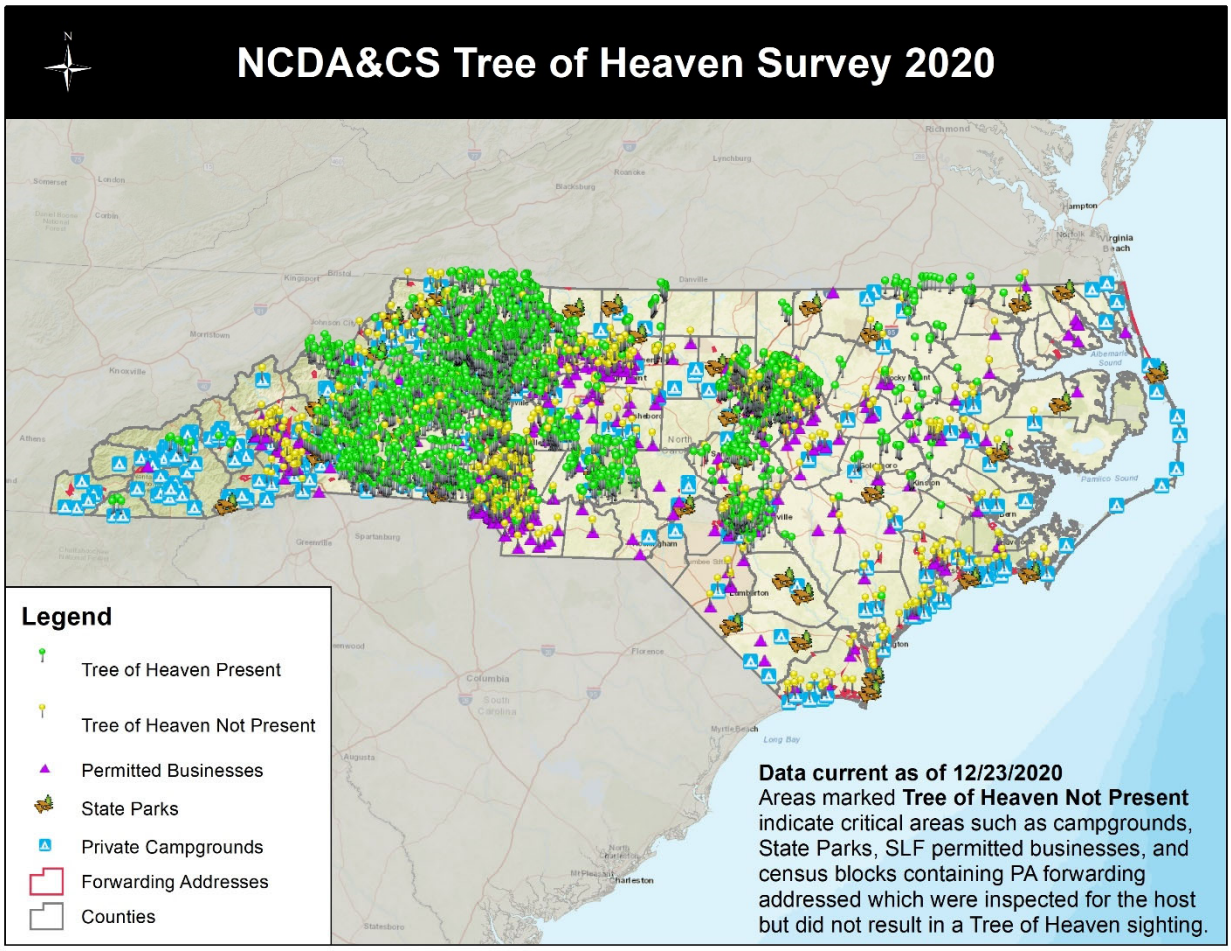


Figure 1. North Carolina Tree of Heaven Survey 2020

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.

Table 1. Number of high-risk locations surveyed to date out of total we plan to survey in North Carolina during the FY20-21 TOH/SLF survey. (These numbers are current as of 23 December 2020)

High-Risk Location Type	# Surveyed to Date	Total to Survey
SLF-Permitted Businesses	419	479
Forwarding Addresses	316	572
Private Campgrounds	152	314
State Parks	17	41

Nine temporary employees and one permanent employee 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. We have spoken with cooperative extension agents, farmers, students, citizens and others to raise awareness of this pest and hopefully increase the number of people who are looking for spotted lanternfly.

On 2 October 2020 an individual reported finding a spotted lanternfly on an airplane in Charlotte. We followed up with the individual to confirm the identification but did not receive a photo until 25 November 2020. We confirmed a single dead adult traveled via the cargo hold of an American Airlines flight from Baltimore-Washington International to Charlotte Douglas International Airport. A second dead adult was reported to us on 2 November 2020 found in Buncombe County (western NC). The insect was collected inside a prefabricated home at an Oakwood Homes model home site. We surveyed the surrounding area for spotted lanternfly and host material but did not find evidence of an infestation. Unfortunately, we have been unable to determine the method of entry for that specimen. Our third, and final, positive SLF detection of the year occurred on 13 December 2020. A homeowner in Onslow County (eastern NC) found two dead adults in his Christmas tree. Upon investigation we were able to determine the trees were purchased from a farm within the Pennsylvania SLF quarantine area. We have done outreach in the community, worked with cooperative extension to have the news to social media, and conducted media interviews to raise awareness that pests can be moved on Christmas trees and to encourage people to check their trees for hidden pests. We will heavily survey Onslow County and the surrounding areas for spotted lanternfly in 2021 on the off-chance eggs made it into our state.

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.

INVASIVE PEST OUTREACH PROGRAM

The Invasive Pest Outreach Program (funded by USDA PPA7721 Agreement AP20PPQFO000C197) supports public outreach centered on invasive pests. An ongoing central goal of this program is to help prevent the spread of invasive 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

As a result of the COVID-19 pandemic many of the outreach events we regularly attend were canceled or modified this year (e.g. BugFest, NC State Fair). However, we were able to quickly adapt to the virtual work world and have been able to conduct outreach through virtual presentations.

Whitney Swink, State Entomologist, modified the original 30-minute presentation on spotted lanternfly to include the most up-to-date information about the pest. The presentation covers the life cycle, behavior, signs & symptoms, and regulatory concerns of the pest. She gave the talk at the following events:

- 15 January 2020 – Carolina Green Industry Network Annual Meeting, Monroe NC (~300 people in attendance)
- 28 January 2020 – NC Nursery & Landscape Association Green & Growin' Show, Greensboro NC (~100 people in attendance)
- 5 March 2020 – Southern Appalachian Forest Entomology & Pathology Seminar, Crossnore NC (~50 people in attendance)
- 27 April 2020 – NCSU Cooperative Extension Webinar (~50 people on webinar)
- 23 June 2020 – North Carolina Urban Forest Council Webinar (~45 people on webinar)
- 2 November 2020 – Guest lecturer for Forest Health class at North Carolina State University, Virtual Presentation (32 students in attendance)
- 2 December 2020 – North Carolina Crop Protection School, Virtual Presentation (100+ people in attendance)

Ms. Swink also developed a presentation covering insects of regulatory concern in North Carolina for NCSU Cooperative Extension area horticulture agents. The presentation covers the boll weevil, emerald ash borer, European gypsy moth, red imported fire ant, spotted lanternfly, and walnut twig beetle (thousand cankers disease). The presentation has been uploaded to NCSU's cooperative extension YouTube channel (https://youtu.be/YFCWNc0prMk).

In addition to the above, Ms. Swink developed a 30-minute presentation on the impacts invasive species have on agriculture. This talk was presented virtually to on 28 October 2020 to 12 high school juniors completing an introductory college course through University of Mount Olive North East Regional School of Biotechnology & Agriscience.

We are scheduled to present at five events during the first quarter of 2021 and plan to increase that number before this agreement ends.

Educational Materials

Last year we modified our 14' spotted lanternfly banners that were displayed at the North Carolina State Fair (Figure 1) to fit 8' pop-up banner stands. In 2020, we printed 50 of these banners and distributed almost all of the 50 banners to county extension offices in regions of the state that we consider higher-risk for spotted lanternfly introduction.

As a result of national news regarding two invasive insects, Asian longhorned beetle (*Anoplophora glabripennis*) and Asian giant hornet (*Vespa mandarinia*), we developed new pest alerts that cover the biology, signs & symptoms, and how to report sightings to the proper authorities. These pest alerts have been posted to our website and were distributed to cooperative extension offices across the state.

Figure 1. Spotted lanternfly banner for NC State Fair (2019)

We designed a magnifying lens with a "Have you seen spotted lanternfly?" message (Figure 2) that will be used with a children's spotted lanternfly search and find activity sheet with "fun facts" about SLF on the backside that we developed (Figures 3-4). We shipped 100 activity sheets apiece to all 101 4-H agents throughout North Carolina. We are in the process of creating invasive species activity kits for children and this sheet will be included in that kit. The kits will also include an SLF origami activity developed at Purdue University, spotted lanternfly and Asian longhorned beetle pest alerts, invasive pest stickers, and SLF temporary tattoos.

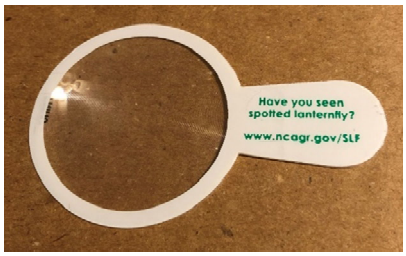


Figure 2. "Have you seen spotted lanternfly?" magnifying lens

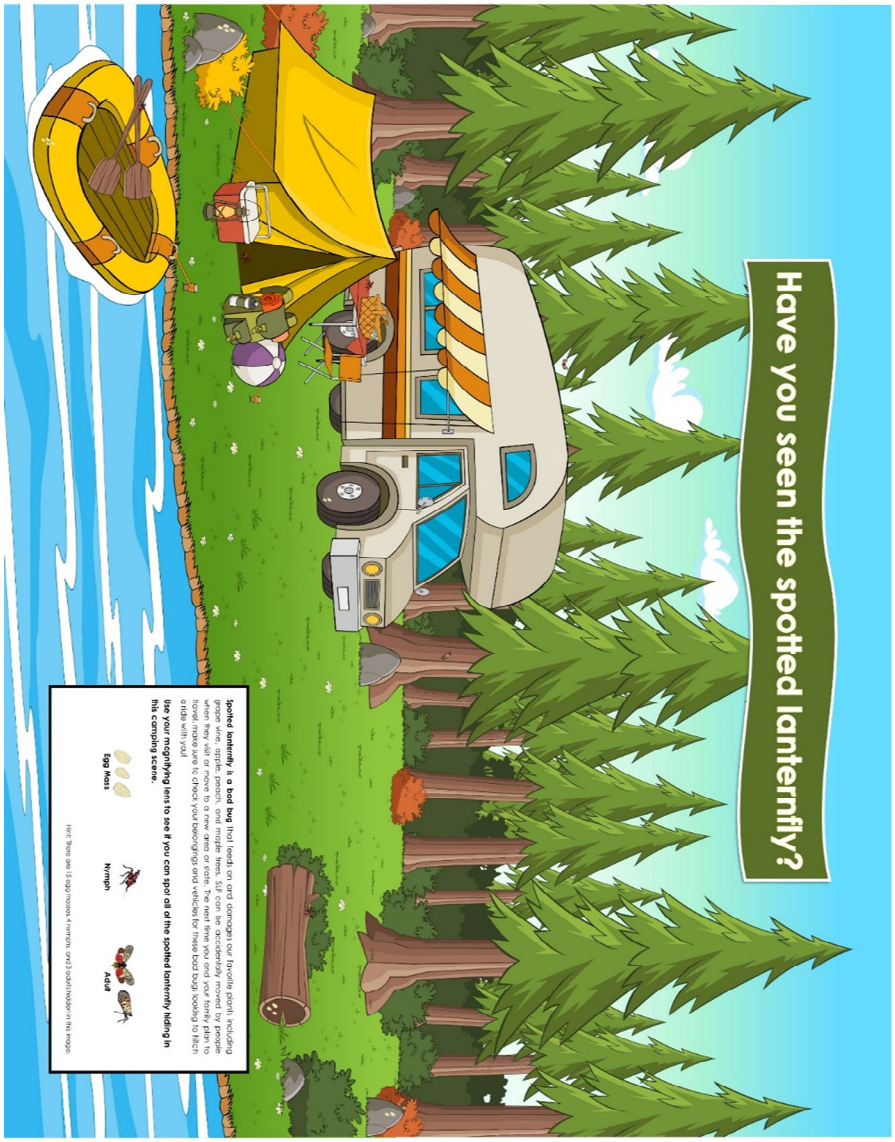


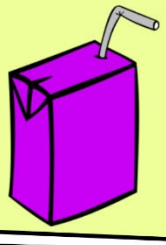
Figure 3. Spotted Lanternfly Search & Find Activity Sheet (front)

Spotted Lanternfly—a Bad Bug with Some Cool Facts

Spotted lanternfly is a bad bug that is invading the United States. **YOU** can help us find them in North Carolina. Whether you are in your yard or at the park, keep these facts in mind when hunting for this bad bug. If you find one, get your parent's help to **See it! Snap it! Report it!** to **badbug@ncagr.gov**.

They bring their own straw!

SLF have mouthparts that work like a straw. They stick their mouth into plants to suck out the sap, the way you do with a juice box. They have been seen on over 70 kinds of plants. **Have you tried 70 different juices?**

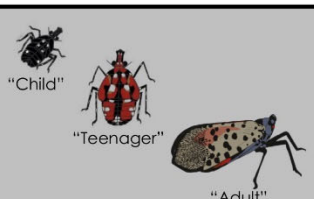


Their eggs look like silly putty

SLF protect their eggs with a gray coating that looks like silly putty or old gum. When you peel it back, you can see rows of eggs! Their eggs are camouflaged which makes them hard to find and remove.

They change colors as they get older

SLF are black with white spots when they hatch, add some red when they become teenagers, and then turn pink with black spots when they become adults.



They poop honeydew!

No, not the fruit called honeydew, but a sugary water also called honeydew. When SLF drink plant sap, they drop excess sugary water onto everything below. Mold can grow in these sticky droplets too, leaving a mess and sometimes damaging the plant.

They are bad at flying—so they hitchhike instead!

SLF can't fly more than a few yards at a time on their own. They can lay their eggs on any flat surface, like cars, trains or firewood, and get moved around by humans accidentally.

They have their own kind of PB&J

SLF's two favorite foods are grapes and tree-of-heaven, an invasive tree that smells like burnt peanut butter.

North Carolina Department of Agriculture & Consumer Services ▪ Steve Troxler, Commissioner of Agriculture ▪ https://www.ncagr.gov/SLF

Figure 4. Spotted Lanternfly Search & Find Activity Sheet (back)

Advertising

Six print advertisements were run in North Carolina publications in 2020. One ad was run in Carolina Country magazine, a monthly publication, three ads each were run in the *Triangle Gardener*, a bi-monthly publication, and two ads was run in *WNC* magazine, a quarterly publication. All five ads run in *Triangle Gardener* and *WNC* magazine were full-page ads and utilized our "Have you seen spotted lanternfly?" poster (Figure 4, left). We made two modifications to the full-page ad (from the 2019 version) to provide greater clarity. The first change was to remove the images of the spotted lanternfly with its wings spread as we determined that was causing people to look for butterfly-like insects, which is misleading. The second change was to include the word "alive" in the "Spotted lanternfly has not yet been found in North Carolina but we need you to be on the lookout" statement as there have been a few detections of dead SLF in our state over the past year. The ad run in *Carolina Country* magazine was a one-third page ad and utilized a modified version of our "See it. Snap it. Report it." message. Since running this ad, we have modified it based on feedback we received from people who saw the original ad we ran last year (e.g. some people who saw our ad thought they were meant to be looking for an endangered species). We added the bolded-red "Bad Bug Alert!" statement to the top and included images of the adult spotted lanternfly with its wings at rest (Figure 4, right). We plan to run these ads again in the Spring 2021 issues of *Carolina Country, Triangle Gardener, WNC* magazines. Other publications will also be considered.

Figure 4. *Triangle Gardener* and *WNC* ad (left) and modified *Carolina Country* ad (right)

MOVEMENT OF LIVE INSECTS FOR RESEARCH, COMMERCIAL OR EDUCATION PURPOSES

The Entomological Programs Manager evaluated 99 federal applications for PPQ 526 e-Permits in 2020. 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 2020**
Emerald Ash Borer (*Agrilus planipennis*)[1]	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*)	Expanded to include all of Alamance, Burke, Guilford, Jackson, and McDowell counties. A total of **77 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*)[2]	**Haywood County.** Quarantine area remained unchanged relative to 2017.

[1]Please note the Federal EAB quarantine was removed January 14, 2021 and NCDA&CS will be lifting the state quarantine in 2021 in response.

[2]In 2021, NCDA&CS will be lifting the walnut twig beetle quarantine as there has been 7-years of negative survey data for North Carolina and the risk for introduction has been analyzed as low-to-no risk for our state.

Nursery Certification Program

NCDA&CS' Plant Protection Specialists inspected 2,992 nursery dealers and nurseries during the 2020 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 1,113 nurseries and 1,879 nursery dealers during the 2020 calendar year (Table 1). Of the 1,113 nurseries, 498 were registered nurseries and 615 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 minimal change in the number of nurseries that were certified. Nursery dealer licensure increased by 182 locations. An increase in e-commerce sales and heightened demand for plants due to COVID-19 consumer spending trends benefitted NC nurseries and nursery dealers and strengthened North Carolina's already robust green 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
2020	498	615	1,879		1,113	2,992

[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 2020, 17 stop sale/movement notices wre issued for box blight (*Calonectria pseudonaviculata*) on live boxwood plants found at retail locations. In addition, 174 individual stop sales were issued for *Ribes* sp. material direct shipped to homeowners from a mail order company, and 2 more were issued in conjunction with a *Phytophthora ramorum* find at a NC Nursery.

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 2020, NCDA&CS staff issued 10,546 federal phytosanitary certificates and 1,903 state phytosanitary certificates. The number of federal phytosanitary certificates issued in 2020 represented a 14.22% increase from 2019 figures while the number of state phytosanitary certificates issued represented a 40% decrease from the previous year. The significant decrease in state phytosanitary certificates was primarily due to the development of a compliance agreement inspection system for interstate movement of sweet potato cuttings to meet the NC Guava Root Knot Nematode (*Meloidogyne enterolobii*) internal quarantine. All sweet potato seeds transiting out of state still require a state phytosanitary certificate. On December 14, 2019 the European Union enacted phytosanitary regulations requiring all US agricultural commodities to ship with a federal phytosanitary certificate. North Carolina is number 1 in the nation in sweet potato production and sweet potato exports. More than half of the 10,546 federal phytosanitary certificates issued in 2020 were for sweet potato exports. In addition, federal phytosanitary certificates were issued were for lumber, logs, tobacco, cotton, cotton seed, Christmas trees, peanuts, nursery and greenhouse plants.

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
2020 (Calendar Year)	10,529	16	1	10,546		1,903

[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 for four-year terms. Board members in 2020 included: Dr. Damon Waitt (chair), Julie Moore, David Hyatt, Jonathan Lanier, Esq., Dr. Bruce Williams, Jim Slye, and Dr. Gary Walker.

In 2020, the Plant Conservation Board received a final set of proposed amendments to the NC Protected Plant List prepared by the Scientific Committee. These updates included status changes as well as name changes due to updates in taxonomy. The proposed rule amendment was published in the North Carolina register with a public comment period from October 1st through November 30th. The Plant Conservation Program received 22 comments, all of which were in support of the proposed changes. The Board intends to finalize the review of the comments and complete the review process in early 2021.

NORTH CAROLINA PLANT CONSERVATION SCIENTIFIC COMMITTEE

PCP also meets regularly with members of the NC Plant Conservation Scientific Committee. This seven-member committee primarily consists of positions designated to the committee by law. Members include Dr. Alan Weakley (chair), Dennis Niemeyer, Dr. Richard Braham, Dr. Johnny Randall, Hervey McIver, Brenda Wichmann, and Jerry Reynolds. In September 2020, Dennis Niemeyer's term ended and he chose not to renew for another four-year term. Dr. Shannon Currey was appointed to this seat to represent the NC Landscape and Nursery Association.

In 2020, the Committee worked with PCP staff and the Plant Conservation Board through the rule amendment process for updating the NC Protected Plant List. The Committee also provided input on management plan documents prepared by PCP staff and provided technical expertise, as needed.

PLANT CONSERVATION PRESERVE SYSTEM

The Plant Conservation Program and the Plant Conservation 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 the conservation of plant species. Due to concerns about resource damage and plant poaching, access is limited to guided tours or to visits authorized by written permission issued by PCP. To help engage the public about rare plants and their conservation, PCP conducts guided preserve tours and gives presentations and lectures for the public through 10 months of the year in collaboration with the Friends of Plant Conservation. The Preserve system consists of 26 Preserves distributed across North Carolina (Figure 1). An interactive version of the same map may be viewed at the Plant Conservation Program's website: https://www.ncagr.gov/plantindustry/plant/plantconserve/preserves.htm.

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 and expands PCP's capacity for education and outreach as well as stewardship of the Plant Conservation Preserves. Due to the coronavirus pandemic through much of 2020, the scheduled preserve tours and events were largely postponed. In partnership with NC Botanical Garden and Friends of Plant Conservation, PCP hosted two tours at Plant Conservation Preserves in 2020: one at Eastwood Preserve in Moore County and one at Hebron Road Prairie Remnant and Eno River Diabase Sill Preserves in Durham County. Friends of Plant Conservation partnered with PCP for seven workday events across the state: three for rare species monitoring and four for habitat management.

In 2019, the NC Botanical Garden Foundation and FOPC initiated a campaign to create a new NC specialty vehicle license plate to support rare plant conservation. The plate design highlights Venus flytrap (the state's official carnivorous plant species) and uses the slogan, "Home of the Venus Flytrap" (Figure 2). These two organizations, with support and public outreach help from PCP staff, were successful in receiving the minimum 500 applications by early 2020 to meet the annual legislative deadline for new plate submissions. However, the legislature's schedule was significantly altered in 2020 in order to address the coronavirus pandemic. The review of new specialty license plates was tabled for the year and will be included in a future session. 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. Examples include the Bog Learning Network, the Southern Blue Ridge Fire Learning Network, Southeastern Plant Conservation Alliance, and the Greater Uwharrie Conservation Partnership.

In addition, PCP outreach to the public includes special presentations and by filling information requests. In 2020, staff gave virtual presentations for events and groups such as the Goldenseal Summit, the New Hope Audubon Society, and for the Friends of Plant Conservation.

Typically, PCP participates in annual meetings such as the Bog Learning Network, the Rare Plant Discussion Meeting, and others. However due to the coronavirus pandemic, many of these events were cancelled in 2020. PCP remains connected to these groups and staff are hopeful that these productive collaborations will resume in 2021.

CLEAN WATER MANAGEMENT TRUST FUND

PCP staff did not prepare grant applications to the Clean Water Management Trust Fund (CWMTF) in 2020. The name of this trust fund was changed to the North Carolina Land and Water Fund (NCLWF).

UNITED STATES FISH & WILDLIFE SERVICE (USFWS) PARTNERSHIP

In 2020, 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 resources to North Carolina each year. This funding covers the program's research specialist position and a portion of the remaining funds support PCP temporary employees for part of the year. More specifically, 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.

ADDITIONAL USFWS 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. PCP previously received funding for two additional reverted funds grants, one to reintroduce two wetland species which have been extirpated from North Carolina and the other to support imperiled plant conservation efforts on state-owned lands not owned or managed by PCP. Both of these projects are ongoing through 2021.

PCP was also awarded a Recovery Implementation Grant in 2019 to fund the development and production of nine management plans for Plant Conservation Preserves. This grant continues through 2024.

In December, PCP learned that their Recovery Challenge Grant proposal was selected for full funding. This new grant will last for five years (2021-2025) and will support research and restoration activities across eight preserves protecting Smooth Coneflower, Schweinitz's Sunflower, and Rough-leaved Loosestrife.

REGULATORY PROGRAMS

PCP is responsible for the protection and conservation of the NC Protected Plant List which currently includes 419 species, of which 28 are also federally listed. In collaboration with the Plant Conservation Scientific Committee, PCP staff finalized a review of the Protected Plant List and proposed a series of updates. Updates included additions, deletions, and other status changes within the list as well as updates regarding name changes and other taxonomic review that have been completed since the last publication of this list in 2010. As this update constituted a rule change, a 60-day public comment period was observed Oct 1-Nov 30. The Plant Conservation Board is scheduled to review all public comments and make a final determination regarding the proposed rule change in January 2021.

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-two protected plant permits were issued and several additional requests were evaluated during 2020. 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 2020 by PCP Staff directly; however, our partners at NC Natural Heritage Program continued a species status update survey initiated in 2019 which PCP staff helped advise. PCP provided population data, burn history, and guidance for site visits to Boiling Spring Lakes and Hog Branch Ponds Preserves. PCP will be attending future meetings to continue to help with this process, as needed. The NC Botanical Garden, a close partner of PCP, is continuing with a range-wide genetic analysis. The results generated from this work will inform future protection needs and priorities.

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 6,280 pounds of calculated dry wild collected and wild simulated ginseng during the 2019 - 2020 season representing 26 North Carolina counties. A total of 44 ginseng dealer license permits were issued during the 2019 - 2020 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 to enhance rare species populations and improve habitats for these species. With assistance and support from NC Forest Service and other partners, PCP staff conducted four prescribed burns totaling 170 acres across four preserves this past year. This was a large decrease from the program's average number of burns and acres burned. Many planned burns could not be completed due to burning restrictions in place during the outset of the coronavirus pandemic. Before that, the NC Forest Service had many employees deployed to western states to help control wildfires, which allowed them less opportunity to facilitate burns at PCP Preserves.

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 controling the highly invasive reed canary grass (*Phalaris arundinacea*). The long-term goal for this preserve is to restore the artificial canary grass 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.): With help from NC Forest Service staff, PCP staff burned approximately 100 acres at these two preserves in the early part of the year before the pandemic hit.

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*), heavenly bamboo (*Nandina domestica*), and Japanese stilt grass (*Microstegium vimineum*).

Cedar Mountain Bog (Transylvania County): PCP Staff held two very effective workdays to clear overgrown 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 (*Lespedeza cuneata*).

Eno River Diabase Sill (Durham Co.): Staff and volunteers worked to reduce and control invasive species populations such as Japanese stilt grass, sericea lespedeza, 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. However, due to the pandemic, nearly all controlled burn plans were put on hold.

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 (*Helonias bullata*). Additional imperiled 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, hairy jointgrass (*Arthraxon hispidus*), fig buttercup (*Ficaria verna*), and Japanese hawkweed (*Youngia japonica*). Staff conducted multiple workdays with volunteers to cut and remove weedy tree species from the glade portion of the property in preparation for transplanting rare plants rescued from an adjacent property slated for development. Additionally, control lines were refreshed for upcoming prescribed burns.

Pondberry Bay Preserve (Sampson Co.): Prescribed burning is always a focus for land management at this preserve. However, with limited capacity due to the pandemic, staff were only able to conduct one burn (67 acres) in 2020. Additionally, PCP contracted a timber harvest of two blocks, one that removed all loblolly pine and the second which thinned loblolly pine. Both blocks represent residual loblolly pine planation which staff are transitioning toward natural communities, including longleaf pine savanna, over time.

Redlair (Gaston Co.): PCP Staff and volunteer steward Haywood Rankin worked to control invasive species such as wisteria (*Wisteria sinensis*), Chinese privet, autumn olive (*Elaeagnus umbellata*), kudzu, 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 successful controlled burn was conducted in the small prairie portion of this property 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 continued to install instrumentation for long-term data collection of weather and surface and groundwater movements. 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 2020, 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:

- Eastern Prairie Blue Wild Indigo (*Baptisia aberrans*) – Durham County (2 sites)
- Gray's lily (*Lilium grayi*) - Watauga Co. (1 site)
- Montane purple pitcher plant (*Sarracenia purpurea* var. *montana*) - Transylvania Co. and Jackson Co. (3 sites)
- Pondspice (*Litsea aestivalis*) – Cumberland and Sampson Cos. (2 sites)
- Ringed Witchgrass (*Dichanthelium annulum*) – Durham County (1 site)
- 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 Preserve (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 continues to make regular monitoring trips to the preserve and facilitates neighboring landowner contacts on behalf of PCP staff. 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 Preserve (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.

The Pondberry Bay Preserve (Sampson Co.) gained a new volunteer steward, Trey Tyson, a neighbor at the preserve and agronomist by trade. Trey has been instrumental in facilitating neighbor contacts regarding roadside litter clean-ups. Trey has also been very helpful in identifying and addressing issues related to unauthorized access at the Preserve and worked with PCP staff to secure access points and post more clear signage.

Plant Pathology Program

Report for period January 1, 2020 through December 31, 2020

Boxwood Blight

Boxwood blight, caused by the fungus, *Calonectria pseudonaviculata*, is a major disease issue for nurseries that are growing boxwood. No boxwood species (*Buxsus spp.*) or varieties are completely immune to the pathogen. Typical symptoms of boxwood blight include leaf spots or blotches, rapid defoliation, and stem lesions. Leaf symptoms are most abundant during the growing season, whereas stem lesions are visible year-round (Castroagudín et al. 2020). In order to prevent the disease from spreading further into landscaping, boxwood plants found in certified nurseries and nursery dealers that were infected by the disease were destroyed, along with all host plants within a 10-feet radius.

In 2020, there were three confirmed cases of boxwood blight at certified nurseries and ten cases at nursey dealers. All confirmed positive plants and host materials within 10 feet were destroyed according to protocol.

Figure 1. Symptoms of boxwood blight. Leaf symptoms and dark brown to black stem lesions.

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 97 participants in the program. Currently, states with established external quarantines against the boxwood blight pathogen include Tennessee and Pennsylvania.

In response to the confirmed cases of boxwood blight that occurred in 2020, NCDA&CS will update the stipulations of the compliance agreement and renew list of the program participants in 2021.

Reference: Castroagudín V.L., Yang, X., Daughtrey, M.L., Luster, D.G., Pscheidt, J.W., Weiland, J.E., and Chouch J.A. 2020. Boxwood blight disease: a diagnostic guide. Plant health progress. 21:291-300.

***Ralstonia solanacearum* race 3 biovar 2**

Ralstonia solanacearum race 3 biovar 2 is a pathogen of concern because of its potential to cause serious harm to U.S. agriculture. It causes plant diseases such as brown rot of potato, bacterial wilt of tomato and eggplant, and southern wilt of geranium. It can be transmitted through contaminated water, contaminated soil and equipment, or by people's inadvertent actions.

Figure 2. Symptoms of *Ralstonia solanacearum* race 3 biovar 2 infection on geranium.

In April 2020, USDA APHIS confirmed the detection of *Ralstonia solanacearum* race 3 biovar 2 (RSr3b2) in a single variety of geranium plants located in a Michigan greenhouse. This particular type of *Ralstonia* can cause a wilt disease in several important agricultural crops such as potatoes, tomatoes, peppers and eggplant. This is the first confirmed case of RSr3b2 in a U.S. greenhouse since 2004. Immediate actions were taken to contain and eradicate the disease from the Michigan facility. AHPIS also confirmed that the infected plants came from a greenhouse in Guatemala. The importer immediately stopped shipments of geranium plants to the United States upon confirmation of the detection and has voluntarily agreed to destroy all shipments that were pending export or in route to the United States. They also provided a list of 288 greenhouses in 39 States that received geranium cuttings from the Guatemala facility.

Two nurseries in North Carolina have received geranium cuttings from the Guatemala facility. NCDA&CS Plant Industry Division took immediate actions to destroy the variety that has been reported positive for RSr3b2, following USDA protocol. A comprehensive inspection of potential host materials (all varieties of geranium, tomato, and pepper) was conducted by the Regional Plant Pest Specialists and Plant Pathologist. Plants with suspicious wilting symptoms were collected and tested for possible *Ralstonia* infection. No infected plants were detected at the time of the initial inspection. Weekly inspections at the nurseries were conducted by the Regional Plant Pest Specialists and Plant Pathologist throughout the season to make sure no plant with latent infection were missed during the initial inspection.

On June 11, 2020, APHIS and its State partners successfully completed actions to eliminate the pathogen from U.S. greenhouses.

For more information: USDA Pest Alert: alert-ralstonia.pdf (usda.gov)

Sudden Oak Death (SOD) caused by *Phytophthora ramorum*

Sudden oak death (SOD), caused by the fungal-like oomycete, *Phytophthora ramorum*, is a major threat for North Carolina nursery industry and natural forests. The pathogen has been identified on well over 100 diverse species of plants, hosts include hardwood and conifer trees, shrubs, herbaceous plants and ferns. An official list of host plants as of 2020 is maintained by the USDA APHIS as part of federal quarantine (usdaprlist.pdf). *P. ramorum* establishment in eastern US forests could be devastating, as there are several important tree species that are susceptible. Hosts that are commonly found in container nurseries includes rhododendron, camellia, viburnum, pieris, and kalmia. For more information: USDA APHIS | Phytophthora ramorum

Figures 3. Symptoms of *Phytophthora ramorum* infection on common nursery hosts.

Survey – see CAPS section

New positive detection and eradication

On June 25th, during routine nursery inspection by Regional Plant Pest Specialist, rhododendron plants from Oregon with suspicious symptoms of *Phytophthora ramorum* infection were found at a certified nursery in Ashe County. The sample was tested positive for *Phytophthora* species by NCDA lab, then forwarded to USDA National Plant Diagnostic Network (NPDN) Lab at University of Florida for species identification and confirmed positive for *P. ramorum* by USDA PPQ.

Upon receiving the confirmation result, NCDA&CS took immediate regulatory actions according to USDA protocols on July 20th by the Plant Pest Specialist and Plant Pathologist. All plants within 2-meter radius of the positive plant were destroyed; all plants within 4-meter radius were held for further inspection. The greenhouse floor and benches were disinfected with 10% bleach. All plants that were received from the same shipment were carefully inspected for symptoms. A comprehensive delimiting survey at the nursery for all the plants on the USDA official host list was done. No additional positive case was detected at the nursery. Water sampling and stream bait sampling was done to make sure the pathogen did not spread into surrounding natural area. Two follow-up inspection of the plants being held were conducted within 90 days. No additional symptomatic plant was found, and all plants were released. This Ashe County certified nursery is currently free of *Phytophthora ramorum*.

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.

In response to the positive detection in North Carolina, the plants were traced-back to a nursery in the State of Oregon. Investigation done by the Oregon Department of Agriculture later found multiple Rhododendron plants infected with *P. ramorum*. The trace forward investigation found one additional shipment was sent to a residential location in North Carolina. The plants were destroyed, and the property was inspected for symptomatic plants. No additional infected plant was found in North Carolina.

Miscellaneous

The Plant Pathologist participates in bi-monthly, national conference calls pertaining to the Sudden Oak Death program and provides summaries to the Plant Pest Administrator. Bi-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.

White pine blister rust and Regulation on *Ribes* spp.

White pine blister rust (WPBR), caused by the fungus, *Cronartium ribicola*, is an invasive fungal disease that kills white pine trees (Pinus strobus) that affects trees of all ages and sizes and can essentially eliminate white pines from certain ecosystems. This disease has spread into the Appalachians of North Carolina since 1953 and is the most destructive disease of white pines in North America.

The fungus cannot spread from pine to pine but is transmitted to pines from spores produced on infected *Ribes spp.* (currant and gooseberry) leaves. Because of the crucial role of Ribes in facilitating the spread of white pine blister rust, North Carolina established the

regulation to prohibit the sale, growing, or planting of currants and gooseberries in 1985 (02 NCAC 48A .0401).

Figure 4. Symptoms of *Cronartium ribicola* infection on *Ribes spp*.

Figure 5. Symptoms of white pine blister rust.

In June 2020, a Plant Pest Specialist in the Eastern region received notification from homeowner that they were unaware of the *Ribes spp.* regulation and purchased six gooseberry and two currant plants through an on-line retail transaction. Upon learning *Ribes spp*. are prohibited in North Carolina, the homeowner surrendered the plants willingly to NCDA&CS and they were destroyed. NCDA&CS contacted the on-line retail nursery to notify them of the violation and requested the nursery provide shipping information for all the *Ribes spp.* they shipped into North Carolina. Between 2015 and June 2020, the nursery reported over 250 shipment of *Ribes* plants statewide to primarily residential locations. NCDA&CS sent out official letters to the homeowners to notify them the threat of vectoring white pine blister rust and requested the homeowners contact their respective Regional Plant Pest Specialists to destroy the *Ribes* plants. As of December 2020, over 65% of the plants were destroyed. The rest of the cases are in urban areas and have proven to be untraceable.

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.

A compliance agreement program was established in 2019 as a condition of issuance of certificates or permits for the movement of sweet potato. Any person engaged in purchasing, assembling, exchanging, handling, processing, utilizing, treating, or moving such article may be required to sign a compliance agreement stipulating that he or she will maintain such safeguards against the establishment and dissemination and comply with such conditions. The compliance agreements are renewed at the end of each calendar year.

Packing and shipping facilities were inspected by Regional Plant Pest Specialists for GRKN. When sweet potato with suspicious symptoms were found packed for shipping, samples were taken and molecularly diagnosed by NCDA Nematology Lab. Any sweet potato shipments confirmed positive for GRKN were destroyed or processed in a North Carolina facility.

In order to safeguard the NC sweet potato industry, NCDA&CS is constantly reviewing and will update the regulations continuously regarding GRKN.

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 reniform and burrowing 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. Reniform and burrowing 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 2020, pathogenic species permit applications were evaluated which included fungi/oomycetes, bacteria, nematodes, and viruses.

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.

The Regulatory Weeds Program

Program Objective

The North Carolina Regulatory Weeds Program protects North Carolina agriculture and native plant ecosystems from the harmful impacts of state and federal noxious weeds. The regulation of noxious weeds is authorized by North Carolina Plant Pest Law under Article 36 of Chapter 106, in conjunction with State Noxious Weeds Administrative Code (Title 02, Chapter 48, subchapter A, rule number/section .1700) which defines and lists our state noxious weeds. The NC Administrative Code is meant to fully interpret statutes set forth by the state legislature. The primary objective of the program is to restrict movement, treat and/or manage regulated federal and state noxious weeds. This is accomplished by conducting surveys and enacting control measures, such as eradication efforts, that lead to effective management of areas associated with infestations. Additional programmatic activities may include issuance of scientific permits for movement of regulated articles, nursery inspections with Field Specialists state-wide and issuance of phytosanitary certificates.

Executive Summary

April 1, 2020, Jarred Driscoll, formerly the NC CAPS State Survey Coordinator transitioned to the role of Regulatory Weed Program Manager. The 2020 Regulatory Weeds Program was successful in administering treatment to sites where regulated noxious weeds were positively identified. The program handled many weeds in 2020 which included; beach vitex (*Vitex rotundifolia*), yellow floating heart (*Nymphoides peltate*), purple loosestrife (*Lythrum salicaria*), tropical spiderwort (*Commelina benghalensis*), cogongrass (*Imperata cylindrica*), tropical soda apple (*Solanum viarum*), wooly frogsmouth (*Philydrum lanuginosum*), itchgrass (*Rottboellia cochinchinensis*), giant hogweed (*Heracleum mantegazzianum*), small broomrape (*Orobanche minor*) and witchweed (*Striga asiatica*). In most cases, the area Plant Pest Specialist and Regulatory Weed Program Manager along with Support Operations staff work together in providing treatment schedules for effective management or eradication of state and federal noxious weeds. The following provides further information about these treatments across the state.

Aquatic Dealer Inspections

Aquatic dealer inspections are an important activity as they help filter out 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 2020, field staff completed inspections at 97 retailers across the state, a decrease from 146 in 2019. No regulated plants were found during those inspections.

Cogongrass (*Imperata cylindrica*)

With help from NCDOT, control was maintained for trouble spots occurring along roadsides in Sampson and Pender Counties (Figure 1). NCDA&CS works in conjunction with NCDOT in identifying and controlling regulated weeds along roadsides. We will continue this effort in the future as efficiency is gained with more staff available to survey and treat.

Figure 7. Cogongrass present beneath a powerline/right of way (left). NCDOT employee surveying a cogongrass infested area along a roadside (right).

Purple Loosestrife (*Lythrum salicaria*)

A Class B State Noxious Weed, and eradication efforts have been ongoing since 1997. Both Guilford and Henderson Counties have larger infestations of this weed and are being treated with the hopes of eradicating. Treatments were accomplished using Element 3A whose active ingredient is triclopyr. These treatments are found to be quite effective especially after several treatments throughout the season to catch all plants that may have emerged later and to prevent further seed dispersal.

Two sprays were completed at the sites in Guilford County (Figure 2). These sites typically include right of ways beneath power lines where infestations are usually the heaviest. A third spray treatment was schedule but needed postponement due to weather. Sites originally observed in 2011 in Henderson County received three successful treatments during 2020. Survey and herbicide treatments will be ongoing in 2021.

Figure 8. A hand-pulled specimen of purple loosestrife from Guilford County.

Itchgrass (*Rottboellia cochinchinensis*)

The battle for control with this weed has been ongoing in Robeson County since 1983. There are at least 6 separate areas located around the town of Rowland that are being monitored and treated. Application of glyphosate were made to areas where plants were observed. For several years, infested areas have been noted as being largely improved from years previous. Survey treatment efforts will continue in 2021.

Tropical Soda Apple (*Solanum viarum*)

Tropical soda apple is a threat to NC agriculture as it can outcompete vegetable crops and serves as an alternate host for many important pathogens for solanaceous species. These include potato leafroll virus, potato virus Y, gemini virus, cucumber mosaic virus, tomato mosaic virus and tomato mottle virus. Prominent members of this genus include tomato, pepper, potato and eggplant. Three, separate survey dates were conducted at a farm in Sampson County during 2020 to identify and pull tropical soda apple (Figure 3). Surveys were focused where previous hot spots existed and were carried out on ATV for the approximately 7,000 ac farm. Well over one-hundred survey hours were worked to identify and pull a total of 152 plants for the season. Plants are carefully pulled to ensure fruit to do not escape and placed in heavy duty paper bags for incineration.

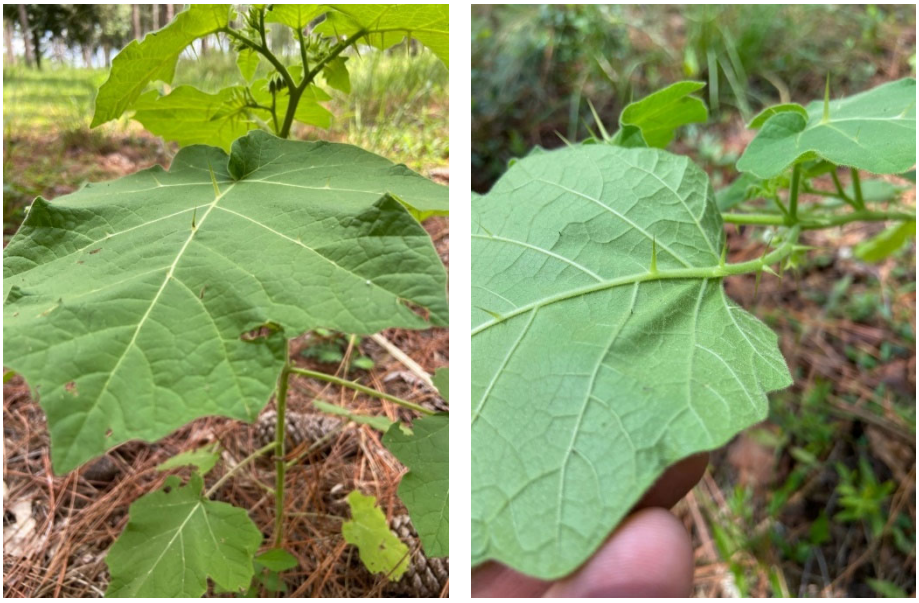


Figure 9. A lone tropical soda apple plant showing off its large thorn-like prickles above (left) and below (right) leaf surface.

Giant Hogweed (*Heracleum mantegazzianum*)

Watauga County remains the only county in NC where giant hogweed has been positively identified. A total of 137 plants were sprayed over five locations. These locations are surveyed annually within the county by the Western Region Field Supervisor. Each summer NCDA&CS receives many calls from the public statewide with potential sightings of this regulated weed. Public concern is high as Giant Hogweed poses a human health concern. There are several native lookalikes and during 2020, there were no additional Giant Hogweed finds in the state. All calls lead to investigations which start with analyzing a digital photo and then transition to a visual inspection when the photos were inconclusive

Wooly Frogsmouth (*Philydrum lanuginosum*)

Initially found in August 2016, this Guam native served as a first find in the U.S. Initially treated in late 2016 and 2017, no treatment was done in 2018 because the plant could not be found. In 2019 wooly frogsmouth was found not only in the original pond, but also in a nearby pond. Treatments began again in 2019 and 2020. The 2020 survey revealed good control for above ground plants while below the waterline plants can escape treatment (Figure 4). NCDA&CS is actively working with NC Wildlife Resources Commission in pursuing other treatment options in addition to the current method of control.

Figure 10 Pender County site infested with wooly frogsmouth. One of two locations in the state.

Tropical Spiderwort (*Commelina benghalensis*)

Tropical spiderwort is found in only a couple areas of the state, all of which have historically been and will continue to be treated. This is a serious regulated weed that if not treated early can become out of control. A small infestation originally found in June of 2015 in Raleigh near North Carolina State University (Figure 5). A much larger infestation is on Cherry Research Station, where much progress has been made due to a large-scale fumigation treatment in 2020. Areas that have historically provided positive identifications will be closely monitored.

Figure 5. Flame weeding tropical spiderwort in Raleigh. (A) General area located near infestation off sidewalk and up to an apartment complex. (B) Flame weeder in action burning tropical spiderwort. (C) Area after treatment with flame weeder.

Beach Vitex (*Vitex rotundifolia*)

Because beach vitex lacks a root system known to be efficient at holding sand. It outcompetes native grasses, which *are* more proficient at holding sand due to their root structure. Both root structure and outcompeting growth lend itself to increased beach erosion. This weed has spread to much of the southeaster shoreline and with current reports of re-infestations a potential renewed interest may exist. Approximately a decade ago the last beach vitex task force completed their survey and management of this invasive dune vine. A recent U.S. Fish and Wildlife grant was completed by a third party aimed at conducting survey and additional research on this plant. Our path forward for the management of this weed will be accomplished by considering this work and the work done by the previous task force. Treatments are being carried out on newly identified infestations. On September 22nd we surveyed Morehead city where an active infestation is being treated (Figure 6). On November 17th, we confirmed several areas along Wrightsville Beach. Effort is being made to contact homeowners with private property know to be infested with Beach Vitex.

Figure 6. Several photos of beach vitex observed along Morehead City beach, September 22nd. All vines were treated and monthly visits are conducted by area field staff.

Small Broomrape *(Orobanche Minor)*

Orobanche minor is an obligate parasitic weed of many broadleaf plants, with origins in North Africa and the Middle East. A total of 134 plants were observed and destroyed at a livestock market in Haywood County. Totals for Mitchell County include 47 plants along Griffith pasture and 26 plants along Highway 226. Several survey dates were conducted starting May 12th, May 14th and June 2nd. By June 23rd, orchard grass and other weeds had overgrown these areas rendering further survey not possible.

Yellow Floating Heart (*Nymphoides peltata)*

North Carolina received an abundance of rain during 2020, with many areas at 10" – 20+" of above average rainfall. This tends to help promote and encourage weeds to develop and spread. Several new sites of yellow floating heart were identified in eastern, central and western North Carolina. These new sites were treated in 2020 and will be monitored in the future. Figure 7 shows the importance of conducting annual treatments of an infested site. From the first time this location in Lee County was observed in 2018 to the first time we sprayed in July 2020, a significant difference is noticeable in the level of infestation. It is expected that even less will be present in 2021. In all, 7 established and 3 newly identified 10 locations were treated for yellow floating heart across the state by NCDA&CS.

Figure 7. (A) Photo taken August 2018 when first found, showing significant growth of yellow floating heart. (B) Same location taken July 1st, 2020. (C) Same location, taken August 6th, 2020 approximately 30 days after first spray treatment of the year.

Witchweed (*Striga asiatica*)

The USDA has been a long-term and faithful supporter of eradicating this federal and state noxious weed (Figure 8). Their continued support ensures forward progress is made as we continue to march down a path towards eradication. The first round of temporary employees were brought on in early June 2020 to begin survey. Survey and treatment efforts were in full swing by the beginning of July when all temporary employees were on-board. Unfortunately, due to supply disruptions in ethylene, Witchweed Inspectors were not able to utilize this most effective way in controlling this parasitic weed. Use of ethylene targets the seedbank in the soil and promotes early germination when no host plants are available to parasitize and complete its lifecycle. Ethylene was procured before the end of 2020 and our hope is that no further disruption to our supply will occur in the future. This is the best tool in our arsenal due to its efficiency and it is the least toxic option to the environment.

Figure 8. A witchweed plant near its host in July 2020.

Highlights for the 2020 season include one newly infested field (Sampson County, 38 acres). This is further reflected when considering that it was Sampson County that saw the only increase in infested acreage of the five counties registering positive for witchweed. All other counties either stayed the same or had fewer infested acres (Table 1).

Table 1. Witchweed infested farms by county for 2019 and 2020.

County		No. of Farms	No. of Fields	Infested Acres
Bladen	2019	33	59	594.70
	2020	**28**	**49**	**498.00**
Cumberland	2019	19	22	186.00
	2020	**16**	**16**	**162.50**
Pender	2019	4	4	36.50
	2020	**3**	**3**	**30.50**
Robeson	2019	13	17	356.30
	2020	**13**	**17**	**356.30**
Sampson	2019	0	0	0
	2020	**1**	**1**	**38.00**
Total	2019	69	102	1,173.50
	2020	**61**	**86**	**1,085.30**

When comparing the past several years 2020 had a higher than normal total for newly infested or re-infested acres. This is most likely due to the significant rainfall from hurricane events of 2018 and only now in 2020 have populations been large enough to observe in field. This coupled with lack of ethylene could have contributed to the increase. Overall, total acres managed for both infested and release phases is down from 3,020 in 2018 to 2,767 in 2019 and 2,593.6 in 2020 (Table 2).

Table 2. Total witchweed acres managed in 2020.

Total Acres in Infested Category	**1,085.30**
Total Acres in Released Category	**1,508.30**
Total Acres Managed by Program	**2,593.60**
Total Acres Treated	**506.71**
Total Acres Surveyed	**31,091.60**
Acres Transferred from Infested to Release Category	**171.4**
Acres New or Re-Infested	**-193.7**
Net Difference Acres Transferred and New/Re-Infested	**-22.3**

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 24 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 2019-20 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 2019-20, the North Carolina Seed Laboratory conducted 3,108 regulatory seed tests and 9,517 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 1296 special tests conducted during the fiscal year. All official regulatory samples taken during the fiscal year 2019-20 represent testing for a total of 28,628,984 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 1 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 Services

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 161 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 0 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. For the 2019-20 fiscal year time period, the Seed board conducted an investigation of one complaint that was filed.

North Carolina Tobacco Variety Evaluation Program

The Tobacco Variety Evaluation Program continued in joint cooperation with N.C. State University. Samples from 32 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 67 different varieties from four different seed companies.

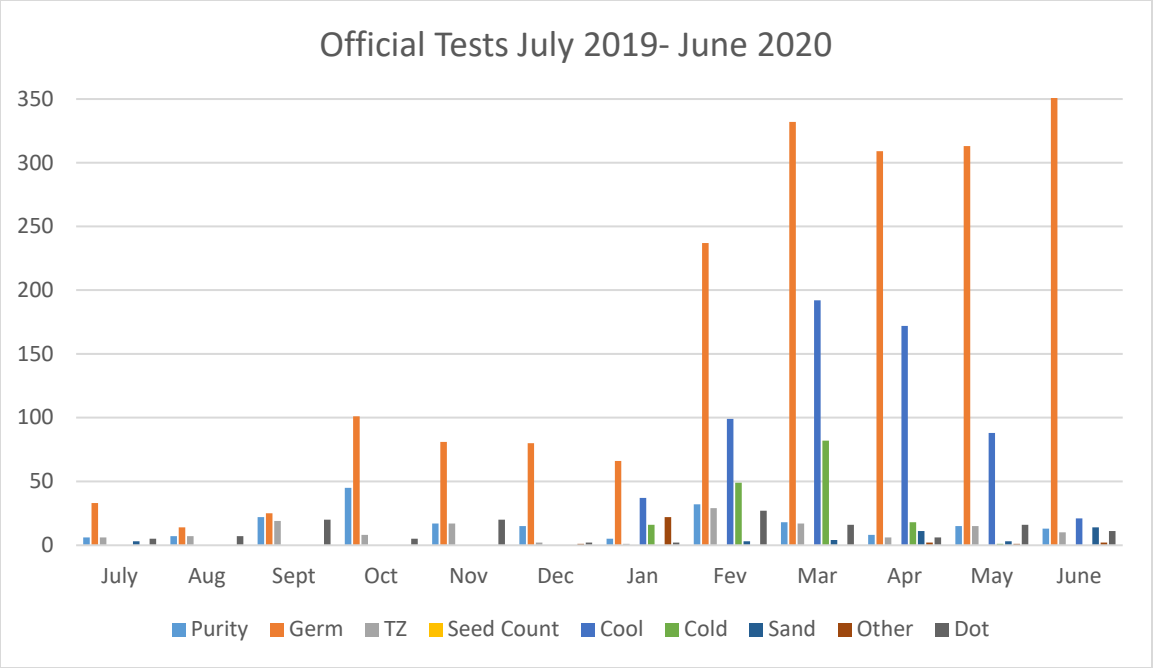


Figure 36 Seed Laboratory Official Tests

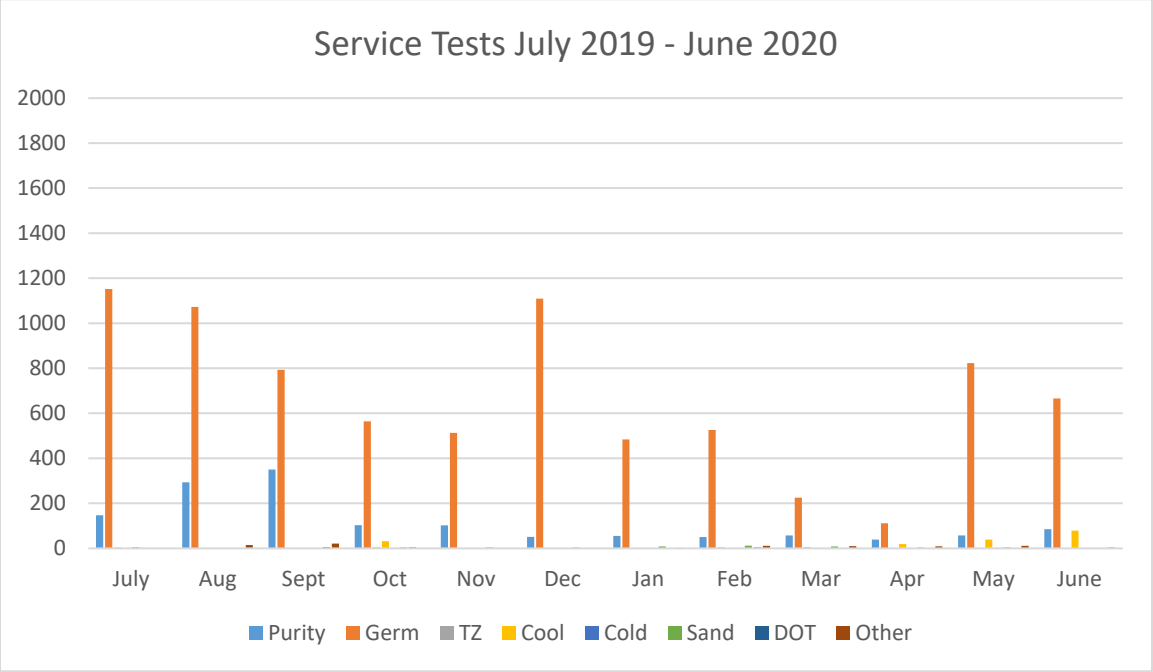


Figure 37 Seed Laboratory Service Tests