NCDA&CS
Plant Industry Division
Annual Report
2018

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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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Plant Industry Division

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

Facilities

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PLANT PROTECTION SECTION ACCOMPLISHMENTS

Apiary Inspection and Biological Control 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 2018 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 (left May 2018), Sam Larsen (hired April 2018), Nathan LaSala (hired November 2018) and John Banask (hired in 2017). Glenn Hackney is a Research Specialist in the Apiary Inspection Program and maintains a lab at the BIL. Other Apiary staff are based at their homes across the state. During 2018, the inspectors were: Greg Farris, western Piedmont, Nancy Ruppert, Sandhills, Will Hicks, NE central counties, Adolphus

Leonard, Coastal Plain, Lewis Cauble, mountain territory, and Don Hopkins, NW central counties, State Apiarist and Apiary Inspection Supervisor.

The past year has seen an exciting growth in our biological control program with new initiatives to tackle existing and emerging pests and invasive species being funded by both the State and Federal Agencies. This includes the expansion of two existing programs (Hemlock Wooly Adelgid and Mile a Minute Biocontrol) and the addition of three new funded initiatives (Knotweed Biocontrol, Alligatorweed Biocontrol and Crape Myrtle Bark Scale Natural Enemies Survey). We are also happy to be collaborators on the red bud borer project and to be continuing our EAB biosurveillance work.

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

Apiary Inspection Program

To protect the health of our honey bee industry, permits to sell bees are required for anyone wishing to sell queens, package bees, nucs, or hives. In 2018, 115 permits were issued to sellers. To obtain a permit, bees must be inspected, and the producers agree to comply with standards designed to maintain healthy colonies. Beekeepers are strongly encouraged to buy only from permitted dealers to avoid buying unhealthy or Africanized honey bees.

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

The mite *Varroa destructor* persists as a major threat to the beekeeping industry in NC and is probably a contributing factor to general poor health or mortality of bee colonies. Several new miticides have been registered; however, the mites have developed resistance to some of these materials in short order and rendered these products ineffective. Currently, the list of registered products for *Varroa* control in North Carolina includes Apistan®, CheckMite+®, Api-Life Var®, Apiguard®, Mite-Away Quick Strips®, Apivar®, oxalic acid (specifically labeled for bees), and HopGuard®. All the aforementioned products are listed in North Carolina as Section 3 general use

pesticides. Although chemical treatment of mites may be necessary, some miticides have been demonstrated to have adverse effects on bees. The growing use of unregistered materials may have adverse effects on honey bee health and may not be efficacious in controlling mites. This and, in some cases, the improper use of antibiotics to control diseases can further complicate useful treatment regimes.

Beekeepers are expressing concerns about pesticides, particularly the neonicotinoids. Bee yards can be registered through the Plant Industry Division. This list is sent to aerial applicators licensed in NC. The NCDA&CS Apiary Inspectors have developed a good working relationship with the Structural Pest and Pesticides Division of the department. The Pesticide Division responds to reports of acute bee losses and follows up according to the evidence. If a pesticide problem is suspected, timely reporting to an Apiary Inspector or the Pesticide Section is crucial for a valid investigation and resolution. Apiary personnel have collected pollen samples from colonies suspected to be suffering sublethal effects of exposure to neonicotinoids. To date, the samples have contained no detectable levels of these chemicals. The Structural Pest Control and Pesticides Division and the Plant Industry Division are working with EPA to develop a Managed Pollinator Protection Plan.

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

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

Implementation of *Cerceris fumipennis* as a Biosurveillance Tool for Pest Buprestidae in North Carolina during 2018

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 2018 studies of the wasp in North Carolina were continued in partnership with the Cooperative Agricultural Pest Survey (CAPS); we conducted biosurveillance at established sites and surveyed for new sites between 22 May and 9 July 2018.

Biosurveillance was conducted in 13 sites in 12 counties, with a total of 500 beetles collected (Table 1). The first beetles collected were from Robeson Co. on 30 May and the last beetles were taken on 9 July in Polk Co. We met out goal of 50+ beetles in 4 of the sites. Nine surveyed sites were unsuitable for further work during the 2018 season (Table 2).

Table 1. Biosurveillance conducted for pest Buprestidae with *Cerceris fumipennis* in 2018

Site #	Site Name	County	Total Buprestidae	No. EAB	% EAB
1	Bradford Pool	Robeson 11	26	0	
2	Faith Christian Academy	Wayne 16	73	16	21.9
3	Havelock Middle School	Craven 1	33	0	
4	Franklinton Park	Franklin 6	73	0	
5	Luddy Park	Franklin 4	3	0	
6	Vance Elementary	Buncombe 12	132	111	84.1
7	Polk Co. Middle School	Polk 2	11	0	
8	Mountain Heritage HS	Yancey 2	91	83	91.2
9	Liberty Hill	Mitchell 8	20	7	35.0
10	Spencer Park	Rowan	1	0	

11	Caswell Co. Parks & Rec	Caswell 2	17	7	41.2
12	Meadowview MS	Surry 5	16	7	43.8
13	Swain Co. Veterans Park	Swain 2	4	4	100.0
	TOTALS: 13 sites	12 counties	500	235	Overall: 47%

This year was the first time that *C. fumipennis* collected *Agrilus transimpressus* and *Dicerca juncea* during biosurveillance; neither beetle, however, is a new state record. *Agrilus subrobustus*, a buprestid native to East Asia, was collected from a site in Wayne Co. (Site 2). This beetle was first detected in North Carolina in 2014 as prey brought back to the nest by *C. fumipennis* from a site in Buncombe Co. (Swink et al. 2015). The collection this year from the sandhills indicates that this non-indigenous beetle is widespread in North Carolina.

Table 2. Sites surveyed/resurveyed: unsuitable for biosurveillance with *C. fumipennis*

	Site	Date Surveyed	Results
1	Caswell 1 - 2012; Bartlett Yancey HS	8 June 18	0 nests
2	Avery 1 - 2011; Crossnore School	24, 26 June 18	~5 nests
3	Watauga 5 - 2010; Mountaineer Ruritan	24 June 18	0 nests
4	Mitchell 3 -2011; Brad Ragen	25 June 18	2 possible nests
5	Mitchell 6 - 2011; Riverside Park	25 June 18	0 nests
6	Caldwell 25 - 2018; Optimist Park	26 June 18	6 + 6 nests (2 fields)
7	Caldwell 26 - 2018; Mulberry Rec Center	26 June 18	4 possible nests
8	Caldwell 27 – 2018; Wilson Park	26 June 18	6 + 15 nests (2 fields)
9	Transylvania 1 – 2016; Cascade Lake	28 June, 8 July 18	4 nests, ~6 nests

Fifty beetles in the genus *Chrysobothris* (10 species) were collected by *C. fumipennis* in NC in 2018 (Table 3); 43 of these were sent to Dr. Bill Klingeman (University of Tennessee) for his studies of potential plant pathogens carried on the bodies of adult Buprestidae. It is notable that of the 43 *Chrysobothris* that were sexed by Dr. Klingeman, females outnumbered males by almost 2:1 (28 females, 15 male *Chrysobothris*).

Table 3. Buprestids in the genus *Chrysobothris* collected in North Carolina by *C. fumipennis* in 2018 (n = 50).

Species	Number
Chrysobothris chlorocephala	2
Chrysobothris cribraria	15
Chrysobothris femorata	1
Chrysobothris orono	2
Chrysobothris quadriimpressa	13
Chrysobothris rotundicollis	1
Chrysobothris rugosiceps	1
Chrysobothris sexsignata	11
Chrysobothris shawnee	2
Chrysobothris viridiceps	2

More than 50% of beetles collected by *C. fumipennis* in 2018 were in the economically important genus *Agrilus* (Table 4), with emerald ash borer (EAB) accounting for the vast majority; EAB was collected in seven sites and accounted for 47% of all beetles taken (Table 1). It was collected primarily in the mountains (Buncombe, Yancey, Mitchell, Swain counties) and along the border with Virginia (Caswell, Surry counties); it was also taken in one site in the sandhills (Wayne county). No new county records of EAB resulted from biosurveillance in 2018.

Table 4. Buprestids in the genus *Agrilus* collected in North Carolina by *C. fumipennis* in 2018 (n = 262). Question marks indicate that the identification requires confirmation

Species	Number
Agrilus bilineatus	7
Agrilus carpini (?)	3
Agrilus celti	1
Agrilus fulgens	2
Agrilus nigricans	4

Agrilus otisosus sp. group	2
Agrilus pensus	2
Agrilus pilosicollis (?)	1
Agrilus planipennis	235
Agrilus politus	2
Agrilus ruficollis	1
Agrilus subrobustus	1
Agrilus transimpressus	1

The history of EAB as collected by *C. fumipennis* in North Carolina is summarized in Table 5; the most informative sites are highlighted in red. *Cerceris* first collected EAB in North Carolina in Franklinton Park (Franklin Co.) in 2015 (Nalepa et al. 2017). Despite comprehensive biosurveillance at that site in three subsequent years it has not been collected there again, supporting the suggestion that the initial collections of EAB at Franklinton Park may have been from firewood. In two mountain sites, the proportion of EAB among the beetles collected by *Cerceris* has increased since EAB was first detected at the site by biosurveillance in 2016. Mountain Heritage (Site 8, Yancey Co.) increased from 15.2% (2016), to 36.5% (2017), to 91.2% (2018). Vance Elementary (Site 6, Buncombe Co.) increased from 10.9% EAB in 2016, to 50.5% (2017), to 84.1% (2018). In the remaining sites we either had mixed results (e.g., Site 2, Faith Christian Academy, Wayne Co.), or the sample sizes were too low to draw conclusions.

Table 5. History of EAB collection in North Carolina. Percentages represent the proportion of emerald ash borers in the total number of beetles collected by *C. fumipennis* at the site; beetle sample sizes are in parentheses.

Site Name	County	2015	2016	2017	2018
Faith Christian Acad	Wayne		3.6% (84)	0% (30)	21.9% (73)
Franklinton Park	Franklin	1.4% (214)	0% (78)	0% (86)	0% (73)
Vance Elementary	Buncombe		10.9% (55)	50.5% (91)	84.1% (132)
Mountain Heritage HS	Yancey		15.2% (46)	36.5% (52)	91.2% (91)
Liberty Hill	Mitchell			8.2% (61)	35% (20)
Caswell Co. Pks & Rec	Caswell			0% (2)	41.2% (17)
Meadowview MS	Surry		0% (24)	0% (1)	43.8% (16)
Swain Co. Veterans Pk	Swain		13.2% (68)	57.1% (7)	100% (4)

We have begun utilizing the EAB collected by *C. fumipennis* to begin studying the biology of this invasive pest in North Carolina.

Two papers related to the project were published in professional journals during 2018:

Nalepa C.A., W.G Swink, and J.P. Basham. 2018. The relationship of body length to fresh weight varies across three buprestid genera (Coleoptera: Buprestidae). Coleopterists Bulletin 72(2): 380-381.

Nalepa, C.A. and W.G. Swink. 2018. Wasp size and prey load in *Cerceris fumipennis* (Hymenoptera: Crabronidae): Implications for biosurveillance of pest Buprestidae. Insects 9, 86; doi:10.3390/insects9030086

Joshua Basham (Tennessee Department of Agriculture), William Klingeman (University of Tennessee) and Whitney Swink (North Carolina Department of Agriculture) identified the Buprestidae. Biosurveillance was conducted by Sue Dial, Jarred Driscoll, Larry Greene, Mike Hodges, Sam Larsen, Christine Nalepa, Nancy Oderkirk, David Pearce, and Michelle Shooter. We are grateful to the schools and parks that allowed us to work on their grounds. **References Cited:**

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

Swink, W.G., C.A. Nalepa and J. Basham. 2015. *Agrilus subrobustus* Saunders (Coleoptera: Buprestidae) first detected in North Carolina as prey of the wasp *Cerceris fumipennis* Say (Hymenoptera: Crabronidae). The Coleopterists Bulletin 69 (2): 274.

Hemlock Woolly Adelgid Predator Rearing at the Beneficial Insects Laboratory

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

Over the past calendar year, we have successfully renovated our facility to expand our cold storage areas, which are needed to rear these winter beetles. This included the building of a new industrial walk in cooler for the storage of freshly collected infested hemlock branches (necessary as the food source for both adult beetles and larvae, and for egg laying) as well as for additional rearing space. We obtained 2 species of *Laricobius* beetles – *L. nigrinus*, native to the Pacific Northwest that were field collected from existing populations in Western North Carolina and *L. osakensis* which were sourced from a laboratory reared colony by the Hemlock

Restoration Initiative. The *L. osakensis* colony are descendants of wild collected individuals that had been collected in Japan in 2017 by the University of Tennessee, Knoxville.

In total our starter colonies comprised of 130 *L. osakensis* beetles and 250 *L. nigrinus* beetles. We began our oviposition cages in January of 2018, following a feeding and maintenance period for our newly obtained adult beetle colonies. Where possible, 20 beetles were placed in a 1-gallon jar provisioned with enough infested hemlock to both feed the adult beetles, and to provide a resource in which females could lay eggs. The infested hemlock was replaced every 2 weeks. The hemlock extracted from oviposition cages was placed in floral foam blocks with additional infested branches added to provide food for the emergent larvae. This process was continued until late March 2018 when all adult beetles had died. From March – Early may, we harvested mature larvae and placed them in pupation chambers where they lay dormant until the late fall/early winter when conditions were changed to trigger adult emergence. In our first season we recorded a total of 1894 larvae that successfully made it to the pre-pupal stage. Of these 1148 were *L. nigrinus* and 746 were *L. osakensis*.

By the completion of the 2018 calendar year, the BIL was successful in developing lab protocols that successful resulted in beetle reproduction and survival to the larval stage. We will assess the success of pupal emergence (and overall mortality vs survivorship) in the 2019 annual report, and compare our larval yields to this year, as we aim to increase our beetle output and refine our laboratory protocols.

In May 2018 the NCDA&CS BIL was approached by the North Carolina Policy Collaboratory to put together a plan and partnership with a research university to improve beetle output and to improve the current understanding of optimal methods of beetle release. We are pleased to announce that we were funded are now partnered with Western Carolina University faculty, Jim Costa, Peter Bates and Angela Mech on planning and implementing our research and rearing projects for 2019. We anticipate this to be the beginning of a continuous and successful partnership and are excited to be contributing to research that will better inform the HWA control effort.

*As this was our first season of rearing *Laricobius* beetles and our initial colony numbers were low, no field releases were conducted. We anticipate some field releases for the 2019 field season and will publish any release data in next year's annual report.

Acknowledgements

Production of HWA predatory beetles at the BIL is supported by funding from the NC General Assembly and the NC Policy Collaboratory. We thank our collaborators at the Hemlock Restoration Initiative for assisting us in obtaining our new *Laricobius* colonies and Pat Parkman and Carrie Jubb of Univ. Tenn. Knoxville and Virginia Tech. Univ., respectively for informing our rearing protocols. Our 2018 HWA biocontrol project was conducted by Steve Turner, Biocontrol Administrator, John Wilson, Research Specialist, John Banask, Research Specialist and Nancy Oderkirk, Research Specialist. We welcome Sam Larsen, Research Specialist, as Laboratory lead of the *Laricobius* project. We say goodbye and good luck to John Wilson in his new position at the NC Zoo.

2018 Mile-A-Minute Vine Biological Control Report

Mile-a-Minute vine (MAM), *Persicaria perfoliata* (aka *Polygonum perfoliatum*,) is a fast-growing annual invasive weed found in riparian areas and along forest edges in the Eastern region of the United States. This plant was first discovered in this range in the mid-1930s. MAM is easily identified by its triangular leaves, spines on the reddish-colored stems and leaf petioles, and a modified leaf (ochrea) that surrounds each node of the vine. Its small white flowers develop into bright metallic blue, berry-like fruits. Seeds can remain viable in the soil for up to 6 years. They spread by floating great distances and are dispersed by seed-feeding birds and mammals. Patches of MAM also travel along waterways during major flooding events.

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

Rapid growth, prolific flowering, long-lived seeds, location along riparian areas, and ability to overtop herbaceous and shrubby plants (Fig.1) and even small trees, make chemical control of MAM difficult. Cultivation is ineffective, because seeds are released during the process, and plant remnants root at the nodes and re-grow. Biological control has therefore proven to be the most practical strategy for dealing with this weed in many cases.

Surveys for natural enemies in its native Asia revealed the weevil *Rhinoncomimus latipes* Korotyaev as the most promising species, with MAM as its sole hostplant. This insect has since been reared at the Philip Alampi Beneficial Insect Lab (PABIL) of the New Jersey Department of Agriculture, which has provided weevils for release throughout the Northeastern and Mid-Atlantic states, including North Carolina. Hough-Goldstein et al. (2008) provide an overview of the biology and biological control of MAM. Delimiting surveys were initially conducted to determine the extent of MAM infestations throughout the known and expected range in North Carolina. Since the initial weevil releases, sites have been visited at least annually, and additional surveys have determined ongoing expansion of the weevil's range.

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

Weevils have been released in multiple years at sites with dense MAM populations, resulting in 25 unique sites in 6 counties over a period of 8 years (Table 1).

Table. Releases of *Rhinoncomimus latipes* in NC by year.

Year	County	# Weevils	# Locations
2011	Alleghany	2200	6
	Yancey	200	1
2012	Alleghany	4800	6
2013	Alleghany	2500	3
2014	Alleghany	300	1
	Guilford	200	1

	Pasquotank	4000	5
2015	Gates	3000	6
	Rockingham	1350	3
2016	Pasquotank	300	2
	Rockingham	300	1
2017	Alleghany	2000	1
	Gates & Pasquotank	500	2
2018	Alleghany	2000	1
	Gates & Pasquotank	3000	1
	Guilford	1000	1
Totals	**8**	**27,650**	**25 (unique)**

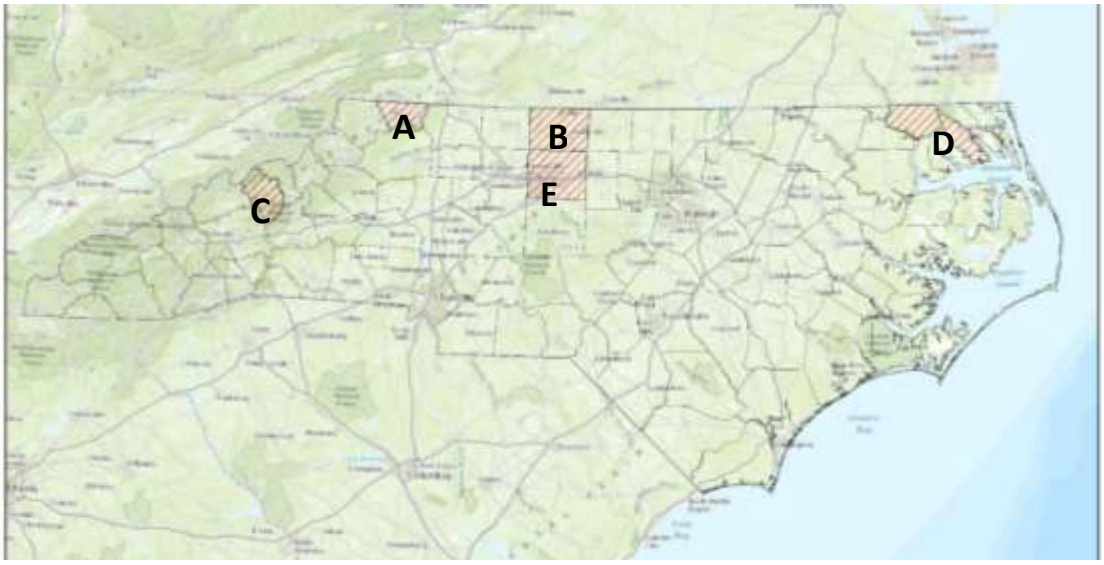

Figure 2. Mile-a-Minute infestations in North Carolina. Counties with hatch markings are infested. Letters correspond with the order in which county infestations were reported. A = Alleghany, B = Rockingham, C = Yancey, D = Pasquotank and Gates, E = Guilford.

Weevils have persisted at all release sites for one or more years after release, and dispersal of almost 5km from release sites has been documented (Fig. 3).

This year NCDA&CS initiated our own weevil rearing program supported through funding from the USDA APHIS Biological Control Program. In previous years, the program had relied on shipments of weevils from the New Jersey Department of Agriculture to sustain our program. However, due to the number of cooperators requesting beetles, the number obtained was

insufficient to meet our needs. Our first year of rearing beetles was successful, allowing us to release more beetles at our MAM sites and has also given us the opportunity to plan experiments to determine the overall effectiveness of the beetles in North Carolina, as the state is the southern edge of the invasive range of MAM and has infestations in areas that are warmer than the regions where the cold adapted weevils originate.

Literature Cited

Hough-Goldstein, J., E. Lake, R. Reardon, and Y. Wu, 2008. Biology and Biological Control of Mile-a-minute Weed. USDA Forest Service, FHTET-2008-10.

Hough-Goldstein, J., M.A. Mayer, W. Hudson, G. Robbins, P. Morrison, and R. Reardon. 2009. Monitored releases of *Rhinoncomimus latipes* (Coleoptera: Curculionid), a biological control agent of mile-a-minute weed (*Persicaria perfoliata*), 2004-2008. Biological Control. 51:450-457.

Poindexter, D.B. 2010. *Persicaria perfoliata* (Polygonate) reaches North Carolina. Phytoneuron. 30: 1-9.

Acknowledgements

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2018 Fire Ant Biocontrol Summary

Phorid Flies for Biological Control of the Imported Fire Ant, *Solenopsis invicta*

The Imported Fire Ant (IFA), *Solenopsis invicta*, was discovered in North Carolina in 1953. Since that time, it has spread to all but the northcentral and mountain regions (NCDA&CS, 2019.) Its painful sting can harm humans, pets, and livestock. This ant is detrimental to agricultural productivity due to its effect on livestock as well as its deterrent effect on the production and harvest workforce and reduces the marketability of agricultural products such as sod. In an effort to slow its spread and to decrease population size, biological control measures have been undertaken across the Southeastern United States. A complex of flies in the family Phoridae is known to uniquely control *Solenopsis* spp. in their native South America (Porter,

1998.) These phorid flies, sometimes referred to as decapitating flies, lay individual eggs into worker ants while they forage or defend their mounds. The fly larva feeds and develops within the ant's head, killing the host in the process and causing the head to detach (Porter et al., 1995.) When phorid flies are present, ants are preoccupied with defense, and decrease foraging to avoid the intensely annoying flies. Less foraging activity results in fewer ants and smaller and/or fewer mounds, allowing native ants and other insects to better compete for resources (Mehdiabadi et al., 2004.)

Releases Since 2000, we have released four species of phorid flies in twelve counties of North Carolina (see Table 1.) Fly species were chosen for release at each locality based on the prevalent ant colony phenology, as follows: *Pseudacteon tricuspis* and *P. obtusus* flies typically attack the larger workers found in monogyne (single-queen) colonies, whereas *P. curvatus* and *P. cultellatus* prefer smaller workers common to polygyne (multi-queen) colonies (Morrison et al. 1997.)

Surveys A modified version of sticky traps developed by Puckett et al. (2007) has been used to monitor phorid flies after their release. Each trap consists of a plastic tri-stand (used by pizza delivery companies) glued to a 60 x 15 mm plastic petri dish. The tri-stand and sides of the petri dish are coated with Fluon™ formulation of PTFE to prevent fire ants from escaping or climbing the tri-stand. An inverted tri-stand is anchored to the original tri-stand with Velcro, and the legs of the inverted stand are coated with Tanglefoot®. Traps are placed alongside fire ant mounds and baited with bits of Vienna sausages to attract ants, and therefore, phorids. Flies become ensnared in the Tanglefoot® when they alight to rest on the upright legs. The traps are collected within 24 hours of placement, so as to sample flies that are active at different times of day.

Surveys are conducted annually for 2-3 years after each release. Three small releases were conducted in 2017, and surveys will conclude in 2019. Phorid fly releases since the inception of this program are presented in Table 1. Survey results confirm that *Pseudacteon curvatus* has established and spread reliably from sites of introduction in North Carolina. Long-term establishment of the other species has not been confirmed (Table 2).

Phorid Fly Release and Recovery Data for North Carolina

Release Site (County)	Nearest Town	Species released	Release Year	Number	Survey Year*	Species recovered
Beaufort	Washington	*P. tricuspis*	2000	3000	< 2009	--
Duplin	Warsaw	*P. tricuspis*	2002	2973	< 2009	--
Robeson	Lumberton	*P. tricuspis*	2003	3849	< 2009	--
Wayne	Goldsboro	*P. tricuspis*	2004	4962	< 2009	--
Wake	Wendell	*P. curvatus*	2005	13,708	2018	*P. curvatus*
Pitt	Falkland	*P. tricuspis*	2006	3639	2017	*P. curvatus*
Scotland	Laurel Hill	*P. tricuspis*	2007	5206	< 2009	*P. curvatus*
Scotland	Laurel Hill	*P. curvatus*	2007	13,008	< 2009	*P. curvatus*
Wayne	Goldsboro	*P. curvatus*	2008	12,000	< 2009	*P. curvatus*
Gaston	South Point	*P. curvatus*	2009	11,000	2009	*P. curvatus*
Pitt	Greenville	*P. curvatus*	2010	12,000	2017	*P. curvatus*
Pitt	Greenville	*P. obtusus*	2010	1100	2017	*P. curvatus*
Randolph	Asheboro	*P. curvatus*	2011	4914	2017	*P. curvatus*
Randolph	Asheboro	*P. obtusus*	2011	2984	2017	*P. curvatus*
Franklin	Franklinton	*P. curvatus*	2012	9312	2018	*P. curvatus*
Franklin	Franklinton	*P. obtusus*	2012	2417	2018	*P. curvatus*
Wake	Raleigh	*P. cultellatus*	2013	6096	2017	*P. curvatus*
Wake	Wake Forest	*P. curvatus*	2013	2592	2018	*P. curvatus*
Wake	Wake Forest	*P. obtusus*	2013	1404	2018	*P. curvatus*
Johnston	Smithfield	*P. obtusus*	2014	5077	2017	*P. curvatus*
Johnston	Smithfield	*P. cultellatus*	2014	4128	2017	*P. curvatus*
Anson	Lowrys	*P. obtusus*	2015	1364	2017	*P. curvatus*
Anson	Lowrys	*P. cultellatus*	2015	9408	2017	*P. curvatus*
Wake	Cary	*P. obtusus*	2017	130	2018	*P. curvatus*
Wake	Raleigh	*P. obtusus*	2017	390	2018	*P. curvatus*
Wake	Wake Forest	*P. obtusus*	2017	630	2018	*P. curvatus*

* Most recent survey results are shown.

Project Summary Phorid flies released for biological control have become established across North Carolina. Of the four species released, current monitoring techniques have allowed for the sustained recovery of a single species, *Pseudacteon curvatus*, and the previous recovery of *P. tricuspis* in one site. At this time, we cannot determine definitively whether these findings are artifacts of the trapping technique, or whether the prevailing species either outcompetes or is better adapted to this northernmost latitude of phorid fly release. We anticipate that final surveys to be conducted in 2019 will help to clarify this result.

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Acknowledgements

Phorid flies for release were kindly supplied by the rearing labs of USDA ARS CMAVE and the Florida Department of Agriculture and Consumer Services, Division of Plant industry, Gainesville, Florida. Nancy Oderkirk has been responsible for the project since 2016. We thank the following collaborators for their assistance with recent field surveys: Paul Adams, Andrew Allen, John Banask, Samantha Larsen, Adolphus Leonard, Mike Massey, and Michelle Shooter.

Emerald Ash Borer Overwintering in North Carolina 2018

A second year of the emerald ash borer (*Agrilus planipennis* = EAB) overwintering study was conducted to quantify the overwintering stages of this pest in North Carolina. In fall of 2017, prior to leaf drop, four green ash trees infested with EAB were selected and flagged at a single

site in Granville county: a roadside location in Butner (36.15290, -78.767530). On 9 February 2018, these four trees, all located within an area of about a half-acre, were felled (Trees A, B, C and D). Participants were Wayne Langston, James Slye, Kelly Oten (NCFS-Forest Health), Rob Montague (NCFS-Granville Co. Ranger), and Christine Nalepa (NCDA & CS Beneficial Insects Laboratory). The bole of each tree was sawed into manageable sections that were labelled sequentially from the base to the top. These were transported to NCDA Support Operations property, where the logs were debarked and inspected for life stages of EAB. The debarking of 36 logs was carried out 12-21 February. Larvae that were present were measured with a Mitutoyo® Absolute Digimatic caliper (0.01mm); life stages not damaged during collection were preserved in alcohol.

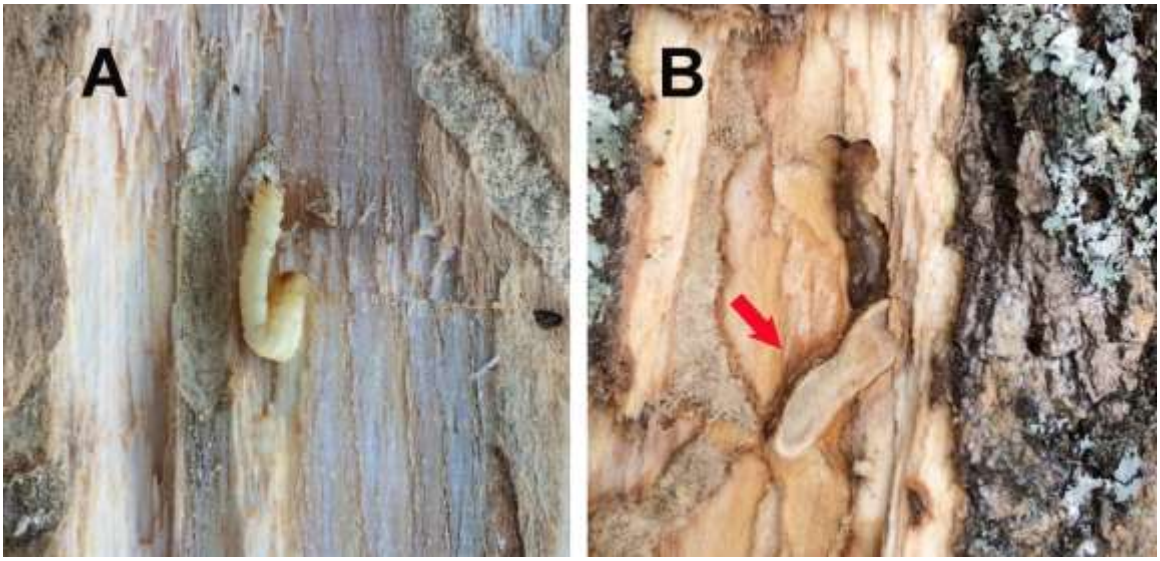

Figure 1. A) J-larva of EAB; B) Cocoon of parasitic hymenopteran (arrow) in gallery below dead EAB larva.

Results: A total of 84 EAB life stages were recovered from overwintering chambers in the logs (Table 1): four J-larvae (the folded, fully grown larval stage prior to pupation) (Fig. 1a) and 80 larvae. Larval lengths ranged from 12.84 to 20.57 mm, indicating that the majority were probably in the third instar (16-26 mm according to Chamorro et al. 2012). However, since the larval body telescopes and because J-larvae were present, it is likely that the larger larvae in the

measured range were fourth instars. It is notable that no EAB pupae were found, because 85% (50 of 59 total) of EAB life stages in late winter of 2017 were pupae.

Table 1. Life stages of EAB found in trees sampled from Granville Co., NC on 9 Feb 2018.

Tree	No. of logs	EAB larvae	EAB J-larvae	EAB pupae	EAB total
A	11	26	1	0	27
B	5	3	0	0	3
C	9	50	1	0	51
D	11	1	2	0	3
Total	36	80	4	0	84

Cocoons of nineteen possible hymenopteran parasitoids were collected from EAB overwintering chambers (Fig. 1b); 16 from Tree A and three from Tree C. These were given to Dr. Matt Bertone (North Carolina State University), who attempted to rear them to maturity, then identified and photographed adult wasps that successfully emerged.

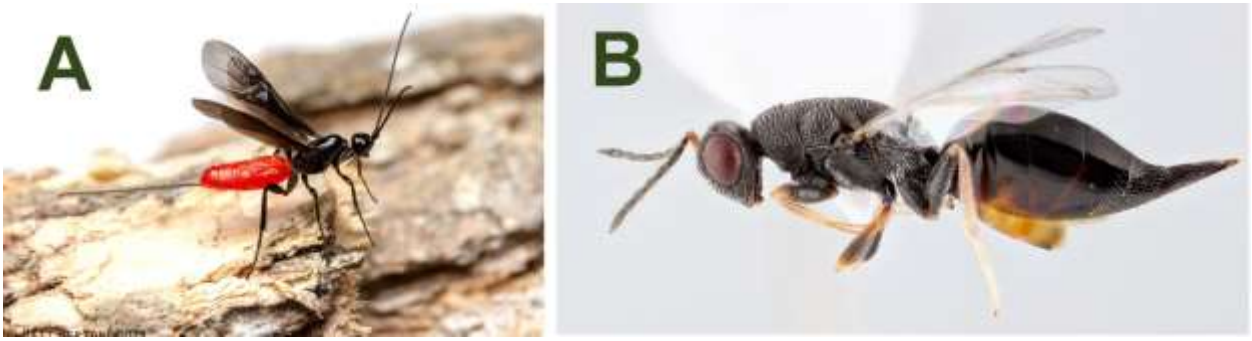

Figure 2. A) *Atanycolus* cf. *cappaerti*; B) *Eurytoma* sp. Photographs by Matt Bertone.

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Seven adult specimens of parasitoids identified as *Atanycolus* cf. *cappaerti* (Fig. 2A) were reared from the cocoons. Six of these were from tree A, and one from tree C. *Atanycolus cappaerti* is a native North American solitary ectoparasitoid known to use EAB as a host (Cappaert and McCullough 2008; Duan and Schmude 2016). If we assume that all cocoons collected were *A.*

cappaerti, EAB in tree A had a 37.2% parasitism rate, and EAB larvae in tree C were parasitized at a rate of 5.6%.

One specimen of *Eurytoma* sp. also emerged from the collected material (Fig. 2b). Because *Eurytoma* is a known hyperparasitoid of *Atanycolus*, it is uncertain as to whether this wasp was parasitizing EAB or *Atanycolus*

None of the parasitoid *Xorides humeralis*, which were recovered from overwintering EAB in North Carolina in 2017 (Bertone et al. 2017), were recovered in 2018.

Parasitoid specimens have been deposited in the North Carolina State University Insect Museum.

We thank Kevin Carpenter for working space and use of equipment.

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Redbud Seed Borer Collection 2018

As part of a collaboration with Dr. William Klingeman (University of Tennessee) and his graduate student Meher Afroze Ony, we took part in a regional survey of redbud seed pods to evaluate the relationship between *Cercis canadensis* and the redbud seed borering beetle (*Gibbobruchus minus* (Say)). The goal of the research project is to further the understanding of this host parasite relationship which can then be applied to the nursery industries raising of *Cercis* species for commercial production. As a part of this survey we also collected leaf samples of naturalized redbuds to look into the genetic variation of *Cercis canadensis* with the primary goal of the project being to map genetic variance in redbuds throughout the southeast.

Our collections were conducted in May at WakeMed Soccer Park, Blue Jay Point County Park, Fred Gould house (residential area Raleigh), JC Raulston Arboretum, San-Lee Park (Sanford, NC), and the Greensboro Arboretum. At each site we took a sample of ten leaves from ten different trees to assess genetic divergence and recorded the coordinates of each tree. We then took nets which we used to cover the branches with heavy seed pod development and gently shook them to get the beetles to fall. Afterwards we sifted through the nets and collected the desired beetles in vials of alcohol. We also collected mature redbud seed pods (Fig. 1) in July and August and placed them in emergence cages in the hopes that adult beetles would emerge. In addition to the emerged *G. mimus*, we collected samples of three different unidentified parasitoid wasps that emerged from seed pods (Table 1).

Fig. 1 Redbud seedpods held for emergence of insects

Table 1. Summary of *Cercis* leaf collection, insect collection, and insect emergence from seedpods

Location	Collection Dates (Leaves and Adult Beetles)	Leaf Samples Taken	Number of Collected Beetles	Collection Dates (Mature Seedpods)	Number of Beetles Emerged from Seedpods	Unknown Parasitoids Emerged from Seedpods
Wake Med Soccer Park	15 May 18	Yes	21	20 July 18	28	1
Greensboro Arboretum[1]	22 May 18	Yes	--	--	--	--
Blue Jay County Park	16 May 18	Yes	13	--	--	--
San-Lee Park[2]	21-22 May 18	Yes	--	--	--	--
Gould House[3]	15-16 May 18	No	11	20 Aug 18	5	17
JC Raulston Arboretum[4]	15 May 18	No	--	--	--	--

[1]*Cercis* seeds were underdeveloped due to shading. No beetles present, and no pods taken.

[2]No beetles were found but leaves were collected.
[3]No leaf samples were taken because of a limited number of trees.
[4]Pods were collected but no leaf samples were taken as most redbuds were cultivars.

Fig. 2 Insects in preservative sent to cooperators

Once all collections had been completed we stored all collected and emerged beetles and parasitoids in 70% alcohol (Fig. 2). The collected leaves were dried between newspaper sections and placed in envelopes with the coordinates of each tree from which they were taken (Fig. 3). These were all then mailed off to Dr. Klingeman and his graduate student for identification and evaluation in their regional survey of redbuds and the seed borer. We look forward in the coming years to participating in any further study Dr. Klingeman wishes to conduct on the parasitoids or further data he might wish to collect on the redbud seed borer.

Fig. 3 Dried redbud leaves sent to cooperator

Appendix: location and coordinates of collection sites

WakeMed Soccer Park: 201 Soccer Park Dr, Cary, NC 27511, six trees bordering NCDA property, 35°47’23” N, 78°45’6” W
Blue Jay Point County Park: 3200 Pleasant Union Church Rd, Raleigh, NC 27614, ~6-8 trees, 35° 58’ 9 to 47’’ N, 78° 38’ 10 to 43’’ W
Fred Gould house: 216 Furches St., Raleigh, NC 27607, one tree in front of house, 35°47’46” N,78°40”53” W
JC Raulston Arboretum: 4415 Beryl Rd, Raleigh, NC 27606, 35°47’39” N, 78°41’59” W
San-Lee Park: 572 Pumping Station Rd, Sanford, NC 27330, 35°28’56” N, 79°07’30” W
Greensboro Arboretum: 401 Ashland Dr, Greensboro, NC 27403, 36°04’13” N, 79°50’31” W

2018 Newly Initiated Programs

This section briefly highlights nascent programs that were recently funded. These programs are in various phases of planning and implementation. We anticipate the expansion of these

programs with results that can be more fully reported in the 2019 Beneficial Insect Laboratory Annual Report.

Biological Control of Knotweeds

This program is funded through cooperative agreement with USFS as part of a wider initiative to develop a biological control program for knotweeds.

In August of 2018 the NCDA&CS Beneficial Insect Laboratory received 2 colonies of an experimental biological control agent, *Aphalara itadori* that is being assessed for its potential use against Japanese, Bohemian and Giant Knotweeds. These plants are highly invasive species and are widespread throughout the United States.

Our initial colonies were both approximately 100 adults strong. They have been successfully maintained and reared into close to 1000 adults per species. We anticipate that scaling up to mass rearing will result in the production of tens of thousands of psyllids. We are currently rearing these agents in our quarantine facility under a cooperative agreement with the US Forest Service and Oregon State University. These agents have already been thoroughly assessed by researchers and is currently under petition for field release in the United States. Whilst we wait for the final approval for releases to be given, we have been building the necessary lab infrastructure required for rearing these biocontrols.

Once, approval is given, the NCDA&CS will lead the mass rearing effort for the Eastern United States and will be involved in participating in experiments to determine the effectiveness of both candidate organisms as suitable biological control agents for the suppression of knotweeds in the field Sam Larsen, John Banask and Steve Turner currently work on this project.

Biological Control of Alligatorweed

NCDA&CS Beneficial insect programs received funding in the 2018 Farm Bill to establish a biological control program for rearing agents for use against alligatorweed, a highly invasive aquatic weed native to Argentina. NCDA&CS personnel have begun the process of obtaining colonies of two biological controls, the flea beetle, *Agasicles hygrophila* and thrips, *Amynothrips andersoni* and have also begun to work on rearing protocols and infrastructure for these organisms.

In November 2018 alligatorweed was harvested from infested sites in North Carolina and moved to the NCDA greenhouse to be used in a propagation program to provide a food and egg laying resources for both the alligatorweed flea beetles and alligatorweed thrips. Alligatorweed flea beetles and alligatorweed thrips will be field collected from existing, established wild populations. The beetles will be sourced from Florida, South Carolina and Louisiana and the thrips from Coastal North Carolina. This project has several collaborating groups including NCDA&CS, The US Army Corps of Engineers and NC Cooperative Extension.

Steve Turner and Nathan LaSala currently work on this project. We thank Nathan Harms of the US Army Corps of Engineers Biological Control Program (Vicksburg, MS.) for his collaboration and assistance in acquiring insect colonies for this project.

Survey for Native Natural Enemies of Crape Myrtle Bark Scale

The NCDA&CS BIL is currently in the planning phase for surveying for potential native natural enemies of Crape Myrtle Bark Scale, an invasive ornamental pest of crape myrtle trees. Sam Larsen, John Banask, Christine Nalepa and Steve Turner are all involved with this project. This program is supported by funds awarded in the 2018 Farm Bill.

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. The state CAPS advisory committee helps drive and focus surveys for each state. Its core members include the State Plant Health Director (SPHD), State Plant

Regulatory Official (SPRO), Pest Survey Specialist (PSS) and the State Survey Coordinator (SSC). Other members may be invited to provide guidance in their area of expertise. National and/or State level surveys concentrate on three main areas of importance; entomological, pathological or exotic weed species. All data collected from these surveys are entered into the National Agricultural Pest Information System (NAPIS) before December 1st for inclusion into the Nation Plant Board's annual report.

Executive Summary

The 2018 North Carolina CAPS program was successful in procuring funding for CAPS and Farm Bill surveys for early detection of exotic plant pests. Seven independent surveys were conducted throughout the state, covering 35 counties. Surveys included; mollusk, forest pests, oak commodity, grape commodity, Asian defoliators, a phytophthoras state specific survey and solanaceous commodity. A total of thirty-eight different exotic plant pests were surveyed from April through the end of October, with survey timing being unique for each pest. All surveys were completed following the 2018 CAPS guidelines, so that negative data were reportable. **There were no positive detections for any of the targeted plant pests during the 2018 survey season.**

Some Farm Bill surveys also fall under the direction of the CAPS program. Grant applications are submitted annually to conduct survey work in solanaceous commodity (tomatoes, peppers, tobacco, etc.), phytophthoras (important plant pathogens affecting nursery and natural areas), grape commodity and Asian defoliators (largely surveyed at ports of entry). These surveys follow CAPS guidelines for how they are conducted. Survey priorities for 2018 were determined with help from the CAPS advisory committee and new survey proposals were submitted through CAPS and Farm Bill section 10007. All grant proposals were funded for 2018 surveys, while proposals for the 2019 survey season were successfully submitted in August, 2018.

CAPS Surveys

Three CAPS surveys were selected for the 2018 season in North Carolina; mollusk, forest pests and oak (Figure 1).

Mollusk Survey

The mollusk survey was completed in June and July at six locations (Figure 1). Eight exotic species of mollusk were surveyed; giant African snail (*Lissachatina fulica*), Hygromiid snails (*Cernuella spp.*) and Leatherleaf slug spp. (*Veronicella spp., Belocaulus spp., Celosias spp., Laevicaulis spp., Sarasinula spp.,* and *Semperula spp.*). Both the Pest Survey Specialist (PSS) at PPQ and State Survey Coordinator (SSC) at NCDA&CS completed the surveys at ports of entry and state Field Specialists completed several at private nurseries. Several specimens were forwarded to identifiers with no actionable findings.

Oak Commodity Survey

North Carolina completed the 2018 oak commodity survey for the following exotics; Japanese oak wilt (*Raffaelea quercivora),* variegated golden tortrix moth (*Archips xylosteanus),* false codling moth (*Thaumatotibia leucotreta),* oak processionary moth (*Thaumetopoea processionea),* green oak tortrix moth *(Tortrix viridana)* and oak ambrosia beetle (*Platypus quercivorus*). Trapping for this survey began in May and ended in September. Monthly visits were conducted at twenty-five locations for lure replacement, sticky card collection or trap replacement. Bi-weekly visits for the oak ambrosia beetle multi-funnel trap were accomplished to limit the decomposition rate of beetle specimens so identification could be possible.

Forest Pests Survey

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

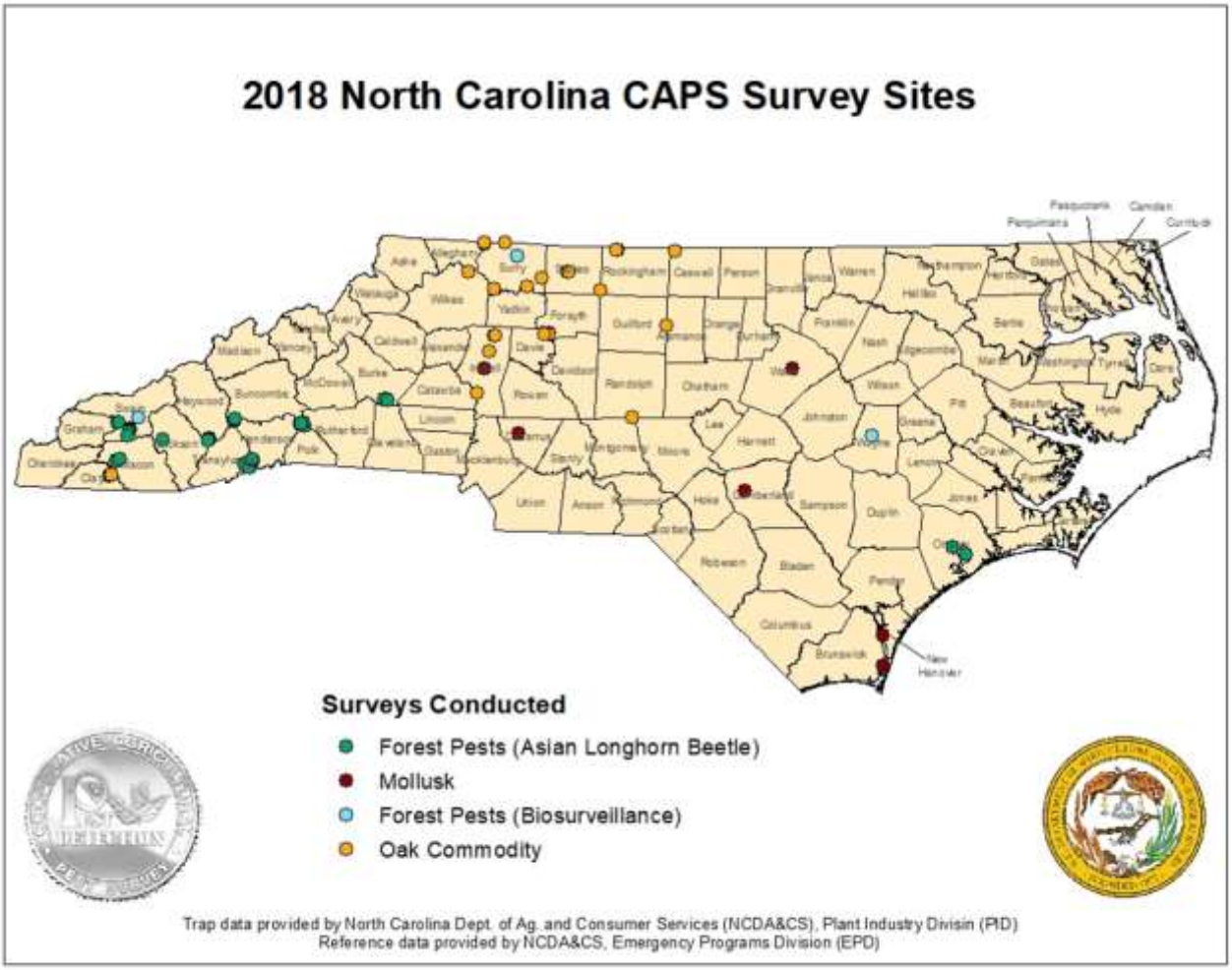

Figure 1. 2018 North Carolina CAPS survey sites.

Farm Bill Surveys

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

Asian Defoliators

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

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

A total of 12 trapping locations were placed at ports of entry over a four-month period from June to September (Figure 2). Monthly site visits were used to replace sticky cards and/or lures. Typical survey sites include deep water ports and military installations. It was previously determined that multiple survey locations exist on larger installations, and may include a combination of several forms of conveyance including deep water ports with rail yards, airstrips or a combination thereof. These are important pathways for this survey and are prioritized accordingly. All samples were collected at the servicing of each trap and screened for the presence of target pests.

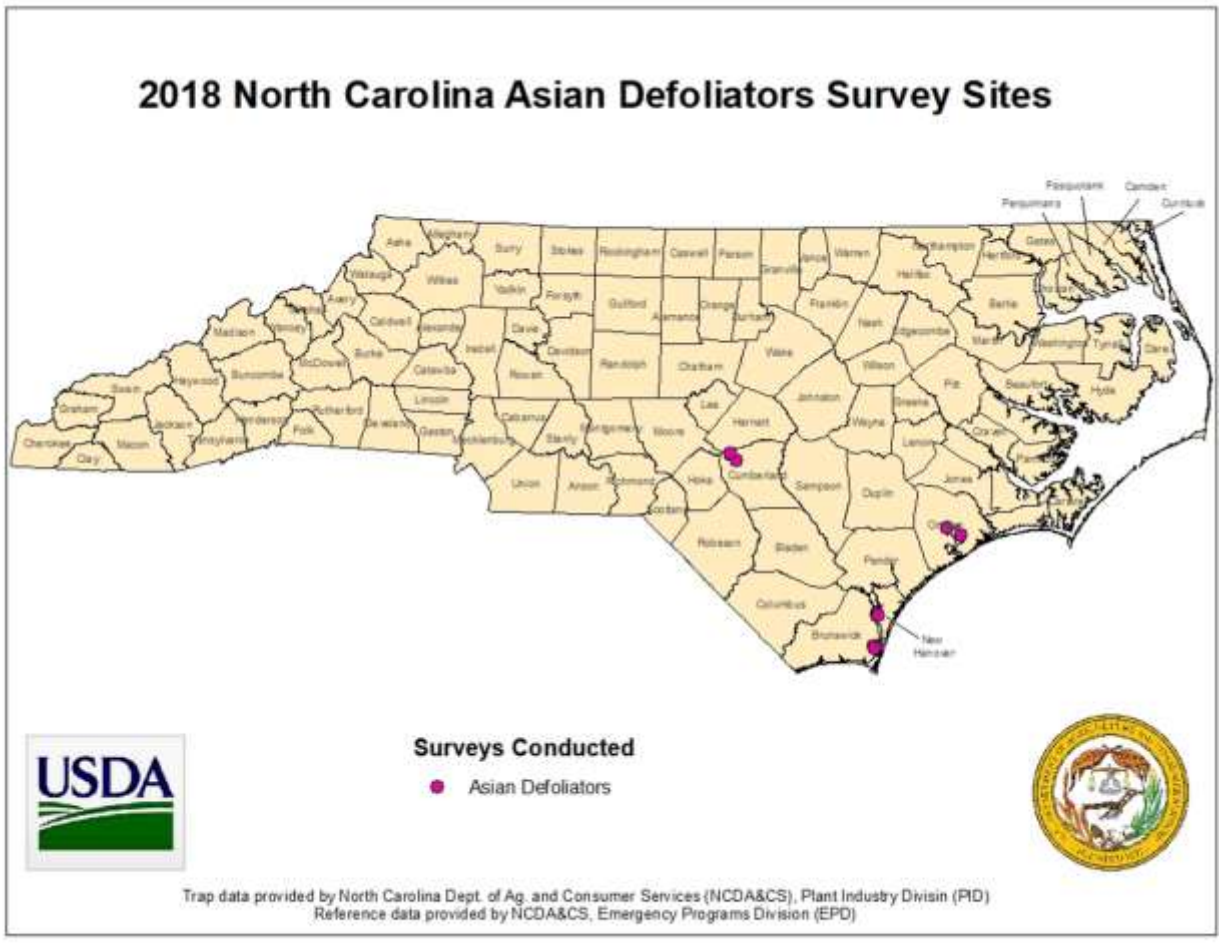

Figure 2. 2018 North Carolina survey sites for the Asian defoliators survey.

Grape Commodity

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

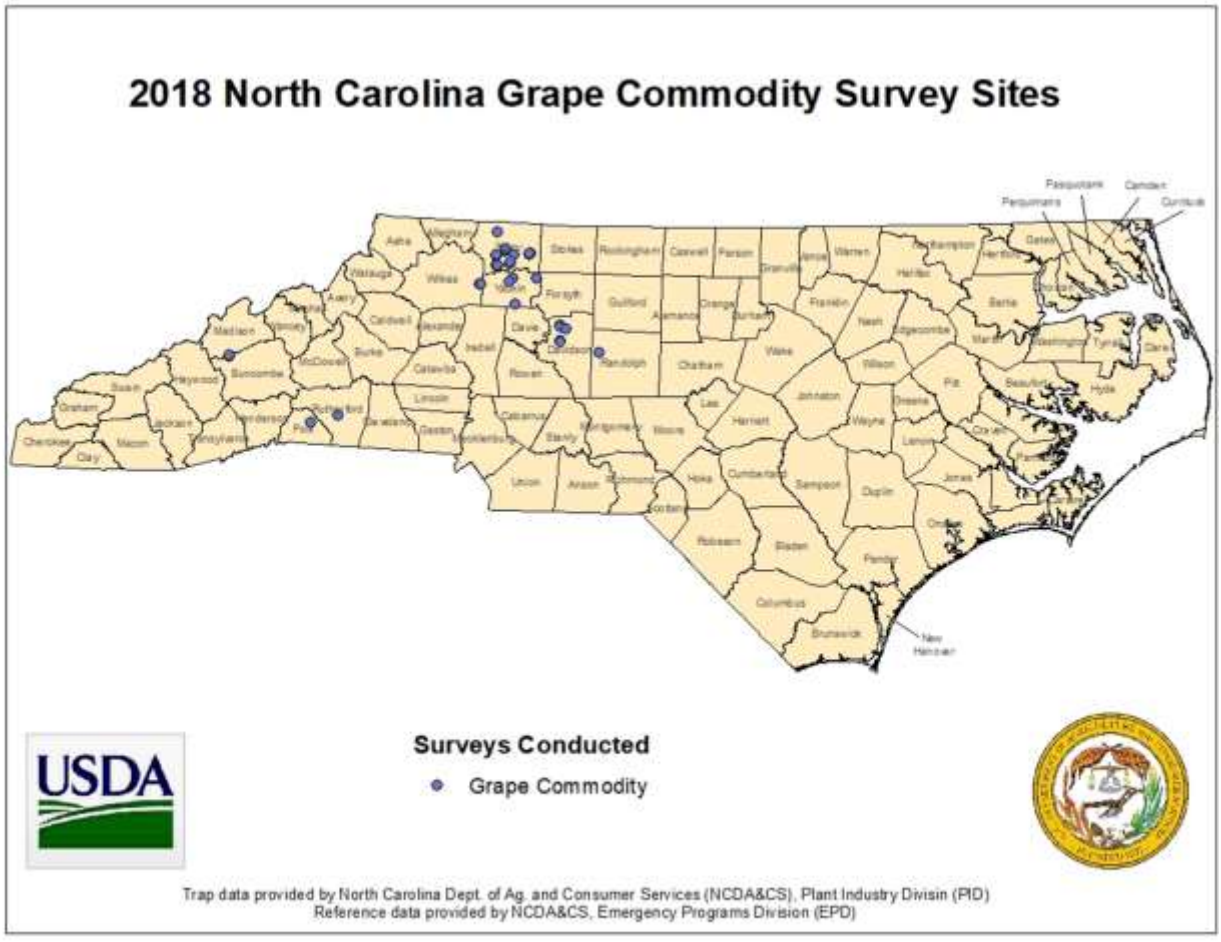

Figure 3. 2018 North Carolina survey sites for the Grape Commodity survey.

Solanaceous Commodity

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

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

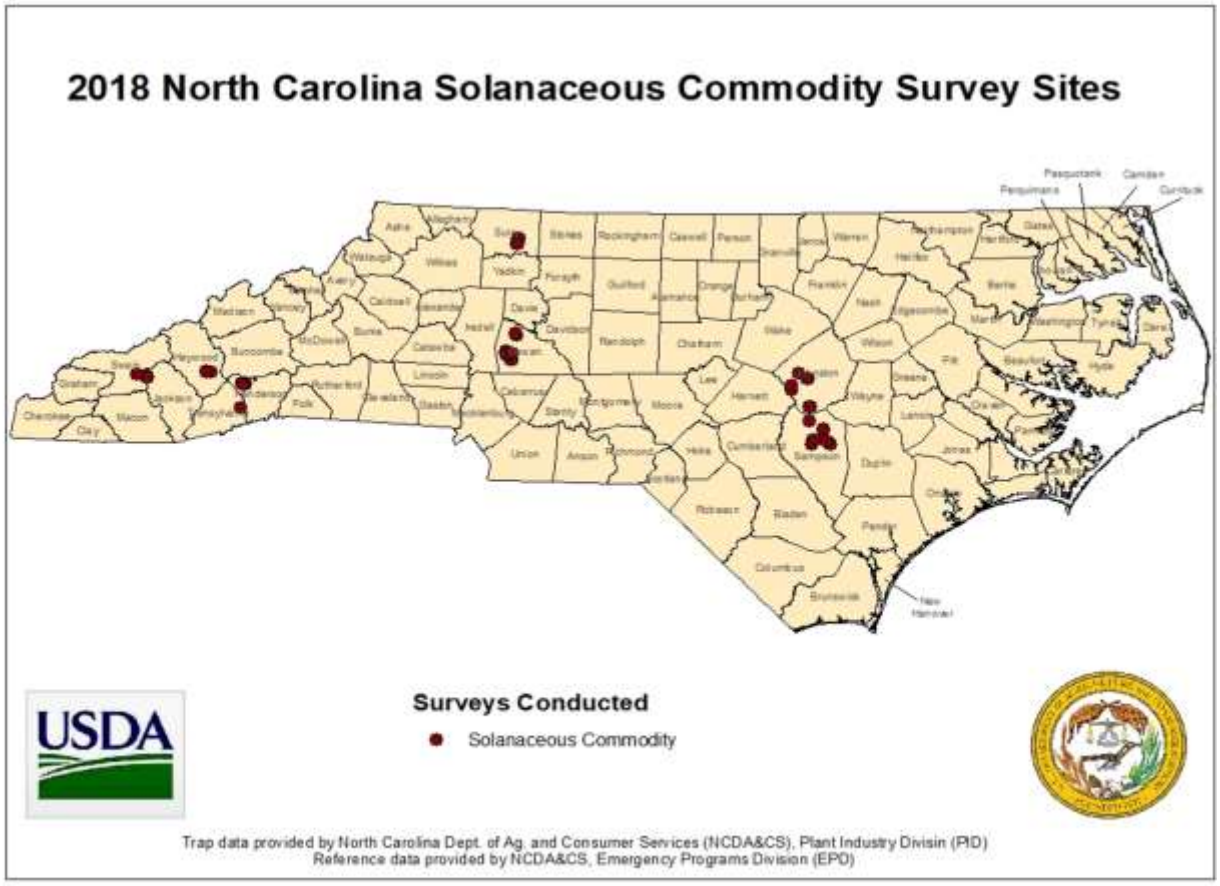

Figure 4. 2018 *Solanaceous* commodity survey locations for North Carolina.

Samples were collected from all traps and were later screened for the presence of target pests during the month of October. A taxonomic expert hired to help with this project conducted acid digestions to rule out positive identifications for *Helicoverpa armigera* (Figure 5). A total of 260 specimens were dissected with no positive determinations.

Figure 5. Dissection of *Helicoverpa armigera* used to discriminate target species from look-a-likes.

Phytophthora spp.

North Carolina conducted a *Phytophthora ramorum and P. kernoviae* survey during 2018. Both pathogens pose a significant threat to NC forests and nurseries. *Phytophthora kernoviae*, also known as phytophthora leaf blight, is not known to occur in the U.S., but does infect important plant species including; *Quercus*, *Magnolia*, *Rhododendron* and *Pieris*. *Phytophthora ramorum*, also known as sudden oak death, has been present along parts of the Pacific Northwest since the mid-1990s and is found intermittently in Southeastern states, including NC. 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. While this survey is still ongoing, to date more than 70 sites have been surveyed from nurseries and natural settings (Figure 6). All suspect samples were screened for the presence of *Phytophthora spp*. using Enzyme Linked

Immunosorbent Assay (ELISA) with positive samples forwarded to Kansas State University-Manhattan Diagnostic Laboratory for further diagnostics. To date, all forwarded samples have tested negative for our targets.

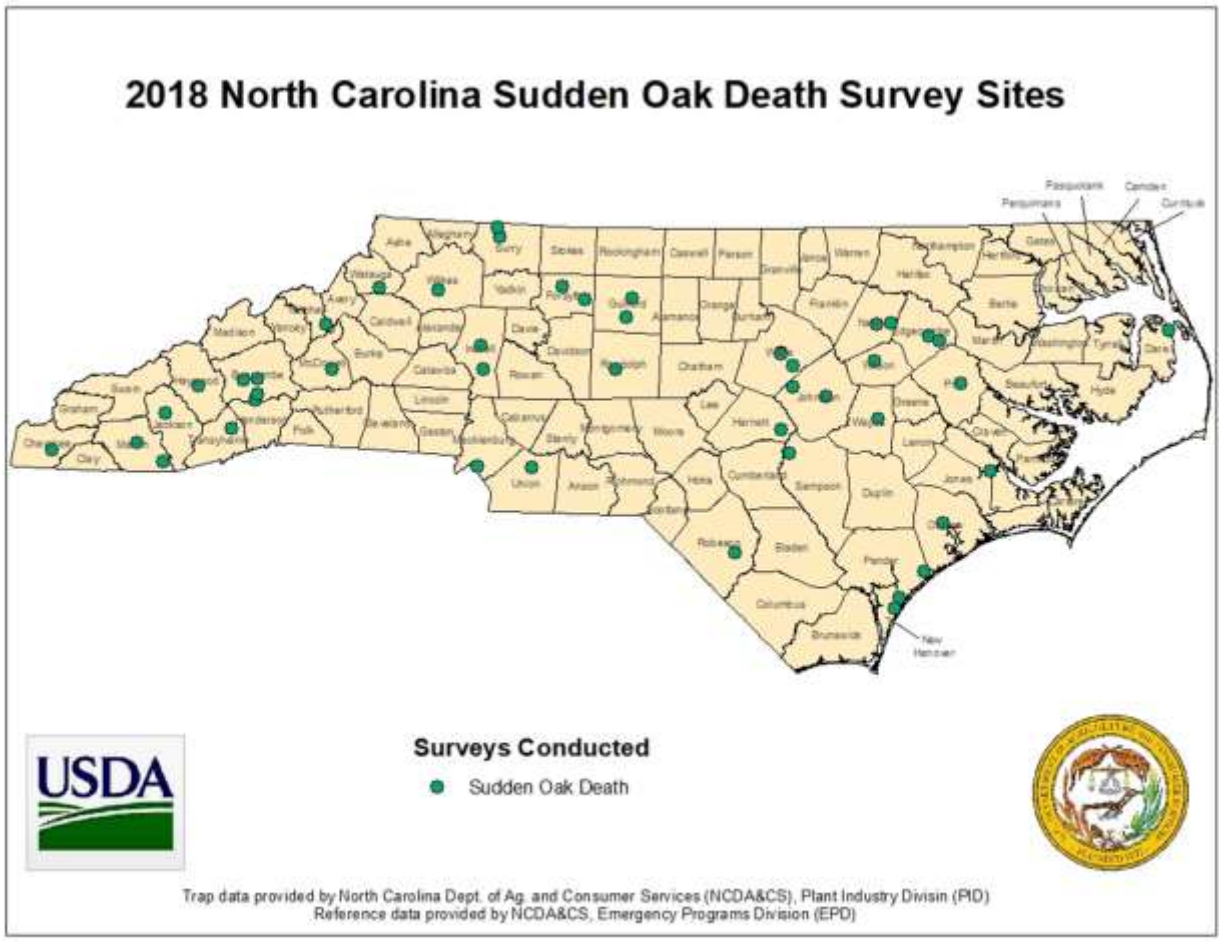

Figure 6. 2018 *Phytophthora spp.* survey locations for North Carolina.

2018 Entomological Programs Annual Report

Prepared by Whitney Swink, Entomological Programs Manager; Chris Elder, 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 2018.

SWEETPOTATO WEEVIL PROGRAM

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

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

Field Surveys

Field surveys were conducted from mid-August through September 2018 in 50 counties, primarily in eastern North Carolina. 10,506 traps were set in 9,329 fields in approximately 77,738 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 6.20 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 2018.**

TABLE 1. SUMMARY OF THE SWEETPOTATO WEEVIL FIELD TRAPPING (2018)

County	Reported Acres	Mapped Fields	Traps Set[1]	Mean no. of days in the field
Beaufort	389.02	93	27	40
Bertie	875.02	100	100	26
Bladen	80.39	13	15	21
Brunswick	9	1	2	26
Camden	3	1	2	28
Carteret	4.67	4	5	38
Chowan	369.97	26	52	27
Cleveland	4.2	1	2	21
Columbus	339.33	60	71	22
Craven	15.7	3	3	38
Cumberland	1462.43	117	197	25
Davidson	0.9	1	--	--
Duplin	4222.07	409	495	28
Edgecombe	7855.24	819	970	32
Forsyth	47.1	9	10	29
Franklin	167.18	20	32	27
Granville	172.03	56	43	31
Greene	4286.09	428	550	28
Guilford	49	9	7	28
Halifax	1025.7	110	125	23
Harnett	1754.8	280	283	31
Hertford	400	40	43	28
Johnston	8411.03	1246	1172	30
Jones	377.16	25	38	40
Lee	67.4	14	16	47

Lenoir	2997.34	272	338	36
Macon	0.4	1	--	--
Martin	314.07	27	43	23
Montgomery	11.1	2	4	32
Moore	117.19	10	19	48
Nash	8306.33	1175	1279	30
Northampton	112.49	11	14	22
Onslow	317.88	53	29	38
Orange	2	1	1	28
Pasquotank	56.83	12	12	28
Person	138.74	20	21	22
Pitt	4652.29	471	491	25
Polk	6.62	2	4	20
Randolph	21	4	2	28
Richmond	21.01	2	--	--
Robeson	834.45	26	72	22
Sampson	11322.36	1100	1643	33
Stokes	7.5	3	5	21
Tyrrell	5.25	2	4	41
Vance	6	1	2	25
Wake	830.67	139	151	36
Warren	46.39	13	18	25
Wayne	6256.2	714	774	28
Wilson	8962.57	1380	1320	32
Yadkin	2.5	3	--	--
Totals	**77,737.61**	**9,329**	**10,506**	**30[2]**

[1]Counties with fields labeled '--'had reported acres with no crop present therefore no traps were placed.
[2]Average number of days in the field across all counties

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 year-round. Because of the inter- and intra-state movement of sweet potatoes these regulatory sites are a high risk pathway for the introduction of sweetpotato weevil. Universal moth traps (or bucket traps) were used instead of the conventional green boll weevil traps in the field because of the higher trapping efficiency (Figure 1b). For these operations, a minimum of two traps (one inside and one outside) were set per structure containing sweet potatoes. Traps were placed in strategic locations where sweet potatoes are stored and/or in and around the locations outside the buildings were sweet potatoes are loaded or unloaded. Lures were changed

in each trap once a month and data collection was done using the same procedure detailed for the field surveys. A total of 205 regulatory sites (totaling 4,100 inspections) were surveyed and **no weevils were found in storage facilities during the 2018 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 and are being checked weekly for presence of weevils. This project is ongoing and is expected to continue beyond the SCB grant duration (expires December 2019).

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 2018, NCDA&CS, in cooperation with USDA-APHIS-PPQ, USDA-Forest Service (USFS), and the Slow the Spread (STS) Foundation, carried out an extensive trapping, treatment, regulatory, and alternate life stage survey program aimed at detection and eradication of European gypsy moth (EGM), a major invasive pest of hardwood trees. The program in North Carolina is divided into two different areas, STS and Eradication, as shown in Figure 1.

Trapping

A total of 18,003 traps were set in 100 counties in NC from April to June 2018 and removed from July to September 2018. 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. 594 adult gypsy moth males were captured in 343 positive traps in NC in 2018. Positive catches were entered into the gypsy moth trapping database at Virginia Tech. Final results of these surveys are shown in Table 1 and in Figure 2.

Male moth captures in 2018 were lower than average and significantly lower than last year, which was a relatively average year. As expected, higher captures were along the Virginia-North Carolina border, probably due to pressure from mounting populations within the generally infested area to the north of those areas. One treatment and multiple delimiting grids are proposed for 2019 to follow up in high-capture locations.

Per 2018 USDA-APHIS-PPQ protocol as stipulated in the cooperative agreement (AP18PPQFO000C140), trapping surveys were conducted in the Eradication area (all non-STS

area) as shown in Figure 1. Delta traps were set in an area-wide grid of 1 trap per 3 kilometers, with some areas being trapped at one trap per 500 or 1000 meters if there was a suspected EGM population. Funding provided by USDA-APHIS-PPQ was used to employ 10 temporary employees, buy the necessary survey supplies (including traps, lures, iPad accessories, and office supplies), and for operational expenses (including fuel and maintenance for survey vehicles). Additionally, funding from USFS was used to hire two temporary employees who monitored traps close to areas treated in 2018 in the Eradication area, purchase supplies, and for operational expenses associated with this work.

In the STS area, 10 contractors set traps in 31 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. Two temporary personnel and three 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.

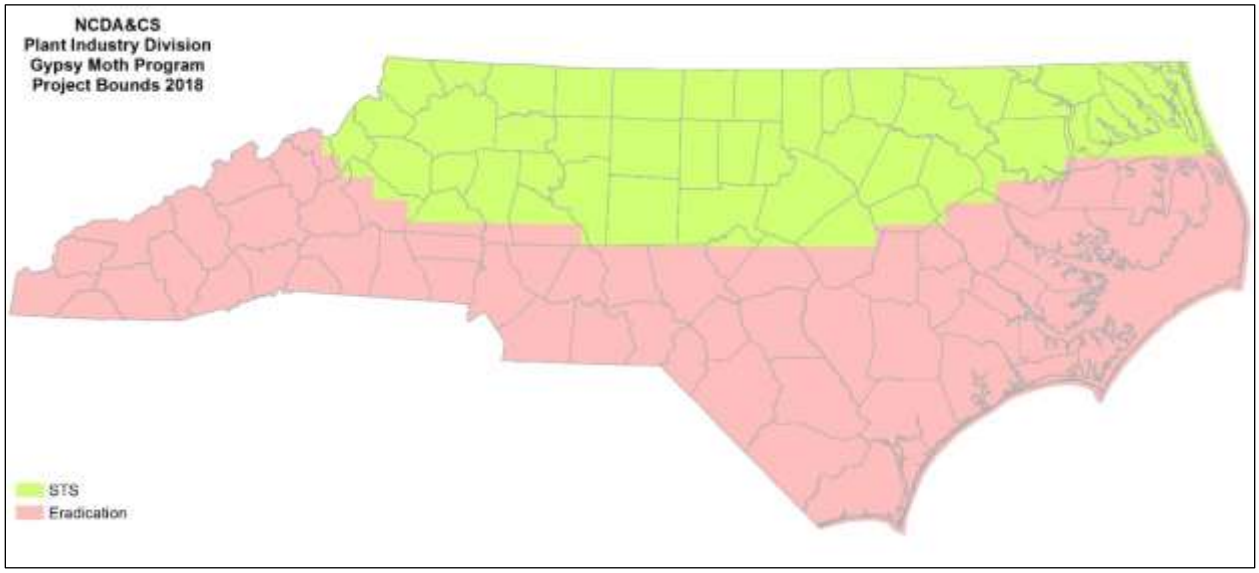

***Figure 1**. North Carolina Gypsy Moth Program Project Boundaries 2018.*

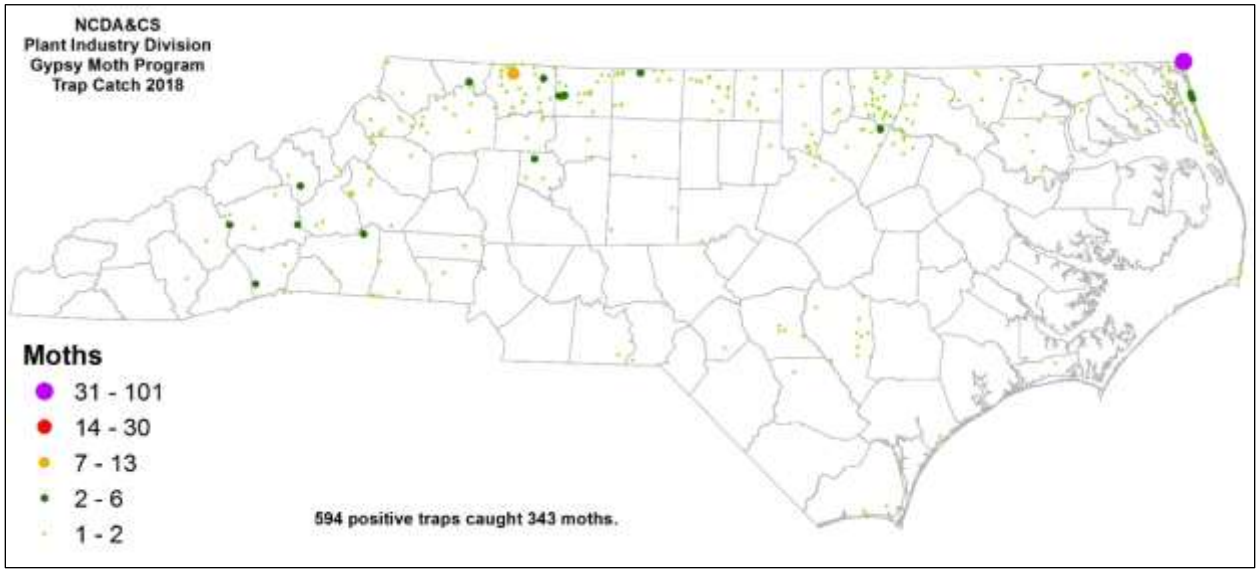

***Figure 2**. North Carolina gypsy moth trap catches in 2018.*

***Table 1**. 2018 survey results in NC showing total number of traps placed per county, number of positive traps for EGM in each county, and the total number of moths in those positive traps.*

County	Total Traps	Total Positive	Total Catch
Alamance	177	1	1
Alexander	78	1	1
Alleghany	216	4	6
Anson	145	2	2
Ashe	279	2	2
Avery	73	2	2
Beaufort	210	0	0
Bertie	305	8	8
Bladen	251	1	1
Brunswick	256	2	2
Buncombe	152	3	4
Burke	185	8	11

Cabarrus	99	0	0
Caldwell	142	2	3
Camden	138	4	5
Carteret	96	1	1
Caswell	387	12	12
Catawba	122	0	0
Chatham	198	1	1
Cherokee	63	0	0
Chowan	81	2	2
Clay	25	0	0
Cleveland	133	5	8
Columbus	263	0	0
Craven	167	0	0
Cumberland	184	4	4
Currituck	195	31	184
Dare	318	16	19
Davidson	171	1	1
Davie	116	3	5
Duplin	219	0	0
Durham	119	1	1
Edgecombe	149	0	0
Forsyth	271	1	1
Franklin	237	11	17
Gaston	122	1	1
Gates	265	3	3
Graham	8	0	0

Granville	325	7	7
Greene	76	0	0
Guilford	350	1	1
Halifax	449	7	8
Harnett	174	0	0
Haywood	99	2	6
Henderson	94	3	5
Hertford	224	3	3
Hoke	107	1	1
Hyde	116	0	0
Iredell	205	0	0
Jackson	73	1	2
Johnston	224	0	0
Jones	123	0	0
Lee	73	0	0
Lenoir	108	0	0
Lincoln	87	1	2
McDowell	74	4	7
Macon	47	0	0
Madison	88	0	0
Martin	129	0	0
Mecklenburg	166	0	0
Mitchell	48	0	0
Montgomery	90	0	0
Moore	203	0	0
Nash	237	8	9

New Hanover	64	1	1
Northampton	357	7	7
Onslow	173	0	0
Orange	178	1	1
Pamlico	96	0	0
Pasquotank	148	5	5
Pender	243	1	1
Perquimans	142	1	1
Person	255	6	6
Pitt	186	0	0
Polk	65	0	0
Randolph	224	2	2
Richmond	127	2	2
Robeson	268	0	0
Rockingham	582	15	22
Rowan	149	0	0
Rutherford	150	2	4
Sampson	276	10	11
Scotland	83	0	0
Stanly	117	0	0
Stokes	441	24	33
Surry	578	35	70
Swain	22	0	0
Transylvania	46	0	0
Tyrrell	54	0	0
Union	182	0	0

Vance	267	6	6
Wake	250	2	4
Warren	354	25	27
Washington	79	0	0
Watauga	196	10	12
Wayne	167	0	0
Wilkes	443	11	12
Wilson	114	0	0
Yadkin	260	4	4
Yancey	63	2	4
Total	**18,003**	**343**	**594**

Treatments

Eleven mating disruption treatments were conducted in North Carolina in 2018 totaling 118,165 acres, ten of which were in the STS area and the other at Buxton in Dare County (Figure 3 and Table 2). Nine sites received one dose of SPLAT Gypsy Moth-Organic at a rate of 6 grams per acre and two received a single dose at a rate of 15 grams per acre. These sites will be trapped in 2019 and 2020 to determine the efficacy of the treatments.

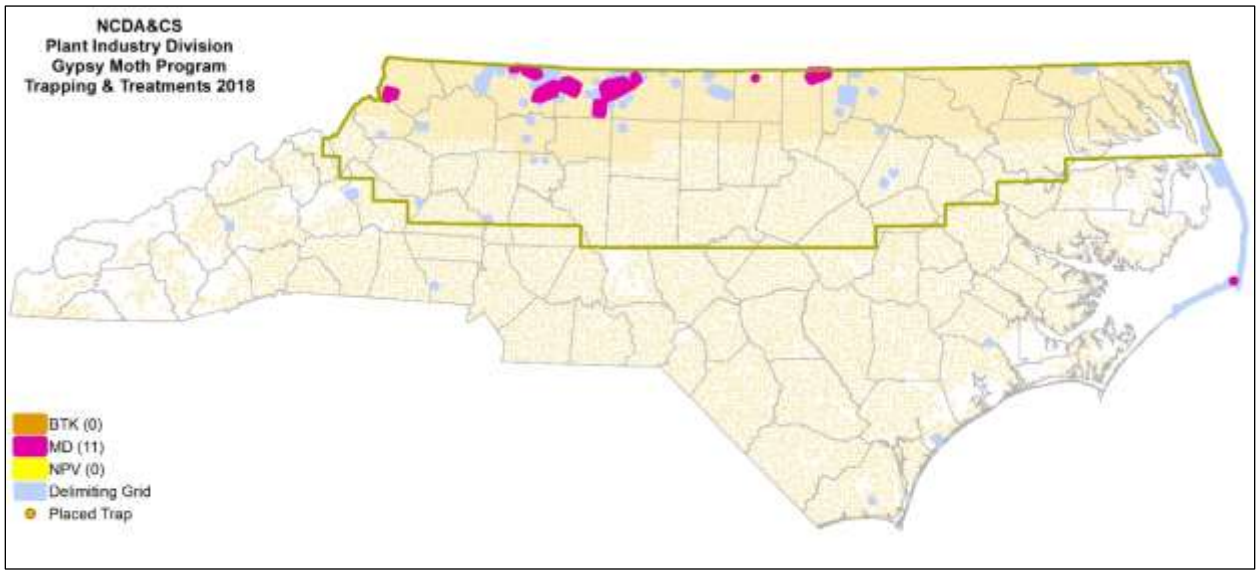

Figure 3. *2018 gypsy moth treatment sites along with delimiting grids and all other traps set.*

Site name	County	Product	Number of Applications	Acres in Block	Total Acres Treated at Site
Baldwin Gap_1	Ashe/Watauga	MD 6g	1	6800	6800
Belews Lake_1	Stokes	MD 6g	1	8478	8478
Buxton_1	Dare	MD 15g	1	389	389
Cana_1	Surry	MD 6g	1	1710	1710
Hanging Rock_1	Stokes	MD 6g	1	17195	17195
Mayodan_1	Stokes/Rockingham	MD 6g	1	35727	35727
Mount Airy North_1	Surry	MD 6g	1	8060	8060
Mount Airy South_1	Surry	MD 6g	1	20695	20695
Roxboro_2	Person	MD 15g	1	350	350
Southwest Eden_1	Rockingham	MD 6g	1	2080	2080
Stovall_1	Granville	MD 6g	1	16681	16681

Table 2. *2018 gypsy moth treatments, county, and acreage. For product, MD 6g = mating disruption at 6 grams per acre, MD 15g + mating disruption at 15 grams per acre.*

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 4.

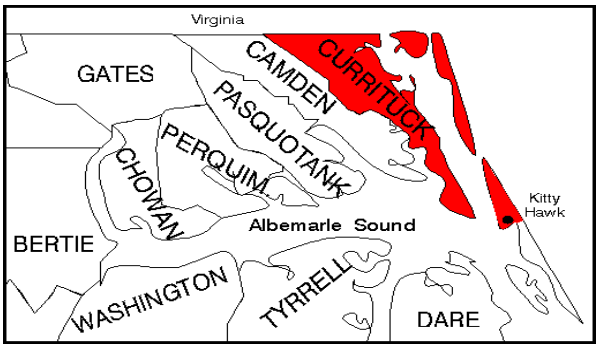

Figure 4. *Gypsy moth quarantine in North Carolina, shown in red.*

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. A number of 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.

BLUEBERRY CERTIFICATION PROGRAM

The blueberry maggot (Figure 1; *Rhagoletis mendax*; BBM) 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.

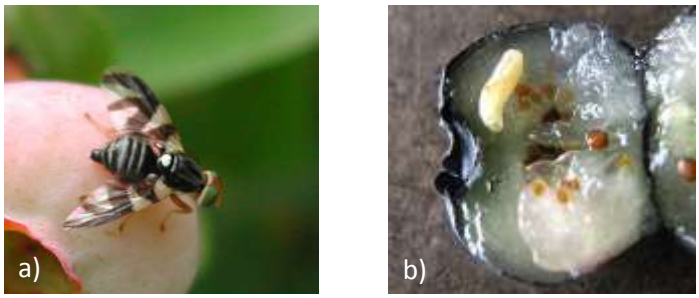

Figure 1. Blueberry maggot (*Rhagoletis mendax*): a) adult; b) larva inside blueberry (Photos by Rufus Isaacs, MSU)

In North Carolina, we currently have 53 blueberry farms located in four southeastern NC counties (Bladen, Duplin, Pender, and Sampson) participating in the Blueberry Certification Program. In May 2018, 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 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 2018 and plan to continue its use in 2019.

IMPORTED FIRE ANT PROGRAM

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

Blitzes and Surveys

Fire ant blitzes were conducted, as part of the IFA regulatory program in NC, in four locations across the state to enforce that operations moving regulated articles outside the quarantine area in NC are in compliance with federal and state regulations. A total of 24 blitzes were conducted in 2018: 20 in the Spring from 28 February-5 April and 4 in the Fall from 16-17 October at the weigh stations in Halifax (I-95 corridor in Halifax County), Lumberton (I-95 corridor in Robeson County), Mt. Airy (I-74 Corridor in Surry County), and Hendersonville (I-26 corridor in Henderson County) (Table 1). Due to Hurricane Florence in September 2018, a number of our planned Fall blitzes were cancelled as the highway weigh stations were temporarily shut down. Forty-nine vehicles (49) were stopped, of which 20 were stopped at the Halifax weigh station, 13 at the Lumberton weigh station, 10 at the Mount Airy station, and 6 at the Hendersonville weigh station. Drivers were asked if they were transporting IFA regulated articles and if yes, they were

asked to provide bills of lading, a copy of the relevant nursery license, and a regulatory official's letter stating they meet the requirements to move regulated material out of the Federal IFA quarantine area. One truck traveling from Florida to Virginia transporting baled pine straw was diverted back south to Atlanta, Georgia because the company shipping the material was unable to provide any paperwork indicating the shipment met the Federal IFA regulations for movement of regulated articles out of the quarantine area. Both the Virginia Department of Agriculture and Consumer Services and the Florida Department of Agriculture and Consumer Services were notified of the re-routed shipment.

Soil samples from 19 vehicles were collected and processed from regulated articles such as potted plant containers and trees and all samples were sent for chemical analysis (NCDA&CS Food and Drug Protection Division Laboratory) to determine the levels of bifenthrin or any other approved pesticides as required by the federal and state regulations. All but four 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. We investigated the non-compliant samples and determined them to not be of regulatory significance.

Drive-by surveys were conducted in 17 counties in NC in 2018 (Table 2). Data was collected using the Survey 123 app on iPads and included new IFA mounds and established sites. The category "Absent" was also included and indicates sites with no mounds reported. This was used as a way to show all areas surveyed (negative controls).

As a result of surveys conducted in 2017 & early 2018 within the state, the non-quarantined portions of Davidson, Orange, and Vance counties were added to the IFA quarantine at the end of 2018. Additional areas will be considered for quarantine expansion in 2019 utilizing the data collected from the 2018 surveys (Table 2).

TABLE 1. NC IMPORTED FIRE ANT BLITZES SUMMARY (2018)

Date	Location	Truck stopped	Soil samples collected	Trucks Diverted
28 February 2018	Halifax weigh station	5	3	0
1 March 2018	Halifax weigh station	2	2	0
7 March 2018	Halifax weigh station	6	5	0
8 March 2018	Halifax weigh station	7	1	1
15 March 2018	Lumberton weigh station	7	2	0
15 March 2018	Lumberton weigh station	6	0	0
28 March 2018	Mt Airy weigh station	6	3	0
29 March 2018	Mt Airy weigh station	4	2	0
4 April 2018	Hendersonville weigh station	2	1	0
5 April 2018	Hendersonville weigh station	4	0	0
17 October 2018	Mt. Airy weigh station	0	0	0
18 October 2018	Mt. Airy weigh station	0	0	0
Totals	**24[1]**	**49**	**19**	**1**

[1]Corresponds to 12 days and two blitzes per day.

TABLE 2. IFA SURVEY RESULTS (2018)

County	Areas Surveyed	Regulatory Action Recommended*	Absent	Established sites	New observation	Total
Alamance	10-mile strip from the 2018 quarantine line	No action	305	9	48	**362**
Alexander	10-mile strip from the 2018 quarantine line	No action	6		1	**7**
Buncombe	10-mile strip from the 2018 quarantine line	No action	7			**7**
Burke	5-mile strip from the 2018 quarantine line	Expansion 2020	8	1	10	**19**
Caldwell	5-mile strip from the 2018 quarantine line	No action	13		4	**17**
Davidson	5-mile strip from the 2018 quarantine line	Expansion 2019	205		72	**277**
Davie	5-mile strip from the 2018 quarantine line	No action	68	1	6	**75**
Granville	5-mile strip from the 2018 quarantine line	No action	29	1	11	**41**
Henderson	10-mile strip from the 2018 quarantine line	No action	4		1	**5**
Iredell	10-mile strip from the 2018 quarantine line	No action	20		3	**23**
Jackson	10-mile strip from the 2018 quarantine line	Add 2020	5		9	**14**
Madison	Along the Tennessee border	No action	2		1	**3**
McDowell	10-mile strip from the 2018 quarantine line	No action	7		1	**8**
Orange	10-mile strip from the 2018 quarantine line	Expansion 2019	156	2	27	**185**
Person	5-mile strip from the 2018 quarantine line	No action	47		5	**52**
Transylvania	10-mile strip from the 2018 quarantine line	No action	4		1	**5**
Vance	10-mile strip from the 2018 quarantine line	Expansion 2019	137		21	**158**
Total			**1023**	**14**	**221**	**1258**

*"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.

COTTON BOLL WEEVIL PROGRAM

Field surveys for the cotton boll weevil (*Anthonomus grandis*) were coordinated and carried out by the NC Cotton Boll Weevil Foundation. In 2018, a total of 419,230 acres were reported in 57 counties (Table 1). Plant Industry Division personnel surveyed cotton gins and cotton processing facilities (n=65) in 36 counties using conventional cotton boll weevil traps, similar to those used for sweetpotato weevil field surveys (Table 2). Traps were baited with a male specific sex pheromone and checked once a month.

TABLE 1. COTTON ACREAGE BY COUNTY (2018)

Anson	2,140.6200	Greene	6,680.6000	Pamlico	1,097.0400
Beaufort	10,982.43	Halifax	56,812.0480	Pasquotank	545.4400
Bertie	26,962.815	Harnett	6,724.9700	Pender	682.7450
Bladen	6,236.4900	Hertford	12,696.8470	Perquimans	9,556.4592
Brunswick	211.7400	Hoke	5,296.0630	Pitt	11,217.2139
Cabarrus	409.8100	Hyde	8,064.8170	Richmond	2,327.1900
Camden	409.7200	Iredell	0.0000	Robeson	15,193.0118
Carteret	465.6100	Johnston	4,563.7310	Rowan	420.7100
Chowan	9,938.8700	Jones	10,012.6900	Rutherford	0.0000
Cleveland	0.0000	Lee	0.0000	Sampson	12,980.1930
Columbus	3,045.2400	Lenoir	11,836.2525	Scotland	4,442.9720
Craven	8,198.7450	Lincoln	138.7100	Stanly	12,340.1989
Cumberland	5,626.7238	Martin	28,774.8474	Tyrrell	5,636.3370
Davidson	396.0000	Mecklenburg	0.00000	Union	1,092.4800
Duplin	5,836.5750	Montgomery	169.81000	Wake	87.9000
Edgecombe	18,563.2612	Moore	245.7400	Warren	275.2800
Franklin	208.9300	Nash	11,281.2200	Washington	6,597.3213
Gates	13,571.9400	Northampton	37,875.2690	Wayne	9,009.3170
Granville	0.0000	Onslow	4,915.4450	Wilson	6,433.6855

	Total	**419,230.07**

TABLE 2. NUMBER OF COTTON GINS/SITES SURVEYED BY COUNTY (2018)					
Anson	1	Forsyth	1	Nash	1
Beaufort	1	Gates	1	Northampton	4
Bertie	2	Greene	1	Pasquotank	3
Bladen	1	Guilford	1	Perquimans	1
Camden	1	Halifax	10	Pitt	2
Chowan	3	Hertford	1	Robeson	2
Craven	1	Hyde	1	Rowan	2
Cumberland	1	Jones	1	Sampson	3
Currituck	2	Lenoir	1	Stanly	1
Duplin	1	Martin	1	Wake	1
Durham	1	Mecklenburg	2	Wayne	2
Edgecombe	5	Moore	1	Wilson	1

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.

MOVEMENT OF LIVE INSECTS FOR RESEARCH, COMMERCIAL OR EDUCATION PURPOSES

The Entomological Programs Manager evaluated 96 federal applications for PPQ 526 e-Permits in 2018. No permits were rejected this year. 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 2018
Emerald Ash Borer (*Agrilus planipennis*)	The e**ntire state** of North Carolina was placed under quarantine in 2015.
Gypsy Moth (*Lymantria dispar*)	**Currituck County.** Quarantine area remained unchanged relative to 2017.
Imported Fire Ant (*Solenopsis invicta*)	The quarantine was expanded to include the entirety of Catawba, Northampton, Rowan, and Rutherford counties and a portion of Burke County. A total of **75 counties** are under entire or partial quarantine in NC.
Sweetpotato weevil (*Cylas formicarius*)	Coastal areas of **Brunswick** (Caswell Beach) and **New Hanover** (Carolina Beach and Kure Beach) counties.
Walnut Twig Beetle (*Pityopthorus juglandis*)	**Haywood County.** Quarantine area remained unchanged relative to 2017.

Nursery Certification Program

NCDA&CS' Plant Protection Specialists inspected 3,168 nursery dealers and nurseries during the 2018 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 1,125 nurseries and 2,043 nursery dealers during the 2018 calendar year (Table 1). Of the 1,125 nurseries, 515 were registered nurseries and 610 were certified nurseries. A *registered nursery* has less than one acre of nursery stock and does not sell outside the state. A *certified nursery* has one or more acre of nursery stock and/or sells outside the state.

The data show a slight decrease in the number of nurseries and the number of acres that were certified. This decrease may be a result of loss of smaller producers due to age and an increase in chain stores selling nursery stock throughout the state which provides convenience and typically lower prices to retail customers. The nursery dealer industry also decreased, potentially for the same reasons. Despite these decreases, the stability in nursery production as well as nursery dealer locations indicates the strength and staying power of North Carolina's nursery industry.

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

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

[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). Currently, most stop sale/movement notices are issued for box blight (*Calonectria pseudonaviculata*) on cut greenery and for sweet potatoes originating from a state or region quarantined for Sweet Potato Weevil (*Cylas formicarius*), however any presence of agricultural risk of regulatory or non-regulatory nature may facilitate the need to take Stop Sale/Movement regulatory action.

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 2018, NCDA&CS staff issued 7,762 federal phytosanitary certificates and 951 state phytosanitary certificates. The number of federal phytosanitary certificates issued in 2018 represented a 3.4% decrease from 2018 figures while the number of state phytosanitary certificates issued represented a 63.9% increase from the previous year. The increase in state phytosanitary certificates was due in part to newly enacted Tennessee regulations for boxwood shipments and the Louisiana *Meloidogyne enterolobii* quarantine as well as inspections related to a special project timber harvest for the pipeline installation at the Virginia border. Federal certificates were issued for the movement of commodities to 88 countries, while state certificates were issued for 44 states, Puerto Rico, and the Virgin Islands. Most phytosanitary certificates issued were for lumber, logs, tobacco, cotton, cotton seed, Christmas trees, peanuts, nursery and greenhouse plants, sweetpotatoes, and sweetpotato cuttings. In 2018, 65% of all federal phytosanitary certificates were issued for commodities traveling to China and Vietnam.

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

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

PLANT CONSERVATION ANNUAL REPORT 2018

NORTH CAROLINA PLANT CONSERVATION BOARD

The Plant Conservation Program meets quarterly with members of the NC Plant Conservation Board whose seven members are appointed by the Governor and the Commissioner of Agriculture. Members in 2018 included: Damon Waitt (chair) Les Hunter, Julie Moore, Alexander Krings, David Hyatt, Jonathan Lanier, and Bruce Williams.

In 2018, the Board developed and approved a civil penalty structure for ginseng poaching violations so that settlement isn't arbitrary and capricious with logic that could be argued in court. This penalty assessment is a mechanism by which the Board enforces the existing law § 106-202.19 (Unlawful acts; penalties; enforcement) which states that a civil penalty of not more than two thousand dollars ($2,000) may be assessed by the Board against any person guilty of violating this Article a second or subsequent time. The clear proceeds of civil penalties assessed pursuant to this subsection shall be remitted to the Civil Penalty and Forfeiture Fund in accordance with G.S. 115C-457.2. The Board moved to assess $1,000 penalty for second offense and $2,000 for third offense regardless of quantity of roots (law states it must be a second offense before a penalty is assessed).

NORTH CAROLINA PLANT CONSERVATION SCIENTIFIC COMMITTEE

PCP meets regularly with members of the NC Plant Conservation Scientific Committee. This seven-member committee consists, primarily, of positions designated to the committee by law. Members include Alan Weakley (chair), Dennis Niemeyer, Richard Braham, Johnny Randall, Hervey McIver, Laura Robinson and Jerry Reynolds.

The Committee continued work on updating the NC protected plant list following procedures and protocols established during the last update in 2008. The Committee will suggest additions, deletions, and technical changes to the Board once an established subcommittee (consisting of PCP, NHP and UNC) completes necessary analyses and ensures a thorough review of any changes to trends and threats of individual imperiled species.

PLANT CONSERVATION PRESERVE SYSTEM

PCP and Board have the regulatory authority to establish Plant Conservation Preserves to protect imperiled plant species. These Preserves are the only state-managed lands selected and designed specifically for plant conservation purposes. The Preserve system now consists of 25 Preserves distributed across North Carolina (Figure 1). One new Preserve was added in 2018, the Suther Prairie Preserve in Cabarrus County along with additional acres added to the Tater Hill Preserve in Watauga County.

The Cabarrus County Soil and Water Conservation District (SWCD) was awarded state grant funding in 2015 to acquire the Suther Wet Prairie in Cabarrus County. PCP staff have been working with Cabarrus County SWCD staff to facilitate this acquisition. In October 2018, the deed was recorded and transferred to the State to be dedicated for permanent protection as a new PCP Preserve. This 78-acre site contains a six-acre wet meadow with two protected plant species, the red Canada lily (*Lilium canadense* ssp. *editorum*) and small sundrops (*Oenothera perennis*).

Approximately 200 acres were added to the eastern side of Tater Hill PCP Preserve in May 2018. This addition adds exceptional habitat and improves the boundary of the preserve to better include the Harmon Knob amphibolite mountain feature. PCP continues to work with the land owners, the NC Natural Heritage Program, and the NCDA&CS Property and Construction Office on a Tater Hill boundary adjustment. This boundary adjustment will result in no net loss of preserved acreage but will increase the conservation value of the preserve. PCP is seeking the most parsimonious adjustment that provides the best protection for the Gray's lilies (*Lilium grayi)* and results in a fair land trade for both parties involved.

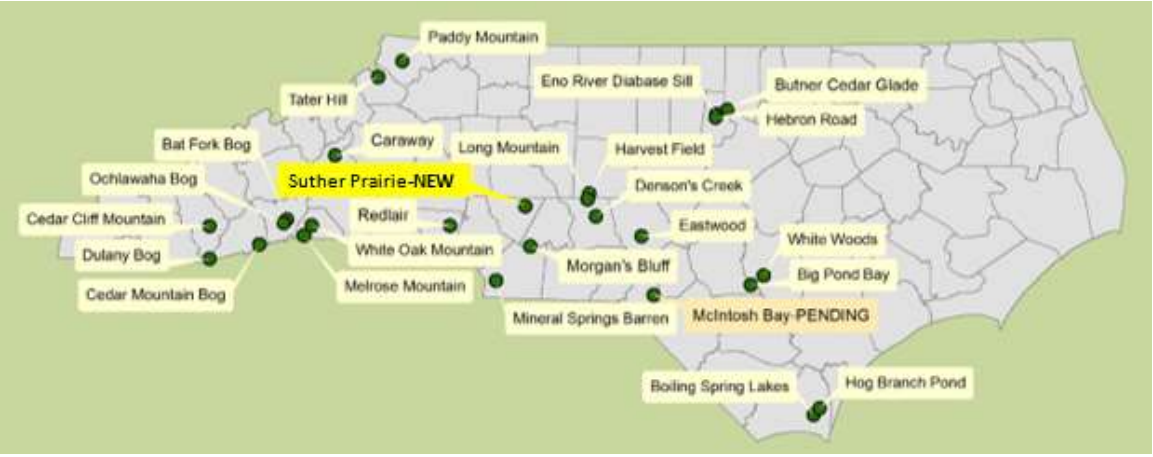

Figure 1. PCP Preserve System

Another property is pending acquisition into the Preserve System and is currently in the due diligence closing procedures process. McIntosh Bays is a collaborative project between The Nature Conservancy (TNC) and PCP whereby TNC has purchased the property from the private land owner and throughout 2018 was in the process of conducting restoration activities before selling the property to PCP as a new Preserve. This site is home to eight protected plant species plus an extirpated record of federally endangered Canby's dropwort (*Oxypolis canbyi*). This project is expected to close in 2019.

PCP is also working on an acquisition for another addition to the Paddy Mountain Preserve in Ashe County in partnership with Blue Ridge Conservancy. This project would increase the preserve by 71 acres, providing additional protection to two federally listed plant species, Heller's blazing star (*Liatris helleri*) and mountain bluet (*Houstonia montana*), along the existing western preserve boundary. Blue Ridge Conservancy submitted a funding proposal to the Clean Water Management Trust Fund in early 2018 to purchase this tract and intends to transfer the property to the state to become part of the Paddy Mountain PCP Preserve. This funding request was selected for approval in November 2018 and procedures for acquisition and transfer to the state will occur in 2019.

PRESERVE FIELD TRIPS

PCP staff's outreach efforts included public lectures, preserve field trips, and volunteer workdays. Due to concerns about resource damage and plant poaching, PCP conducts guided preserve tours

open to the public. Access by researchers and educators is by permit only. Each trip provides participants the opportunity to observe rare plants, while also learning more about land management and ecological stewardship. Staff scheduled tours/workdays on preserves in 2018 and responded to various requests for public presentations. Nine guided tours were conducted at Picture Creek Diabase Sill, Mineral Springs Barren, Caraway, Redlair, Eno River Diabase Sill and the pending McIntosh Bays preserve, reaching citizens across the state. One additional scheduled preserve tour was unfortunately cancelled due to bad weather at Tater Hill Preserve.

PARTNERSHIP & OUTREACH PROJECTS

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

In addition, staff regularly reaches out to the public with special presentations and by filling information requests. In 2018, staff gave presentations across the state for festivals such as Fire in the Pines and groups like the Native Plant Society, NatureServe's Southeast Biodiversity Forum, NC Botanical Garden and for the Friends of Plant Conservation programs.

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

CLEAN WATER MANAGEMENT TRUST FUND

PCP staff did not prepare grant applications to the Clean Water Management Trust Fund (CWMTF) in 2018. However, we were represented in partner applications for fee simple purchases that would be transferred to PCP as new Preserves or additions to Preserves. In 2018, PCP partners submitted one application to CWMTF which received funding. PCP staff worked closely with the NCDA&CS Property and Construction Office to carry out previously awarded grant contracts with closings occurring at Tater Hill and Suther Prairie and progress made on each of the remaining contracts. Active contracts in 2018 include:

- Additional property acquisition at Tater Hill Preserve (Watauga Co.)
- Additional property acquisition at Paddy Mountain Preserve (Ashe Co.)
- Boundary adjustment at Tater Hill Preserve (Watauga Co.)
- New preserve acquisition at McIntosh Bays (Scotland Co.)
- New preserve acquisition at Suther Prairie (Cabarrus Co.)

UNITED STATES FISH & WILDLIFE SERVICE (USFWS) PARTNERSHIP

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

USFWS REVERTED FUNDS GRANTS

Intermittently, USFWS offers grant opportunities for reverted Section 6 funds to cooperating states, this regional and national competition awards funds to high priority conservation projects. This year for the first time, USFWS was seeking proposals that would implement highest priority recovery actions, the Recovery Challenge grant program. In August 2018, PCP submitted a

proposal to develop 9 management plans for protected populations in the PCP preserve system. While this proposal was not selected for funding, it laid the groundwork for future funding opportunities.

PCP did receive funding in January for the USFWS reverted funds grant entitled: "*Reintroducing Two Federally Listed Wetland Species (White fringeless orchid, Platanthera integrilabia & Canby's dropwort, Oxypolis canbyi)".* With this grant, PCP proposed site preparation and reintroduction efforts at Bat Fork Bog Preserve and McIntosh Bays Preserve to restore listed species which have been lost not only to these sites, but all of North Carolina. A target donor population was identified in Tennessee to collect seeds to propagate for reintroduction. Professor Lawrence Zettler from Illinois College, had been keeping several seeds from that Tennessee population in cold storage for years. As an experiment, he tests germinated the seeds with *mycorrhiza* from a South Carolina site and all the seeds were successfully germinated. By March 2018, he had grown out 22 seedlings in soil collected and mailed to him from the Bat Fork Bog Preserve. In June, the Scientific Committee approved the white fringeless orchid reintroduction plan. This plan received final approval in July from USFWS with the addition of several benchmarks for success. This summer, PCP set up a contract for invasive control of privet, bittersweet and multiflora rose in the areas planned to transplant the orchid. In October, USFWS and the Atlanta Botanical Gardens (ABG) had a successful seed collection trip to that population in Tennessee. They collected 1-2 capsules from each of 207 plants. All the material was taken back to Atlanta where they plan to grow them using an a symbiotic aseptic in vitro method. We will design this reintroduction so that the fates of these two sets of plants (the ones grown by ABG vs. Illinois college) can be compared. Staff are currently identifying sites for reintroduction in anticipation of a 2019 planting, this grant runs through December 2019.

The other species listed on this grant is Canby's dropwort. This plant is also extirpated in NC, with the only known pop last observed in 2004 at McIntosh Bays in Scotland County. There are no known safeguarded material from this population. So, PCP proposed to develop a management plan at this site and reinitiate annual monitoring for this species for 5 years. We're hoping this monitoring will allow us to see it reemerge in response to already ongoing restoration. If it does not, PCP has identified a donor population in South Carolina for propagation and augmentation. If this species does reemerge naturally, then propagated individuals would be returned to their

parent populations. In 2018, staff visited the site in August for removal of weedy hardwoods and monitoring for reemergence of the dropwort.

REGULATORY PROGRAMS

PCP is responsible for the protection and conservation of 419 plant species across NC, of which 27 are also federally listed. Staff meets quarterly 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 the state. This permit requirement applies to transplant and rescue projects, nurseries which propagate and sell protected species, public educational exhibits, as well as many scientific research projects. The review process incorporates input from the US Fish and Wildlife Service and NC Natural Heritage Program. Twenty-two protected plant permits were issued and several additional requests were evaluated during 2018. 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 2018. PCP staff continued to monitor repatriated plants on PCP Preserve land which had been confiscated from poachers. The USFWS was petitioned by a private individual in 2016 to list this species federally. PCP was not involved in this petition process but became aware of it in collaboration with USFWS. In December 2017, the USFWS 90-day finding decided this species presented substantial scientific or commercial information to indicate that the petitioned actions may be warranted. This warranted finding sets in motion the process to further review the species with a Species Status Assessment which is an analytical approach developed by the Service to deliver foundational science for informing all Endangered Species Act (ESA) decisions. After that, a 12-month finding is reported, a decision regarding whether the species warrants listing under the ESA. In addition, a species status survey has been funded and will be conducted by the NC Natural Heritage Program in 2019-2020.

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 5,910 pounds of calculated dry/wild collected ginseng during the 2017 - 2018 season representing 29 North Carolina counties. A total of 44 ginseng dealer license permits were issued during the 2017 - 2018 season.

Galax

The sale of wild-collected Galax (*Galax urceolata*) is regulated in North Carolina within a stated buying season which prohibits harvest during the early growing season to allow for new leaves to emerge and grow. Similarly, the US Forest Service which allows for this plant to be harvested from some national forests, also has a harvest ban during the early growing season. In an effort to align these two seasons to eliminate confusion, the PCP Board changed the state buying season to match that of the USFS. Effective January 20, 2016, 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 striving to manage Preserves for the benefit of the rare plant species and habitats present on these sites and to conduct sufficiently detailed monitoring to determine the status of rare species at these sites. Some examples are as follows:

Controlled Burning Program

Prescribed burning is one the most pressing management needs across the Preserve system and around NC to enhance rare species populations and improve habitats for these species. Following new procedures effective in 2017, staff were able to conduct prescribed burns at over 500 acres across 9 preserves and 2 partner properties with the direct assistance of the NCFS during this past

year. 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 further collaboration for the upcoming year.

Preserve Highlights:

Bat Fork Bog Preserve (Henderson Co.): Staff continued efforts to develop a treatment plan for optimal herbicide control methods for the highly invasive reed canary grass (*Phalaris arundinacea*). Over the winter 2017-2018, PCP learned of a NC Department of Transportation pilot program to use a drone to apply herbicide to invasive species. Staff coordinated with colleagues at NCDOT to find NCDA&CS sites that fit certain parameters for drone application. This included open fields with little canopy and a non-selective herbicide application, in other words, where a monoculture of an invasive plant existed. Bat Fork Bog fit these site parameters and PCP was excited to be included as a site for the first application of this newly emerging technology! Over the winter, NCDOT contractors obtained the required Federal Aviation Administration (FAA) and NCDA&CS licenses and certifications. They were the first drone to have been issued a NCDA pesticides contractor's license in NC. A June drone application was planned in parts of the field that were inaccessible by ATV and backpack spray methods due to inundated conditions. PCP and Support Operations staff were encouraged to see quick results from the initial treatment in June, with no *Phalaris* resprouting throughout 2018. The subsequent treatments in July, August and September focused on areas unreachable during the first treatment, resulting in approximately 90% of the total impacted area being treated in 2018. PCP will monitor resprouts in the spring of 2019 and plan additional treatments with Support Operations staff in the hard to reach parts of the property. Part of the long-term goal for this preserve is to restore the artificial meadow to a swamp forest like the adjacent areas of the preserve and to restore habitat for the existing and extirpated protected plant species known to this site.

Boiling Spring Lakes & Hog Branch Ponds (Brunswick Co.): The use of mechanical mulching and midstory removal continued in 2018 to restore longleaf pine savannas and pond pine flatwoods which have become heavily overgrown with shrubs. In many cases, the mulching machine is used to prepare burn units to allow for a safer controlled burn by removing ladder fuels and thus reducing the fire intensity.

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

Eno Diabase Sill Preserve (Durham Co.): Staff spent time thinning the midstory here to open the canopy and facilitate effective prescribed burns. Staff and volunteers performed extensive control activities to reduce invasive species such as Japanese stilt grass, sericea lespedeza (*Lespedeza cuneata*), and Queen Anne's lace (*Daucus carota*) as well as numerous other invasive plants. More than a mile of fire line was refreshed in preparation for burning the site. Prescribed burns were conducted over eleven acres on two partner tracts to improve habitat for imperiled species.

Since discovering the Michaux's sumac (*Rhus michauxii*) population in 2014, PCP staff and stewards have annually examined the flowers and except for a few perfect flowers, only male plants had been observed. However, in 2017, Preserve Stewards Herb and Pat Amyx found five plants in fruit (females). Mature fruits were collected and sent to the NC Botanical Garden for propagation during 2018 and eventual population augmentation. Although PCP is managing this population, the plants are growing in the right-of-way of a defunct railroad, not within the property boundary of the PCP preserve. PCP staff are hopeful that this population will expand into the protected property where we can better manage them and their habitat. Given that very few Piedmont populations of Michaux's sumac have both male and female plants, the possibility of having some natural regeneration at this protected site is especially encouraging.

In late summer, twenty federally endangered smooth coneflower plants (*Echinacea laevigata*) propagated from seed collected at the Preserve were planted back on site to augment the existing population along with hundreds of seeds collected, cleaned and then sown back on site following the spring burn.

Hebron Road (Durham Co.): Control lines for upcoming prescribed burns were installed around a small portion of the Preserve and existing lines were refreshed for a 6-acre burn accomplished in April. Efforts to control invasive exotic species were conducted by staff, focusing primarily on Japanese stilt grass and hairy jointgrass (*Arthraxon hispidus*).

Pondberry Bay Preserve (Sampson Co.): Two culverts and several hundred feet of roads were destroyed during Hurricane Matthew and further exacerbated during Hurricane Florence this year. In 2018, PCP collaborated with Support Operations staff to complete the install of replacement culverts and install erosion control devices. Additionally, a 22-acre controlled burn was accomplished in February to remove dense layers of duff and reduced some of the shrubby competitive growth encouraging restoration efforts within the longleaf pine community type.

Redlair (Gaston Co.): PCP Staff and volunteer steward Haywood Rankin worked to control invasive species such as wisteria, Chinese privet, autumn olive (*Elaeagnus umbellata*), Japanese stilt grass, and hairy jointgrass across the Preserve. Planning was initiated with the stewardship committee devoted to advising PCP staff on management of this Preserve to grow native woody plants to restore areas following treatment for heavy invasive plant infestations.

In conjunction with the Redlair Stewardship Committee and the Redlair Foundation it was decided to start development of this Preserve as a research station called the Redlair Observatory. The Department signed an MOU with UNC Charlotte in December that is a management agreement which outlines responsibilities of each party. The first research project that will begin this year is funded from a Duke Energy Water Resources grant that seeks to increase knowledge regarding streamflow and groundwater at the Redlair Preserve as well as the surrounding watershed. It will study how water quality and quantity is being impacted by invasive exotic plant species. Data will be available for researchers, planners, land managers and educators - providing long-term research into undeveloped watersheds adjacent to the rapidly growing urban areas of Charlotte and Gastonia.

Cedar Mountain Bog (Transylvania County): Swamp pink is a federally listed species and was historically reported observed at Cedar Mountain Bog. No one has observed the plant there since 2006. In 2015, a plan was derived to reintroduce the species following intense site rehabilitation. Source seeds were collected from a neighbor's property and propagated at the Atlanta Botanical Gardens (ABG). The Scientific Committee approved the reintroduction plan in September 2017. The site was burned in April of this year and finally in June, PCP reintroduced 57 of those three-and-a-half-year-old plants at five microsites along the interior edges of the bog. Partners from the ABG and USFWS were also in attendance. There were more plants that the ABG grew out, approximately fifty were kept back to reintroduce at later date to account for stochastic events.

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 2018, census and/or population monitoring work was conducted for the following federally listed species:

- Bunched arrowhead (*Sagittaria fasciculata*) - Henderson Co. (2 sites)
- Swamp pink (*Helonias bullata)* - Henderson, Transylvania Cos. (8 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 purpurea* var. *montana*) - Transylvania Co. (1 site)
- Montane purple pitcher plant (*Sarracenia jonesii*) - Transylvania Co, (1 site)
- Heller's blazing star (*Liatris helleri*) - Ashe Co. (1 site)
- Gray's lily (*Lilium grayi*) - Watauga Co. (1 site)

A qualitative assessment of bunched arrowhead indicates a stable or increasing population at Bat Fork and Ochlawaha Bog Preserves. PCP and National Park Service staff used NPS developed protocol to tag and collect population data at the Heller's blazing star occurrence at Paddy Mountain Preserve. A census of five smooth coneflower populations was conducted as part of an ongoing project to determine population trends for this species in North Carolina. Flowering trends for Schweinitz's sunflower, are relatively stable to apparently increasing across PCP Preserves. Flower production among mountain sweet pitcher plant and purple mountain pitcher plant populations was monitored at Cedar Mountain Bog Preserve. The Dulany Bog site had a new record of montane purple pitcher plant documented in 2017*;* the plants were previously only known to the portion of the site owned by the Highlands Biological Foundation. PCP will continue to monitor this site to document new natural recruitment. The swamp pink population adjacent to the Bat Fork Bog Preserve was monitored—this population grows on a parcel PCP is funded to purchase to provide better protection to this species as well as additional patches of bunched arrowhead.

Lastly, at Tater Hill Preserve, monitoring occurred for Gray's lily and wood lily this year. Evidence of lily leafspot disease was observed and confirmed with laboratory testing. PCP has coordinated with NC Botanical Garden staff to begin planning a seed collecting effort next year given the very low seed production rate due to early dieback caused by lily leafspot disease.

Additional rare plant surveys/monitoring conducted this year:

- Canby's dropwort (*Oxypolis canbyi*) - Scotland Co. (1 site)
- Northern Oconee bells (*Shortia galacifolia var. brevistyla*) - McDowell Co. (1 site)
- Michaux's sumac (Rhus michauxii) - Durham Co. (1 site)
- Canada lily (*Lilium canadense* ssp. *editorum*) - Henderson Co. (1 site)
- Sandhills Lily (*Lilium pyrophilum*) - Moore Co. (1 site)
- Buffalo clover (*Trifolium reflexum*) - Granville Co. (1 site)
- Pursh's wild petunia (*Ruellia purshiana*) - Durham Co. (1 site)
- Reticulate nutsedge (*Scleria reticularis*) - Scotland 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 travel from Wake County to participate in a panoply of activities including, but not limited to, prescribed burn preparations, trash pick-up, invasive species control, seed plot establishment, seed collection, leading guided tours, etc. Herb and Pat Amyx are heading up augmentation efforts for smooth coneflower, state Endangered tall larkspur (*Delphinium exaltatum*), and state Threatened smooth aster (*Symphyotrichum leave var. 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 Bat Fork Bog (Henderson Co.) volunteer steward, Tom Baugh, performed a variety of monitoring duties at the Preserve. He assisted in improving the understanding of the spatial extent and spread of imperiled and invasive species on the Preserve.

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 leads tour groups and permitted researchers at this large preserve on behalf of the PCP Staff, increasing our capacity for engaging the public at this site.

The Cedar Mountain Bog (Transylvania Co.) volunteer steward, Torry Nergart, Conservation Easement Manager with Conserving Carolina (CC), a long-time partner of PCP in the southern mountain region, was a tremendous help to PCP staff this year. He recruited and led volunteers on management workdays to remove invasive plants. Torry also helped provide updates on imperiled plant fruit ripening at the preserve to facilitate in a seed collecting project with the NC Botanical Garden for long term ex situ conservation. PCP hopes to deepen the collaboration between our office and CC for advertising volunteer stewardship activities.

The Tater Hill Preserve (Watauga Co.) volunteer steward, Matt Estep who is a professor at Appalachian State University researching evolution and population genetics of rare plants, has been 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. Matt is also an invaluable resource for connecting with other neighbors in the small community who live along Replogle Drive.

Eastwood Preserve (Moore Co.) volunteer steward, Jeff Marcus, NC Longleaf Pine Restoration Director for The Nature Conservancy, began stewarding at this site at the end of 2018. Already he 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.

NCDA&CS Plant Pathology Program

Report for period January 1, 2018 through December 31, 2018

Boxwood Blight

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.

Cut greenery issue

Boxwood greenery is a common component of holiday wreaths and garlands. The process of individuals going from field to field to cut this greenery is a pathway for the spread of boxwood blight. In addition, using infected greenery in holiday decorations provides a pathway by which the disease can spread into home landscapes. Infected greenery originating in North Carolina was detected in Florida in November of 2018 on boxwood wreaths. This find sparked an investigation on the NC producer and all states that potentially received infested material as well were notified immediately. The home office for the retail location for the sale of these wreaths and the producer were also notified the day we received the Florida detection correspondence.

Fungus Report on *Ruscus*

USDA identified the first report of the fungus *Phaeosphaeriopsis glaucopunctata* in *Ruscus* in the United States found in a nursery in North Carolina. An immediate Stop Sale/Movement was issued for all *Ruscus* at the nursery while an investigation was completed by NCDA&CS- Plant Industry Division and USDA-APHIS-PPQ. USDA-APHIS-PPQ completed a risk analysis

and determined the pathogen is not of actionable concern and in Great Britain and Ireland *P. glaucopunctata* is "almost always present where the host plant is located" (Cannon 2019). *Ruscus* is the only reported host plant. All *Ruscus* at the originating nursery are on hold while in-house research trials are completed. These plants will be inspected regularly by NCDA&CS – Plant Protection and none can be sold until the plants have cleared the regulatory screening process.

Sudden Oak Death (SOD)

Survey – see CAPS section

Recurring positive location

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

Trace-forward/trace-back notifications

USDA-APHIS-PPQ notifies NCDA&CS when a nursery in another state has plants test positive for *Phytophthora ramorum* infection. If the positive nursery has recently sent host plants to NC, a trace-forward event occurs, the plants in question are inspected, and possible regulatory action is taken. No trace-forward notifications occurred in 2018.

Guava Root Knot Nematode (*Meloidogyne enterlobii*)

Guava Root Knot Nematode (GRKN) is a tropical 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, soil, used equipment and any other article that could spread GRKN. These regulated articles can move without restriction in North Carolina. On October 10, 2018 Louisiana issued a GRKN quarantine for Florida, North Carolina and South Carolina which prohibits the movement of sweet potatoes and plants for planting or consumption from these states. The quarantine sates sweet potato seeds can move under a special permit issued by the Louisiana Department of Agriculture. On December 28, 2018 Mississippi issues a similar quarantine for all three states as well.

November 5, 2019 NCDA&CS began an official statewide survey for GRKN. The survey will conclude in March 2019 and will be comprised of more than 2000 samples taken from at least 900 fields. At this time, there are 7 known counties where GRKN occurs: Edgecombe, Greene, Harnett, Nash, Sampson, Wayne, and Wilson.

Miscellaneous

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

Thousand Cankers Disease

Thousand Cankers Disease threatens eastern black walnut (*Juglans nigra),* a high value, ecologically, and culturally important tree species in North Carolina. The disease is caused by a fungus, *Geosmithia morbida*, spread by the walnut twig beetle (*Pityophtorus juglandis* Blackman (Coleoptera: Scolytidae)) and can kill trees in as few as three years once symptoms appear. Thousand cankers disease may also infect butternut trees (*Juglans cinerea*).

In 2018, NCDA&CS received federal Farm Bill funding to conduct surveys for the walnut twig beetle and thousand cankers disease. Surveys spanned across 18 counties in North Carolina. Trapping occurred predominately in western and central areas of the state where black walnut

occurs in greater numbers. Special focus was placed around Haywood County, the only location in the state where TCD is known to occur and a quarantine is in place. A total of 36 Lindgren multi-funnel traps were set in June 2018. Samples were collected every two weeks for eight weeks. No walnut twig beetles were detected, to date.

White Pine Blister Rust

White Pine Blister Rust regulations prohibit the growing of *Ribes* species (currants and gooseberries) in NC because *Ribes* spp. are necessary alternate hosts to the white pine blister rust pathogen, *Cronartium ribicola*. The regulations were put in place to protect the white pine industry. Re-evaluation of this regulation occurred in 2018. Consultation with representatives from the NC Forest Service, US Forest Service, NC State University and forest industry leaders met to discuss the impact white pine blister rust has on their industry. The consensus was unanimous support of keeping the *Ribes* regulation intact. During the period of public comment for the regulation review, no comments were received.

Forest Pest Outreach

An on-going goal of the outreach program is to reach certain audiences with workshops and oral presentations. Through coordination with the NC Dept. of Environmental Education, workshops have become targeted at teachers and informal educators with a "train the trainer" format. Presentations generally covered the most imminent invasive pest threats to NC forests, namely, Asian longhorned beetle, emerald ash borer, redbay ambrosia beetle/laurel wilt disease, Asian gypsy moth, and walnut twig beetle/thousand cankers disease of black walnut. Information on basic identification techniques and pest biology was provided.

In addition to oral presentations, outreach efforts took advantage of relevant public events. NCDA&CS set up booths at the NC Museum of Natural Science's "BugFest," which is attended by over 30,000 people and the NC State Fair, attended by nearly one million. Outreach efforts at the NC State Fair were paired with those of the NC Forest Service and focused on the "Don't Move Firewood" message. It is estimated that

approximately 500 individuals were reached directly through presentations and public events.

As part of Farm Bill-funded outreach efforts, advertisements concerning invasive species have routinely been placed in Western NC magazine, Our State Magazine and Triangle Gardener. Advertisements consist of graphics created by the USDA APHIS HungryPests campaign.

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.

Export: Tobacco blue mold – requirements for export of tobacco to China

If blue mold of tobacco occurs in a state's tobacco crop in a given year, that state must complete field surveys to detect the sexual spore stage (oospores) of the blue mold pathogen, *Peronospora tabacina*. If oospores are not detected in infected fields, the tobacco may still meet requirements for export to China. Survey procedures developed by USDA-APHIS-PPQ are required. The Plant Pathologist updates the NC survey procedures yearly and sends them to the NCSU Plant Pathology Tobacco Extension Specialist for distribution to NC Cooperative Extension Service county personnel in the event that blue mold occurs. NCCES county agents conduct the survey by collecting samples from affected counties and submitting them to an approved lab (i.e., the NCSU Plant Disease and Insect Clinic). Industry groups pay for sample assays.

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. [Note: 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

The 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 2018, pathogenic species permit applications were evaluated which included fungi/oomycetes, bacteria, nematodes, and viruses.

Tobacco Plant Inspections

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

from one growing region into another, which could initiate a premature disease epidemic. There were no certified tobacco plant nurseries during this reporting period.

Vegetable Plant Inspections

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

FY 2018 Regulatory Weed Program Report

Program Objective

The North Carolina Regulatory Weed Program protects North Carolina agriculture, public health, and native plant ecosystems from the harmful impacts of noxious weeds. The regulation of noxious weeds is authorized by the North Carolina Plant Pest Law and the Aquatic Weed Control Act of 1991. Program activities include inspections, issuance of Phytosanitary Certificates, issuance of Scientific Permits for movement of regulated articles, education of the public, and the survey, control, and eradication of Federal and State listed noxious weeds. The Witchweed Eradication Project, funded by USDA, APHIS, PPQ, is one vital part of the Regulatory Weed Program. In addition, the program manager recommends justified changes to the NC Administrative Code that are relevant to noxious weed listings and quarantine boundaries.

Program Accomplishment Highlights

Witchweed Eradication

- The Witchweed eradication program continues to make gains in released acres in spite of the discovery of new or re-infested fields. The total acreage of active fields (i.e. fields with fewer than 5 points) is now 1,119 acres in NC.
- There were 20 new or re-infested acres in 2018. This highlights the need for vigilant survey, and shows the excellent work ethic of the Plant Pest Inspectors who are currently working on the witchweed eradication program. Each of these fields were discovered as part of regular delimited surveys in infested counties.
- 1,735 acres were treated in the quarantine area as part of the witchweed eradication program, using treatments of disking, ethylene, hand pulling, and herbicide application to control the germination and/or flowering of the weed.
- A total of 43,700 acres were surveyed during 2018 to evaluate the status of witchweed infestation in the 5 quarantine counties of NC. This is impressive considering the budgetary and weather constraints during the year.

Tropical Spiderwort

- The Wake county location of Tropical Spiderwort (discovered in June 2015), is decreasing. It was treated with herbicides two times in 2018. The site will continue to be monitored.

Cogongrass

- Cogongrass (*Imperata cylindrica)* continues to be monitored in NC. There are now 13 active sites of Cogongrass being managed in North Carolina, with an objective of complete eradication. Eleven individual Plant Pest Specialists conducted a roadside "Cogongrass Blitz" survey in May of 2018, covering 4,677 miles in 41 NC counties. Inspectors found no new cogongrass populations.

Other Noxious Weeds

- Eight hundred and seventeen Tropical Soda Apple plants (*Solanum viarum*) were found during the 2018 survey at Faircloth Farms in Sampson County. This is a significant increase in plant material, and survey efforts increased in number and size during 2018. A total of five complete days were spent (240 hours) surveying the entire farm (~7,000 acres). The plants were bagged and incinerated, and maps were made to document the location of the populations.
- Small broomrape (*Orobanche minor*) was found in two new counties, for a total of 4 individual sites in Mitchell and Haywood Counties.
- Purple loosestrife (*Lythrum salicaria*) is still confined to two general sites; Forsyth County and Henderson County. Annual surveys are necessary to find the plants and treat them with herbicide to prevent spread. The Henderson county site continued to spread in 2016, so an aggressive treatment plan was implemented.
- Seven sites are actively being managed for infestations of itchgrass (*Rottboellia cochinchinensis*) in Robeson County. Meetings between landowners started a partnership between NCDA&CS, NC DOT, and the growers to help combat this weed. Pre and Post emergence herbicides were used to control the growth of the plant. Two temporary employees were dispatched to the sites once a week from July to November, and they made incredible progress with the weed. The morale of the farmers is high, which is key to the continuation of this project.
- Several farm ponds were discovered to be infested with Yellow Floating Heart in in Lee and Moore Counties. Plant Pest Inspectors spent many hours surveying for additional ponds, obtaining permission from landowners for permission to apply pesticides, and conducting follow-up visits to the infested sites. Some sites were treated in 2018, and but management plans are being additional sites in 2019.

- Efforts continued to evaluate efficacy of weevil releases as a biocontrol agent for mile-a-minute vine (*Persicaria perfoliata*) in Alleghany and Guilford counties. Weevils were released in both counties during 2018, and plants and weevils were being reared in quarantine at the NCDA&CS Biocontrol Lab in Cary, NC.

- Giant hogweed (*Heracleum mantegazzianum*) came to the forefront in 2018 as a result of new discoveries in the state of Virginia. As a result of media coverage, two new sites were discovered in Wataugua County, NC. Both sites were treated several times with herbicides, and the remaining 4 "old" sites were also monitored for plants.

Regulatory

- Seventy-eight phytosanitary certificates were issued to support the Witchweed (*Striga asiatica*) quarantine program. This number has decreased in recent years because of the issuance of Compliance Agreements with several cooperators.

Public Relations and Outreach

The Weed Specialist serves in an advisory role for a number of weed species in a number of workgroups and Technical Advisory Committees (TAC). Tasks related to these responsibilities include attending numerous meetings across the state and weighing in or reporting upon the status of weed control programs, writing weed management plans with other stakeholders in the TAC, coordinating outreach within the group, and weighing-in on budgetary concerns regarding the control programs. The groups include:

<u>Committee or board member:</u>

- North Carolina Aquatic Weed Council
- Eno River Hydrilla Technical Advisory Committee (Outreach Committee & Scientific Committee)
- Hydrilla in the Chowan Workgroup

- Lake Waccama Technical Advisory Group for Hydrilla Management
- Aquatic Nuisance Species Workgroup (Writing an ANS Plan)
- Invasive Species Action Team – Albemarle Pamlico National Estuary Partnership
- White Lake Technical Advisory Committee for Hydrilla Management

The Weed Specialist is a member of the following Regional Weed Science Groups:

- North Carolina Weed Science Society
- North Carolina Invasive Plant Council (Past-President)
- South Carolina Aquatic Plant Management Society
- Weed Science Society of America

Educational talks were given to the following groups of people:

Date	Group	Location	Title of Talk	People Reached
12 and 13th of March, 2018	NCDA, PID Field Specialist Meeting	Raleigh	Cogongrass and Update on other weeds	30
4/9/2018	Western Region Specialist Meeting	Morganton	Cogongrass Identification and Status in NC	10
4/17/2018	Columbus County Master Gardeners	Whiteville	Invasive Weeds in NC	10
4/26/2018	NC Association of Consulting Foresters	Dunn, Harnett Co.	Cogongrass Identification and Status in NC	75

25 May, 2018	Agency and Consulting Foresters Meeting (western Region)	Asheville	Cogongrass Identification and Status in NC	40
7/11/2018	Master Gardeners - Vance County	Hendersonville	Invasive Weeds in NC (Hogweed, MAM, cogongrass, CFY, salvinia, PLS)	40
7/11/2018	Forestry Group	Burgaw - Pender Co.	Invasive Weeds in Forestry (Cogongrass, YFY, MAM, Salvinia, TSA)	35
7/31/2018	Extension Pond Workshop	NCSU - Lake Wheeler Research Station	Invasive Aquatic Plants and Regulations	75
9/22/2018	Pasture Weeds Workshop	Moore County, Private Farm	Musk Thistle; Biology, Identification, Control and NC Distribution.	15
10/30/2018	Pesticide Recertification Class	Pasquotank Co. Center, Elizabeth City	Invasive Weeds in NC	50
11/27/18	NC Association of Soil and Water Conservation Districts, Area 7 Fall Meeting	Richmond Co.	Invasive Weeds in NC	100

The Weed Specialist attended and/or gave the following talks at Research and Education Meetings:

Date	Group	Location	Title of Talk	People Reached
March 5, 2018	Weed Science Society of NC	Raleigh, NC	none	n/a
March 20, 21st 2018	NC Invasive Plant Council	Chapel Hill, NC	Cogongrass: A new threat to Rights-of-Ways in Eastern NC.	75
October 3-5, 2018	SC Aquatic Plant Management Meeting	Myrtle Beach, SC	none	n/a

Guest Lectures were given in the following classes:

Date	Group	Location	Title of Talk	People Reached	Contact Person
January 25, 2108	CS 415 - IPM Course	NCSU - Raleigh, NC	Invasive Weed Program and Regulatory Issues in NC	50	Dr. David Jordan

The Weed Specialist wrote or contributed to the following publication:

Date	Group	Activity	Title of Publication	Publication Type
November 2, 2018	Tree Care Industry Association Magazine	Interviewed	Recent giant Hogweed Scare has Arborists On Alert	Magazine Article

Other Outreach Efforts:

- The weed specialist and an employee of the Aquatic Weed Control Program sent letters to homeowners in the Upper Eno River Watershed to ask for permission to scout their farm ponds for the presence of hydrilla. Three days were spent scouting about 30 different ponds to ascertain presence or absence of hydrilla. The results were added to the results from scouting efforts in 2016 and 2017, and published in color maps of the area.
- Numerous weed-related web pages were updated and placed on the Division Website. Fact sheets were created and printed for several invasive weeds, including Giant Hogweed and Floating Heart so that they are available for outreach efforts.
- An “Itchgrass Town hall” meeting was held in Robeson County in Feb 2018. Approximately 20 people attended (farmers, DOT employees, Cooperative Extension, NCDA&CS) the workshop to discuss distribution, control efforts and status of the control program.
- The Weed Specialist continued to serve as the official verifier for invasive plant reports in North Carolina and posted to the EDDMaps website by the general public.

- The Weed Specialist provided assistance to Mr. Sam Brake to select the Grantees for the Bioenergy Research Initiative Program in November of 2018.
- On several occasions assistance was provided to outside individuals who requested images of invasive weeds for publications and signage.
- On numerous occasions, assistance was provided to help identify weeds and provide weed control recommendations in crop, turf, aquatic and non-crop sites.
- On numerous occasions, assistance was provided to recommend control methods for a particular weed problem for a citizen or farmer who requests assistance.

Aquatic Dealer Inspections

Aquatic dealer inspections are completed each year by the Plant Protection Specialists. In 2016, the database organizing these inspections was revised. A new database was rolled out to the Plant Pest Inspectors in 2017 with over 400 locations that needed to be inspected. Many of the locations no longer sold aquatic plants. Most of the Specialists were actively inspecting the nurseries again in 2018. Several new nurseries were also added to the database. By the end of the inspection period, at least 72 retailers were inspected for aquatic plants.

General Weed Survey and Eradication Program Details

Survey Methodology and Rationale: Surveys for all projects were done by visual reconnaissance. Survey objectives are: 1) identify new infestations of target noxious weed (i.e. detection surveys); and, 2) delimit the boundaries where the weeds were mapped in previous years (i.e. delimiting surveys). Detection survey location targets were selected based on probability that subject plant pest would be present. In some instances, GPS coordinates were recorded to provide reference points for mapping and relocation, if needed.

Roadsides close to wet areas and home landscapes were targets for Purple loosestrife detection surveys. Locations known to have been infested with small broomrape (*Orobanche minor)* in the past were checked several times during the summer for reoccurrence of the weed. Also,

past known locations for itchgrass (*Rottboellia cochinchinensis*) were surveyed in June through October to monitor results of pre-emergent herbicide treatments applied in February 2017, and to ascertain new infestations. Cattle slaughter houses and holding farms in Sampson county are surveyed twice annually for infestations of tropical soda apple.

Since plant species must be identified during the growing season, all surveys are done during the period from full leaf (June) through the first hard freeze (usually mid-November).

SEED & FERTILIZER SECTION ACCOMPLISHMENTS

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

The mission of this section is accomplished by:

- Ensuring that all locations that offer seed, commercial fertilizers, agricultural liming materials, landplaster, and soil additives for sale in the state are registered.
- Implementing a sound regulatory compliance program by conducting inspections and sampling of seed and fertilizer offered for sale in the state.

- Implementing seed purity, germination, and other specialized laboratory tests in support of the seed regulatory and service programs.
- Implementing a joint federal/state administered biotechnology permitting and inspection program.
- Conducting the fertilizer bioassay and endophyte testing programs.
- Coordinating activities of the N.C. Seed Board such that complaints regarding the failure of agricultural or vegetable seed to produce or perform as labeled or warranted are heard and responses are provided.

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

Seed and Fertilizer Field Programs

During the fiscal year 2017-18 the Seed and Fertilizer Section remained very active providing services to producers and individuals within North Carolina and some service to non-residents of the state. Administrative staff was responsible for issuing 4,490 licenses for business that sold wholesale and retail seed. During the 2017-18 fiscal year 506 fertilizer licenses were issued to companies manufacturing or distributing fertilizer products. These products were sold through chain and private retail outlets and through 215 farm supply outlets.

Seed and Fertilizer Field Staff are responsible for conducting inspections and sampling seed and fertilizer offered for sale in the state. The staff also implements a regulatory program to ensure full compliance with laws and regulations. An overview of program accomplishments is provided in Table 27.

Seed and Fertilizer Field Staff also provided support to the North Carolina Department of Transportation by collecting 313 samples from 36 seed lots to be utilized on highway projects. The lab tests performed on these seed lots detected several violations and as such remain a critical part of the program.

Commodity prices on all major crops generally remained above the long-term average and this was reflected in additional tonnage being applied. Along with traditional fertilizers, producers also took advantage of animal and poultry waste to provide nutrients to their crops.

Table 34 Seed and Fertilizer Program Inspection and Regulatory Activities**,** FY 2017-18

Number of Seed and Fertilizer Dealer Visits:	**3,506**
Seed and Fertilizer Samples collected	
Official Seed Samples	2,970 (34,526 lots)
Official Fertilizer/Lime Samples	1,581 (24,842 lots)
Regulatory Compliance Program	
Seed Stop Sales Issued	112
Seed Stop Sales Issued and Resolved on Site	10
Seed Stop Sales (N.C. Seed Lab)	102
Fertilizer Stop Sales Issued	20
Fertilizer Stop Sales Issued and Resolved on Site:	20

Table 35 and Table 36 provide additional information on fertilizer and lime samples taken by field staff and subsequently analyzed to ensure compliance with applicable statutes and regulations.

Table 35 Data of fertilizer samples analyzed for the current and previous fiscal years

FERTILIZER SAMPLING AND TONNAGE						
Year	#Samples	#Compliant	%Compliant	Tonnage Reported	Tonnage Sampled	%Sampled
2017-18				1,505,275		
2016-17	1,010	636	62.97	1,556,575	16,627	1.07
2015-16	899	605	67.30	1,504,612	13,809	0.92
2014-15	1,081	730	67.53	1,497,209	18,862	1.25
2013-14	1,374	1,058	77.00	1,509,378	22,309	1.48
2012-13	1,228	868	70.68	1,378,111	21,920	1.59
2011-12	1,195	876	73.31	1,243.164	56,762	1.5
2010-11	1,437	1,019	70.90	1,295.362	33,170	2.56
2009-10	1,651	1,141	69.11	1,251.026	26,539	2.12

Table 36 Data of lime and landplaster samples analyzed for the current and previous fiscal years.

LIME SAMPLING AND TONNAGE						
Year	#Samples	#Compliant	%Compliant	Tonnage Reported	Tonnage Sampled	%Sampled
2017-18				826.733		
2016-17	680	505	74.26	909,685	31,767	3.49
2015-16	571	505	88.44	731,932	28,539	3.90
2014-15	587	510	86.88	741,188	28,757	3.88
2013-14	646	498	77.00	831,854	28,620	3.44
2012-13	692	615	88.87	825,596	33,941	4.11
2011-12	758	541	71.37	767,766	36,965	4.8
2010-11	895	724	80.90	793,925	43.680	5.50
2009-10	729	611	83.81	640,106	35,793	5.59

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 2017-18, the North Carolina Seed Laboratory conducted 2,970 regulatory seed tests and 9,790 service seed tests. These tests involve required testing for purity and germination. Multiple tests are generally conducted on each of the samples submitted with 12,760 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 568 special tests conducted during the fiscal year. All official regulatory samples taken during the fiscal year 2017-18 represent testing for a total of 50,392,396 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 20 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 208 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 6 field inspections conducted by NCDA&CS field staff. As a prerequisite for participation in the project, all field staff were required to participate in training conducted by USDA-BRS focusing on work flow, confidential business information, and steps in effectively completing a field inspection.

North Carolina Seed Board

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

North Carolina Tobacco Variety Evaluation Program

The Tobacco Variety Evaluation Program continued in joint cooperation with N.C. State University. Samples from 20 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 19 different varieties from four different seed companies.

North Carolina Industrial Hemp Program

The Seed and Fertilizer Section is responsible for licensing growers, registering processors, and sampling crops for THC levels. During the 2018 calendar year, the Seed and Fertilizer Section remained very active providing services to producers and individuals within North Carolina. Administrative staff was responsible for issuing 342 licenses to growers to produce industrial hemp in the state. Seed and Fertilizer filed staff collected 433 regulatory hemp samples for THC analysis. In addition, 247 industrial hemp processors were registered across the state.

Seed and Fertilizer Field Staff are responsible for sampling Industrial hemp grown in the state. The staff also implements a regulatory program to ensure full compliance with both Federal and State laws and regulations.

Seed and Fertilizer Administrative staff also collaborated with North Carolina State University and North Carolina A&T State University with numerous educational programs to assist growers and law enforcement in their understanding of the NC Industrial Hemp Program.

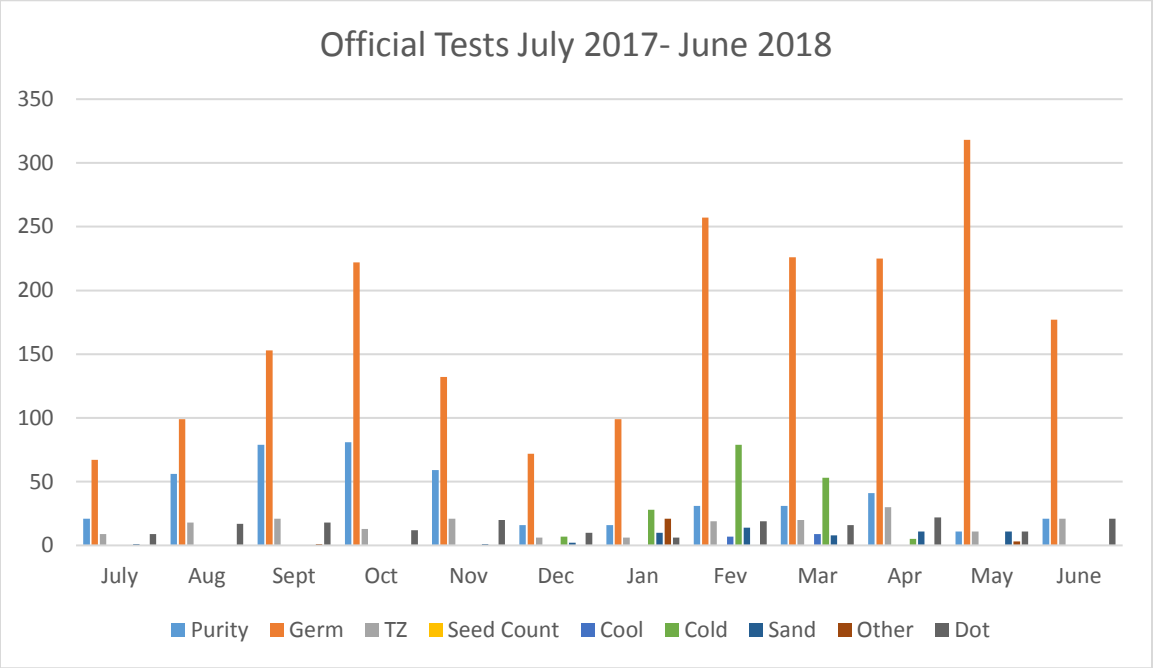

Figure 36 Seed Laboratory Official Tests

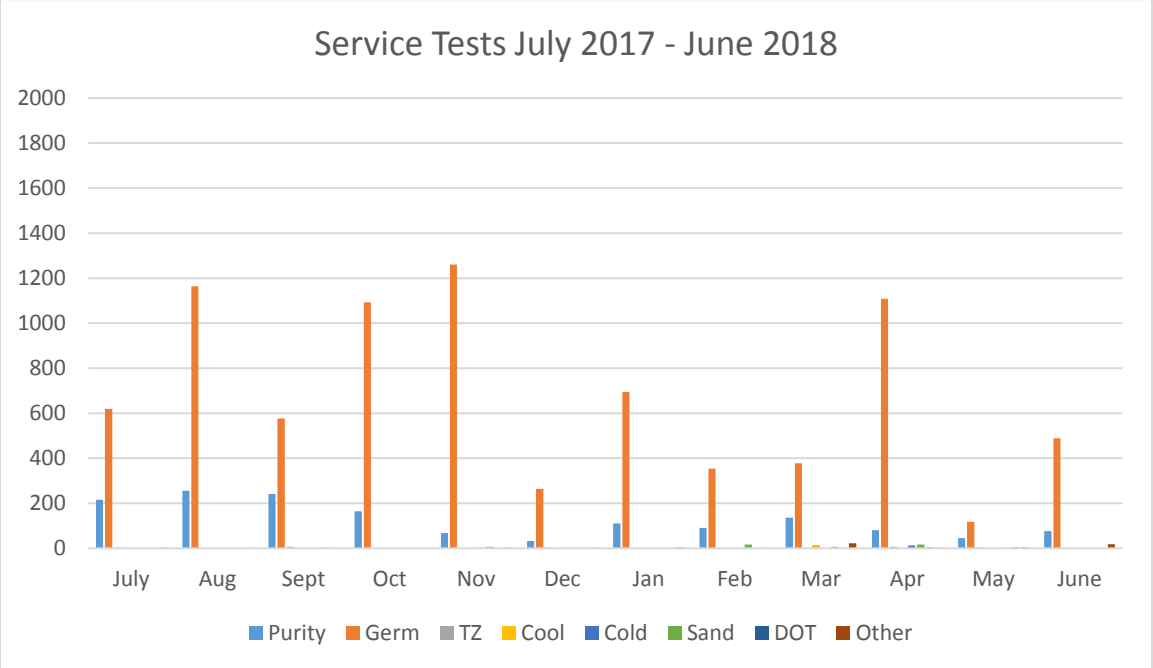

Figure 37 Seed Laboratory Service Tests