



NCDA & CS
Plant Industry Division
Annual Report
2022

Steve Troxler
Commissioner of Agriculture

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NORTH CAROLINA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES



Mission Statement

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

Steve Troxler

Commissioner of Agriculture

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North Carolina Board of Agriculture



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Plant Industry Division

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

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Support Operations

Physical Address: 1013 Blair Drive, Raleigh, NC 27603

Biological Control Services

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

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Plant Protection Section

Apiary Inspection Program

Prepared by D. Hopkins & G. Hackney

To protect the health of our honey bee industry, permits to sell bees are required for anyone wishing to sell queens, package bees, nucleus colonies (nucs), or hives. One hundred and seventy-two permits to sell were issued for 2022. To obtain a permit, bees must be inspected, and the producers must agree to comply with standards designed to maintain healthy colonies. Beekeepers are strongly encouraged to buy only from permitted dealers to avoid buying unhealthy or Africanized honey bees. The list of currently permitted beekeepers can be found here:

<https://www.ncagr.gov/plantindustry/Plant/apiary/documents/PermitToSell2023.pdf>

Our newest inspector, Ms. Shirley Harris, joined our team in August 2022. She covers a fourteen-county region in the Sandhills area. This region had been served by our former inspector, Nancy Ruppert. However, after more than ten years of dedicated service to the apiary program and to the beekeepers of North Carolina, Ms. Ruppert has retired from our inspection team.

One of the most devastating and difficult to control bee diseases is American foulbrood (AFB). In 2022, over 5,500 colonies were inspected statewide, of which just two colonies were found to be positive for American foulbrood.

The mite *Varroa destructor* persists as a major threat to the beekeeping industry and is probably a contributing factor to general poor health and 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®, Formic Pro®, Apivar®, Api-Bioxal®, and HopGuard®. All of the aforementioned products are listed in North Carolina as Section 3 general use pesticides. Although chemical treatment of mites may be necessary, some miticides have been demonstrated to have adverse effects on bees. The growing use of unregistered materials may have adverse effects on honey bee health and may not be efficacious in controlling mites. This and, in some cases, the improper use of antibiotics to control diseases can further complicate useful treatment regimes. In order to reduce the improper use of antibiotics, we again coordinated with the Veterinary Consortium to facilitate further education of veterinarians in honey bee disease diagnostics.

Beekeepers are expressing concern about pesticides, particularly the neonicotinoids, but the evidence of pesticide misuse has not been commensurate with the concern. Bee yards can be registered through the Plant Industry Division. The list of registered apiaries is sent to aerial applicators licensed in North Carolina. The NCDA&CS Apiary Inspectors have developed a good working relationship with the Structural Pest Control and Pesticides Division (SPCP). The SPCP responds to reports of acute bee losses and follows up according to the evidence. If a pesticide problem is suspected, **timely** reporting to an Apiary Inspector or the Pesticide Section is crucial for a valid investigation and resolution. The SPCP and Plant Industry Divisions are working with EPA to develop a Managed Pollinator Protection Plan.

Another threat facing the beekeeping industry of North Carolina is the Africanized honey bee (AHB) (*Apis mellifera scutellata*), which is established in southern Florida and has been found at least once in Georgia. The NCDA&CS apiary inspectors maintain swarm traps at the ports of Wilmington and Morehead City, in order to intercept any bees coming in via ship with plans 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 and 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. NCDA&CS and NCSU are collaborating to conduct this defensive bee survey. At this time, none of the samples collected have been determined to be AHB. Beekeepers and the general public are encouraged to contact their regional apiary inspector should they see colonies displaying any unusual behavior, especially excessive defensiveness to safeguard North Carolina's beekeeping industries from this more defensive type of bee.

Honey bee viruses are an issue that seems to be a growing concern among beekeepers. Currently, the NCDA&CS Apiary Lab does 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 and hope to expand our capabilities to perform some of the molecular diagnostics that they are developing. We have had the opportunity to assist the NC State University Apiculture Research and Extension Program with some of their projects and would like to express our gratitude for their assistance in many of ours.

Biological Control Program Annual Summary 2022

Prepared by Martha Flanagan, Nancy Oderkirk, Rose Riggs, & Greg Wiggins

Program Overview

The NCDACS Biological Control Program operates the Beneficial Insects Laboratory (BIL) and implements and maintains biological control projects that benefit the residents and environment of North Carolina. Biological control is the use of natural enemies to help regulate pest populations. The NCDACS Biological Control Program focuses on the implementation of classical biological control against invasive pest species, where the natural enemies and invasive pest are from the same region of origin (i.e., they have a coadapted ecological association) and their life cycles are synchronous with one another. Currently, we have projects that focus on managing the invasive insect species hemlock woolly adelgid and spotted wing drosophila, as well as invasive knotweeds and alligatorweed.

Skilled and dedicated staff are required to successfully conduct these targeted biological control projects. During 2022, Dr. Christine Nalepa who served her notable 40 year career at the NCDA&CS Beneficial Insects Laboratory retired. Dr. Nalepa worked at the BIL as a Research Specialist, and during her career assisted with projects focusing on a range of agricultural and environmental weeds and pests, such as alligatorweed, citrus whitefly, white peach scale, azalea lace bug, Asian multicolored lady beetle, emerald ash borer, and others. Dr. Nalepa has published more than 40 scientific papers related to biological control, as well as developed numerous reports and presentations on her work. She was instrumental in developing a biosurveillance program for invasive wood-boring beetles by monitoring beetles collected as prey by the native wasp *Cerceris fumipennis*. She was also adjunct faculty in the Department of Entomology and Plant Pathology at North Carolina State

University and served on the committees of several graduate students. We appreciate the years of service and the numerous contributions of Dr. Nalepa to the Biological Control Program.

In July 2022, Martha Flanagan was hired as Research Associate at the BIL. Ms. Flanagan previously worked as Head of the Living Conservatory and Arthropod Zoo at the North Carolina Museum of Natural Sciences. She is now leading the spotted wing drosophila biological control project, as well as providing critical assistance and input with other projects.

Several other staff made significant contributions to the Biological Control Program during 2022. Dr. Nancy Oderkirk, Research Specialist, leads the knotweed biological control project, as well as serving as Quarantine Officer. She also initiated the spotted wing drosophila colonies and has assisted greatly with the hemlock woolly adelgid project. Jackie Fredieu, Entomology Program Specialist, provided vital assistance with the hemlock woolly adelgid project. Additionally, the BIL employed four Temporary Research Assistants. Zoe Chavis, Charles Dial, Nathan LaSala, and Chandler Purser contributed to the work being conducted on the hemlock woolly adelgid, invasive knotweeds, and spotted wing drosophila projects. Also, Rose Riggs, who interned at the BIL, conducted a study on alligatorweed biological control.

Greg Wiggins

Biological Control of Hemlock Woolly Adelgid

Biological control programs focused on hemlock woolly adelgid, *Adelges tsugae* (Hemiptera: Adelgidae) (HWA) to this point have resulted in the mass rearing and release of natural enemies of HWA in the genus *Laricobius* (Coleoptera: Derodontidae) (Fig. 2.1A) and *Sasajiscymnus tsugae* (Coleoptera: Coccinellidae) (Fig. 2.1B). Despite the establishment of these predators on HWA, certain aspects of the biological control program could be strengthened. *Laricobius* species can be labor-intensive to rear, and mortality of the colony over the summer months remains a problem rearing facilities must contend with annually. Additionally, while *S. tsugae* were released to feed on HWA after *Laricobius* begin their dormant period during the summer months, little is known of their establishment and impact at release sites. Surveys to document establishment of *S. tsugae* would provide a means to assess their impact on HWA populations. To provide additional predation on the summer (progreadiens) generation of HWA, predatory flies in the genus *Leucotaraxis* (formerly *Leucopis*) (Diptera: Chamaemyiidae) have been released but not recovered in the field (Fig. 2.1C). This lack of recovery could be due to flies dispersing following release and not being able to find a mate. The use of whole-tree cages to contain these flies on infested trees following release may yield insight to the factors important to their establishment in the southern Appalachians.



Figure 2.1. Predators of hemlock woolly adelgid: A) *Laricobius osakensis*, B) *Sasajiscymnus tsugae*, C) *Leucotaraxis* sp.

A program was initiated with the overall goal to enhance current biological control measures targeting HWA. The major objectives of this program are: 1) to assess the effectiveness of egg releases as a viable method to establish *Laricobius* spp. in release sites, 2) to utilize whole-tree cages to determine the ability of silver flies (*Leucotaraxis* spp.) to establish on hemlock species infested with HWA in the southern Appalachians, and 3) to initiate a survey effort to investigate establishment of *S. tsugae* at historical release sites. While individual studies have demonstrated *Laricobius* spp. can establish in an area from egg releases, we propose to refine rearing and release protocols that can be utilized by other rearing facilities. To refine these protocols, we will evaluate establishment of *Laricobius* spp. in release sites by conducting post-release monitoring. Establishing silver flies in North Carolina would enhance the biological control of HWA, as *Leucotaraxis* spp. would prey on the second generation of HWA in the spring, thereby further reducing the overall levels of HWA on hemlock trees. Documenting *S. tsugae* at historical release sites would demonstrate long-term establishment and would guide efforts to document the impact of these beetles on HWA in the field.

Investigating Novel Methods to Release *Laricobius* spp. on Eastern Hemlock

For this study, *L. osakensis* is the primary beetle species on which efforts are focused (Fig. 2.1A). This *Laricobius* species is from the same region of origin in Japan as the HWA that infests hemlock in the eastern U.S., and *L. osakensis* has been released in the U.S. for several years. Through cooperation with staff of USDA Forest Service, NCDACS Forest Service, and the Hemlock Restoration Initiative, several sites that serve as field nurseries for *L. osakensis* have been identified for use to collect these beetles for use in studies. To obtain eggs for the egg release study, *L. osakensis* collected in western NC in November 2021 were placed in 1-gallon containers (ca. 10 males and 10 females per container) with bouquets of HWA-infested hemlock and monitored for egg production. Populations of *L. osakensis* were supplemented with 100 adults supplied by Dr. Pat Parkman and David Bechtel, Lindsay Young Beneficial Insects Laboratory, University of Tennessee. Oviposition initiated in our colony on 18 January 2022. As eggs of *L. osakensis* were produced, they were counted, and twigs with similar numbers of eggs were grouped into containers to take to the field; eggs were taken to the field and placed on trees within six days of oviposition. At the site, twigs from the lab with eggs were attached to HWA-infested twigs on study trees with colored pipe cleaners. Over 1,000 eggs of *L. osakensis* were produced in the laboratory colony.

In December 2021 in cooperation with a private landowner, a hemlock nursery in McDowell County, NC (35.55, -81.87) was selected for the study site. There were about 30 hemlock trees in the nursery mixed with planted Leyland cypress, and the hemlock trees there were of suitable size and appropriate HWA infestation to use for our *L. osakensis* egg release study.

To initiate the egg-release phase of this study, on 5 January 2022 HWA densities on 15 study trees were determined by counting the number of woolly masses on the apical 20 cm of four branches per tree. Beat-sheet sampling was conducted on these trees (four samples per tree), and two *Laricobius nigrinus* were collected, indicating *L. nigrinus* was present at this location. Treatments for this study consisted of three densities of *L. osakensis* eggs (50 eggs/tree, 100 eggs/tree, 150 eggs/tree), and three trees per treatment level and control treatment (no eggs) were assigned. Eggs of *L. osakensis* were deployed on study trees between 10 February and 22 March 2022 by attaching twigs from the Lab with *L. osakensis* eggs onto study tree foliage with pipe cleaners (Fig. 2.2A). After all study trees received the assigned egg densities, no other activity was conducted at the site until September 2022. This period of inactivity allowed the beetles to develop and aestivate with minimal disruption.



Figure 2.2. *Laricobius* egg release study: **A)** hemlock branch with *L. osakensis* egg-laden twigs attached with pipe cleaners, **B)** soil emergence cages under egg release canopies.

To initiate the collection-phase of this study, on 7 September 2022 soil emergence traps were deployed underneath the canopies of study trees at the hemlock nursery site. Under each of the 12 study trees, three soil emergence traps (BugDorm, 60cm x 60cm x 60cm, 150 x 150 mesh) were placed under branches where eggs of *L. osakensis* had been deployed in February and March 2022 (Fig. 2.2B). Each trap was staked to the ground at each corner, and the fabric flanges at the base of each cage were covered with soil to help stabilize the cage. On 28 September, bouquets of hemlock were constructed, and one bouquet was placed in each of the 36 cages. Beat-sheet sampling was conducted on all study trees on both previous dates, and no *Laricobius* beetles were collected. Cages were monitored weekly beginning 5 October 2022. Beetle specimens collected in emergence cages and beat-sheet samples will be visually identified and sent to Dr. Nathan Havill, USDA Forest Service, for confirmation of identification by molecular analysis.

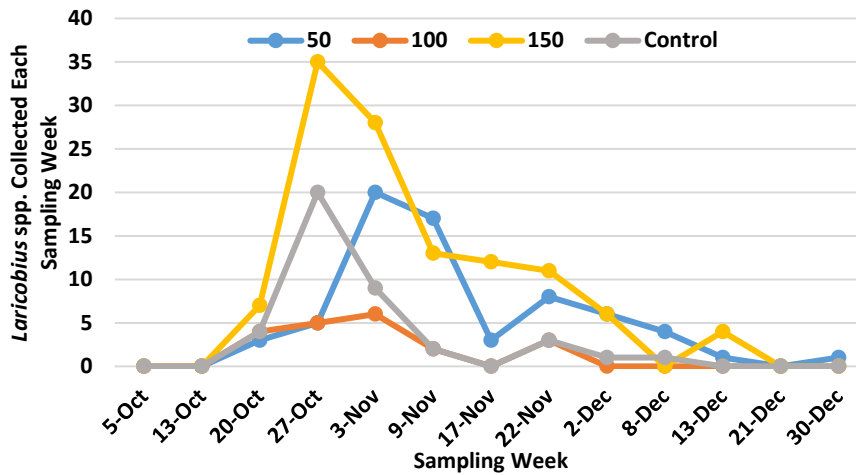


Figure 2.3. *Laricobius* species collected each sampling week, egg release study nursery, Fall 2022.

The first adults of *L. osakensis* were observed in cages on 20 October 2022, and the emergence period has continued into 2023 (Fig. 2.3). Peak emergence occurred in late-October/early-November. The collections of *Laricobius* species in the control treatments indicates the presence of *L. nigrinus* on these trees. Monitoring is continuing through February 2023, and beetle species identifications are ongoing. A second round of this study is planned for 2023, and results from both studies will be compared.

Investigating Novel Methods to Establish Silver Flies (*Leucotaraxis* spp.) in the Southern Appalachians

Although *Leucotaraxis* spp. have been released in several locations throughout the eastern U.S., recoveries have been sporadic. One suspected reason for lack of recovery is that flies may disperse quickly following releases, making it difficult to find mates and reproduce. To help limit dispersal, silver flies have been released in sleeve cages on branches of hemlock infested with HWA. However, few recoveries have been documented from sleeve cage studies, and little is known if these cages limit behaviors or cause detrimental conditions for silver flies. The use of whole-tree cages (Fig. 2.4) was investigated as a method to contain these flies on trees while allowing free range of movement within the tree canopy.

A hemlock nursery in Bent Creek Experimental Forest, Buncombe County, NC (35.492016, -82.630622) was selected as the site for this study. Fifteen trees were then selected for use as study trees based on HWA infestation, and infestation levels were assessed by counting woolly masses on new growth on the apical 30-cm of four branches of trees within the site. *Laricobius osakensis* was released previously at this site, and adults were collected during tree assessments. Prior to the initiation of the study, some trees were removed from the vicinity of the study trees to make room for the installation of the whole-tree cages.



Figure 2.4. Whole-tree cage study site: **A)** caged tree next to uncaged control tree, **B)** hemlock with cage floor installed around tree base, **C)** NCDACS Plant Industry staff after completion of cage installation at study site (left to right-Bill Foote, Charles Dial, Chandler Purser, Martha Flanagan, Greg Wiggins), September 2022.

The whole-tree cages used for this study are constructed of anti-insect UV-resistant mesh (Green-tek, Janesville, WI), measure about 8 m high and 6 m basal diameter and are supported by a central pole attached to the bole of the tree. A zipper runs the height of the cage allowing it to envelop and enclose a tree. These cages were constructed by Camel Custom Canvas (Knoxville, TN) and were delivered to the Mountain Horticultural Crops Research Station on 16 September 2022. These cages were deployed in the field from 19-21 September 2022. In addition to NCDA&CS staff (Fig. 2.4C), several USDA Forest Service cooperators assisted with the installation of cages, including Dr. Bud Mayfield, Bryan Mudder, Kenny Frick, and Sara Farmer.

Study trees were assigned treatments, and each treatment had three replicates. Since *L. osakensis* has established at this site, some treatments will allow the presence of naturally-occurring *L. osakensis* and some treatments will exclude *L. osakensis*. These beetles were excluded from within cages by using a mesh floor in the cage where *L. osakensis* is to be excluded (Fig. 2.4B). This mesh floor allows water and air circulation but restricts *L. osakensis* from entering the cage as it emerges from the soil in the Fall.

An explanation of the treatments follows. An uncaged control treatment accounts for the ambient conditions of trees and HWA in the site. A caged control-no predator treatment allows comparisons between new growth and HWA numbers on trees without predators and other treatments. A caged control-*L. osakensis* treatment allows ambient numbers of *L. osakensis* to emerge within the cage and accounts for any cage effects that may influence other treatments. A treatment with *Leucotaraxis* released in cages with *L. osakensis* excluded allows establishment of these flies without competition from *L. osakensis*. A treatment with both *Leucotaraxis* and *L. osakensis* provides information on establishment of *Leucotaraxis* on trees where *L. osakensis* also occurs.

Leucotaraxis species will be obtained from Dr. Mark Whitmore, Cornell University, NY, by arrangement with Dr. Mayfield. Releases of *Leucotaraxis* spp. will be made in January-February 2023, and cages will remain on the trees for 16 months.

Evaluating establishment of *S. tsugae* at historical release sites in North Carolina

In 2002, the Beneficial Insects Laboratory initiated rearing and releasing the lady beetle *Sasajiscymnus tsugae* (Coleoptera: Coccinellidae) (Fig. 2.1B), a predator of HWA. At the conclusion of this rearing and release program in 2016, over 640,000 *S. tsugae* beetles had been reared by the Beneficial Insects Laboratory. However, despite *S. tsugae* having been released in over 170 locations in North Carolina, little was known of their establishment and persistence at release sites.

To assess the establishment of *S. tsugae* at historical release sites, a survey effort focusing on recovery of *S. tsugae* was initiated in May 2022. Release locations of *S. tsugae* were obtained from the Hemlock Woolly Adelgid Predator Database maintained by Virginia Tech, and 172 release sites *S. tsugae* were recorded in North Carolina. A total of 24 release sites of *S. tsugae* were surveyed from 24 May – 7 July 2022. At each site beat-sheet sampling was conducted on hemlock infested with HWA with a uniform sampling time of 1-2 hours. Collected beetles were visually identified as *S. tsugae*. To confirm the identity of these beetles, collected specimens were placed in 95% ethyl alcohol and stored in a freezer until they were shipped to Dr. Havill for molecular analysis.

A total of eight adult *S. tsugae* adults were found in four of the 24 release sites surveyed. Molecular analysis confirmed that all collected specimens were *S. tsugae*. At the locations where beetles were collected, releases of *S. tsugae* had last been made between 2004 and 2009, so these populations have been established in these areas for several years. This finding is significant, as *S. tsugae* feeds on the eggs of the second summer generation (progrediens) of HWA, on which *Laricobius* species do not often feed. This survey effort will continue in 2023. As more locations are surveyed and *S. tsugae* recoveries are documented, future studies on their impact to the summer generation of HWA may be initiated.

Greg Wiggins

Biological Control Initiative for Spotted Wing Drosophila in North Carolina

The NCDA&CS Biological Control Program at the BIL launched a new program to address invasive spotted wing drosophila, *Drosophila suzukii*, (Diptera: Drosophilidae) (Fig. 2.5A) in our state. Spotted wing drosophila (SWD), a small vinegar fly with the potential to damage many fruit crops, especially thin-skinned fruit, is native to eastern Asia. Most species of vinegar flies attack overripe or damaged fruit, lessening the impact on growers/sellers. However, SWD is unique as the female can lay eggs in healthy fruit using a large, serrated ovipositor with two rows of teeth. Once the eggs hatch and the larvae (maggots) move around inside eating, the fruit becomes soft and unmarketable. Detection of a single SWD larva in the fruit can cause the rejection of an entire shipment, leading to high financial risk for farmers of impacted crops.

While known to be in Hawaii since the 1980s, SWD was first detected in the continental United States when an infestation was reported in California in 2008. Found in NC in the late summer of 2010, SWD have spread throughout most the US since that time.

SWD control presents multiple challenges. SWD is polyphagous, meaning it feeds on many different plants, all soft skinned fruits. Hosts include blackberries, blueberries, raspberries, strawberries, cherries, peaches, apples, pears, nectarines, plums, grapes, and figs. Chemical control (insecticides) can be ineffective, only targeting adults, as the chemicals won't reach the eggs and larvae already

inside the fruit. Depending on temperature, SWD can complete all 4 life stages in under 14 days (Fig. 2.5B) and an adult female can lay over 300 eggs in her lifetime. As is often the case with invasive species, part of their success is due to the lack of natural enemies. Because of the ability of SWD to encapsulate and kill the eggs of our native parasitoid wasps, research has focused on identifying non-native parasitoids successful in controlling this species.

In 2021 *Ganaspis brasiliensis* (Hymenoptera: Figitidae) (Fig. 2.5C), an Asian parasitoid wasp, was approved for release and further testing by the USDA, as initial research determined it to be an effective and host-specific biological control agent for SWD. *G. brasiliensis* is a solitary larval parasitoid of SWD found in overlapping ranges in east Asia. The adult female wasp inserts her ovipositor and lays her eggs into SWD larvae within the fruit. The *G. brasiliensis* egg hatches inside the SWD larva and over time consumes the host as it progresses through its larval, prepupal, and pupal stages. Eventually a single adult wasp emerges from the host puparium.

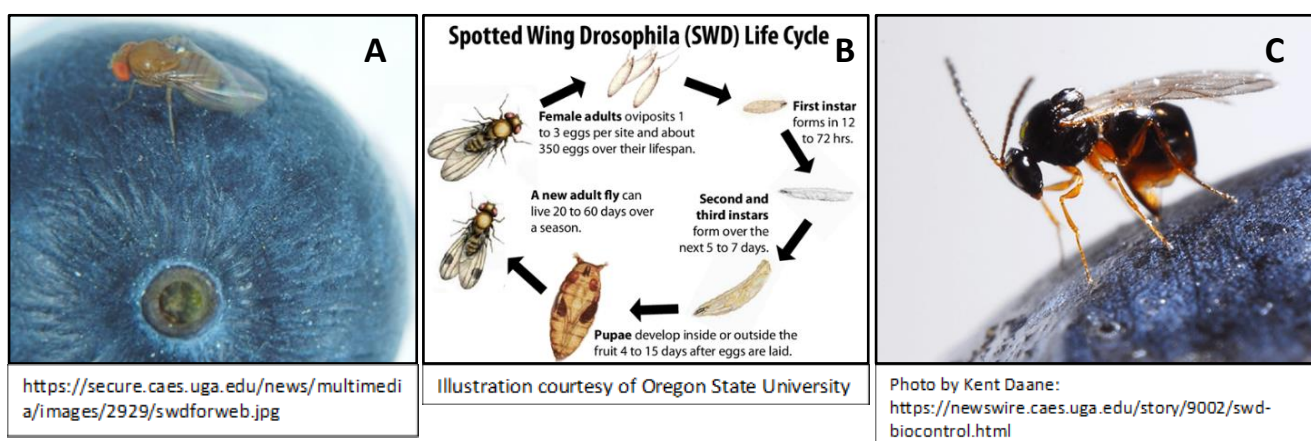


Figure 2.5. A) *Drosophila suzukii* laying an egg in a blueberry, B) *D. suzukii* life cycle, C) *Ganaspis brasiliensis* parasitizing SWD larva.

Members of the BIL are cooperating in a regional USDA study of *G. brasiliensis*. Along with other State and Federal cooperators, we performed standardized releases and intensively monitored release sites to determine establishment, seasonal phenology, and parasitism levels in both crop and non-crop habitats. Our primary objectives for this project were to 1) initiate a lab-reared colony of *G. brasiliensis* in cooperation with State and Federal collaborators, 2) identify cooperators for releases of *G. brasiliensis* against SWD and perform pre-release sampling, 3) release *G. brasiliensis* at pre-determined sites and perform post-release sampling to determine establishment, and 4) participate as the southernmost state in a *G. brasiliensis* overwintering study to assess the ability of both adult and prepupae *G. brasiliensis* to survive winter for reestablishment in the Spring.

Building Lab Reared Colony of *Ganaspis brasiliensis* and Preparing for Field Releases

In fulfillment of the first objective, in April 2022, Nancy Oderkirk and Greg Wiggins traveled to the USDA ARS Beneficial Insects Introduction Research Unit (BIIRU), Newark, Delaware, and met with Dr. Kim Hoelmer, Director, and staff. They toured the containment facility, and specifically met with Amanda Stout to discuss rearing protocols and see the arrangement and design of rearing containers for *G. brasiliensis*, strain G1, for release against spotted wing drosophila.

We received SWD adults and selected rearing supplies from Dr. Hannah Burrack, Michigan State University, to initiate our colony. We received shipments of *G. brasiliensis* (one in May, one in June, 200 each shipment) from the BIIRU to initiate the colony for NCDACS. We used blueberries infested with SWD (Fig. 2.6A) as the host material and media for rearing *G. brasiliensis*. Colonies of SWD and parasitoids are stable and can be manipulated when needed to produce parasitoids (Fig. 2.6B and C) for field releases and studies.

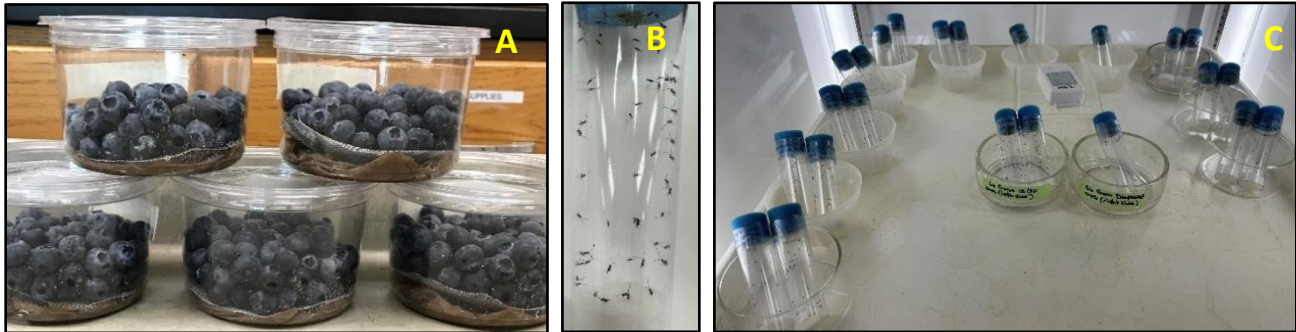


Figure 2.6. A) Blueberries infested with SWD used for *G. brasiliensis* rearing, B) vial of *G. brasiliensis* aspirated from blueberry cups, C) environmental chamber with *G. brasiliensis* vials.

To accomplish our second objective, we met with Dr. Burrack and Dr. Hannah Levenson, North Carolina State University, regarding release sites for the parasitoids. Three NCSU-NCDACS Research Stations (RS) were selected as release locations (Fig. 2.7):

Mountain Horticultural Crops RS (Henderson

County), Piedmont RS (Rowan), and Sandhills RS (Montgomery). Both Dr. Levenson and Dr. Burrack had research plots or cooperators at these stations, and we coordinated with Station Directors to gain permission and information on the appropriate release plots. Pre-release sampling was conducted at each location to assess the presence of SWD and native parasitoids prior to the introduction of *G. brasiliensis* to the system. No adventive *G. brasiliensis* were collected in these pre-release samples, indicating this parasitoid was not present in the system.

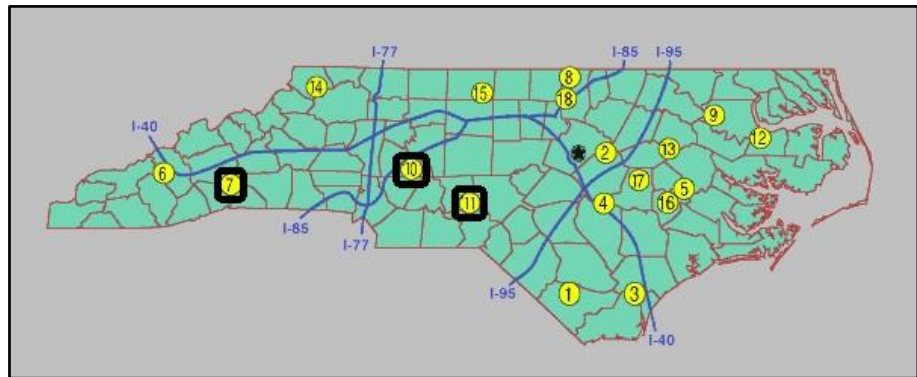


Figure 2.7. Research Stations 7, 10, & 11 (outlined in black) were chosen for initial releases.

Performing *Ganaspis brasiliensis* Field Releases and Investigating Establishment

To address our third objective, in July and August, releases of *G. brasiliensis* were conducted at all three Research Stations, with 451 parasitoids released at Mountain Horticultural Crops RS, 486 released at Piedmont RS, and 483 released at Sandhills RS (Table 2.1). Parasitoid releases were conducted on SWD-infested blackberries at Mountain Horticultural Crops RS and Piedmont RS and on SWD-infested blueberries at Sandhills RS.

Table 2.1. *Ganaspis brasiliensis* release data, Summer 2022.

SITE	COUNTY	RELEASE DATES	# Gb RELEASED	TOTAL RELEASED
Sandhills Research Station	Montgomery	26-Jul	204	483
		4-Aug	130	
		11-Aug	149	
Piedmont Research Station	Rowan	28-Jul	205	486
		4-Aug	131	
		11-Aug	150	
Mtn Horticultural Crops Research Center	Henderson	28-Jul	200	451
		3-Aug	126	
		11-Aug	125	

Post-release monitoring was initiated following the final releases of *G. brasiliensis*. In late August (approximately 12 days after the final releases), field fruit collections were performed at all three release locations. These collections included samples of any field fruit within 100 meters of the release points. This comprised both the crop berries and any wild berries in the vicinity. Berries were delivered to NCSU (Dr. Levenson’s lab) for monitoring of any *G. brasiliensis* emergence.

Sentinel trapping with Delta traps and infested fruit began approximately 30 days post release. Our first post release trapping was launched on September 8 at all three sites. Six Delta traps were deployed at each site along the wood line, half containing infested bananas and half containing infested blueberries. Additionally, a liquid trap with a scented lure was set up to attract adult flies. (Fig. 2.8A-D) Fruit from all three sites was collected on September 12 and subsequently delivered to Dr. Levenson’s lab to hold in growth chambers and allow any parasitoids to mature, emerge, and subsequently be identified. The liquid traps were left in the field to continuously sample for SWD. Post-release sampling continued monthly, as described above, two additional times in early October and early November.



Figure 2.8. A) NCDA&CS Plant Industry Staff Charles Dial setting up Delta trap, B) delta trap with infested fruit, C) liquid trap for SWD, D) sentinel trapping and liquid trap along wood line at Piedmont RS.

At this time, we know that parasitoids have emerged from our post-release trapping in Dr. Levenson's lab. We are currently waiting on identification of these wasps for results of this initial effort. Our findings, in combination with the findings of other collaborators in the program, will guide the future direction of this program. Currently our plan is to expand *G. brasiliensis* releases in 2023. We hope to add a Research Station in the Coastal Plain, and possibly also partner with an organic berry farm. We also intend to increase the number of wasps released at each site as we've refined our ability to rear.

Assessing Overwintering of *Ganaspis brasiliensis*

Our 4th objective, to assess the ability of *G. brasiliensis* to survive winter conditions, is being performed in collaboration with labs in Maine, New York, and New Jersey and in partnership with Dr. Levenson at NCSU. As the southern-most state in this trial, with variable winter temperatures, we are interested in knowing how this could impact the ability of the wasp to stay in diapause throughout the season and successfully emerge at the appropriate time next Spring. Our study plot includes a total of 36 field assay containers (2 treatments x 3 reps x 6 time points). The treatments include diapausing *G. brasiliensis* prepupae and adult *G. brasiliensis* that have been acclimated to the cold. The six time points run December 2022 through May 2023 monthly.

G. brasiliensis were reared as above, on SWD infested blueberries. However, 5 days after the wasps had access to SWD larvae, the parasitized blueberry cups were moved to a colder chamber set at 15°C to initiate facultative diapause. At this temperature, the wasp larvae will develop to a 5th instar within the host SWD puparium but will not emerge. Just prior to use in the field trials, parasitized pupae were extracted from the rearing containers and partitioned into cohorts of 50 each (Fig. 2.9A).

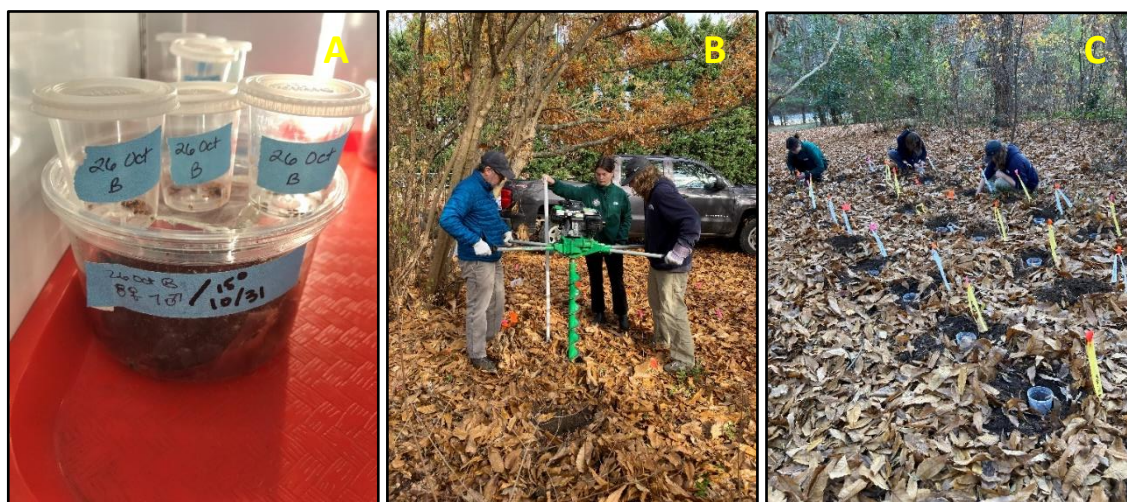


Figure 2.9. A) Diapaused *G. brasiliensis* extracted from rearing containers, B) NCDA&CS Plant Industry Staff Greg Wiggins, Zoe Chavis, and Chandler Purser digging holes for field trial, C) NCDACS Plant Industry Staff Zoe Chavis, Martha Flanagan, and Chandler Purser prepping holes with field containers.

Adult wasps were also reared. These wasps were acclimated to colder temperatures by gradually moving them from rearing temperature (25°C) to 10°C. They were held at 10°C for 5 days prior to being placed in the field.

Overwintering trials in the field consisted of 18 32-ounce cups with 50 parasitized prepupae each and 18 32-ounce cups with 12 cold acclimated adults each. After an appropriate site at the NCDA&CS Beneficial Insects Lab was chosen, 36 holes were made for the field trials (Fig. 2.9B). Each cup was filled with soil and leaf litter prior to placing the wasps inside. After wasps were placed in the cups (adult wasps also received an apple slice for moisture), the cups were covered, labeled with their time

point, and were randomly placed into a hole at the site (Fig. 2.9C). Wire mesh was anchored over each container to prevent any wildlife interference and all containers were covered with leaf litter. Two HOBO data loggers (one inside a cup and one on a nearby tree) were deployed to track temperature and humidity for the duration of the trial. This study is ongoing and will be concluded in 2023.

Martha Flanagan

Biological Control Assessment for Invasive Knotweeds in North Carolina

The NCDA&CS Biological Control Program at the BIL continues to develop and assess a biocontrol strategy for invasive knotweeds in our state. Knotweeds within the *Fallopia* (syn. *Reynoutria*) species complex, native to East Asia, were once planted widely for their ornamental value and for erosion control. They have since escaped cultivation and have become invasive throughout their introduced range in Europe, Australia, New Zealand, Canada, and the United States. These plants can spread beyond control via underground rhizomes and incidental distribution of viable plant fragments, forming stands that outcompete native plants via aggressive growth and production of allelopathic chemicals. Their unwanted presence is particularly notable within fragile riparian habitats and forest ecotones, along highway rights-of-way, and in areas under agricultural production. Further harm occurs as winter dieback facilitates erosion that further disrupts aquatic ecosystems and can lead to highway pavement collapse. Knotweed control presents challenges due to limited access for mechanical control, accidental transport of plant fragments, the inadvisability of herbicide applications in the vicinity of croplands and aquatic habitats, and the long-term ineffectiveness of chemical controls that have been utilized in some less-restrictive settings. Thus, initiatives have been undertaken to establish biological control as an achievable and sustainable element of an integrated management plan.

Members of the BIL are collaborating in a North American effort to control this weed by introduction of a knotweed-specific “plant flea,” the knotweed psyllid, *Aphalara itadori* (Hemiptera: Psyllidae). Knotweed psyllids cause severe leaf-curling of their host plants (Fig. 2.10) in their countries of origin, leading to reduced photosynthetic capabilities, stunted growth, and eventual death of the plant. This insect was Federally approved for release in the United States in 2020. Since then, we have been working with two genetically distinct populations of the psyllid: the Hokkaido biotype, from Northern Japan, is specific to giant knotweed, *Fallopia sachalinensis*, while the Kyushu biotype, from Southern Japan, prefers Japanese knotweed, *F. japonica*, and the hybrid Bohemian knotweed, *F. x bohemica*. Our objectives are to



Figure 2.10. Severe leaf-curling of knotweed attacked by knotweed psyllids (arrows).

determine whether the psyllid can overwinter and establish in North Carolina, and to compare effects on knotweeds in the field with those observed in lab settings.

Psyllids are maintained in our lab on knotweeds propagated from field-collected rhizomes. We utilize plexiglass cages on rearing carts in the lab. In addition, psyllids are overwintered in tents within field cages to assess and retain overwintering capability and phenotypic plasticity.

Psyllids were released at each field site via three established methods during the first two years (Fig. 2.11A, B, and C.) In year three, we also conducted field cage releases (Fig. 2.11D) which will be assessed in 2023. Surveys were conducted two weeks post-release and periodically during the growing season, for a minimum of 30 minutes per survey. We recorded numbers of psyllids and plant damage observed.



Figure 2.11. Methods used to release *Aphalara itadori*: **A)** sleeve release, **B)** infested plant, **C)** free release, and **D)** field cage release.

We have conducted psyllid releases in ten counties thus far, within all four ecoregions of North Carolina (Fig. 2.12). Over 24,000 psyllids have been released to date (Table 2.2). Our strategy is to release psyllids annually for three consecutive years at each viable site, and to survey annually during release years and for three additional post-release years.

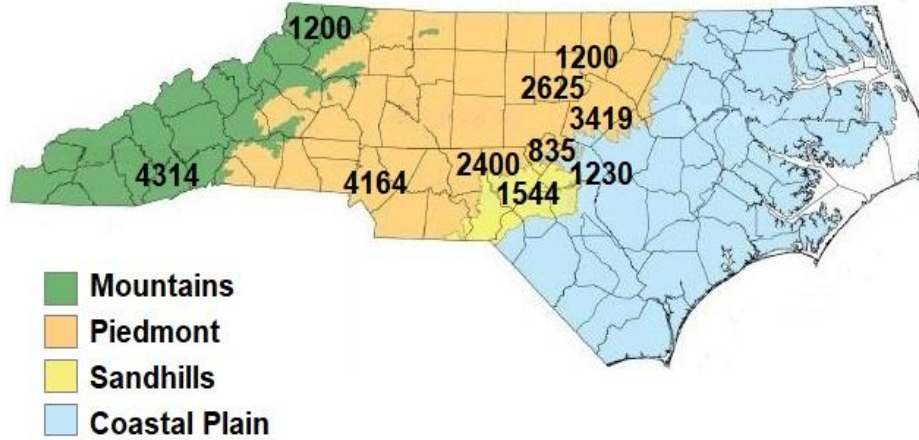


Figure 2.12. Knotweed psyllid release sites in North Carolina, 2020-2022.
 Map modified from [Vascular Plants of North Carolina website](#).

We have recovered live psyllids from the overwintered field cages each year for three years, even following extended sub-freezing and near-record low temperatures for our region. This year, we also discovered psyllids that had overwintered at one of our field sites, where open and plant releases had been conducted the previous year. These findings provide solid evidence that knotweed psyllids are physiologically and behaviorally capable of surviving winter and establishing populations in North Carolina.

Table 2.2. North Carolina knotweed psyllid release sites, 2020-2022.

County	Knotweed species	# Released 2020	# Released 2021	# Released 2022	# Released to Date
Ashe	Giant			1,200	1,200
Durham	Japanese			1,200	1,200
Harnett	Bohemian			1,230	1,230
Henderson	Giant		1,914	2,400	4,314
Hoke	Bohemian	780	764		1,544
Lee	Japanese	835			835
Mecklenburg 1	Bohemian	800	764		1,564
Mecklenburg 2	Bohemian			2,600	2,600
Moore	Japanese			2,400	2,400
Orange	Japanese		2,675	1,200	3,875
Wake 1	Japanese	500			500
Wake 2	Japanese	500	1,219	1,200	2,919
	Yearly Totals	3,415	7,336	13,430	
	Total To Date				24,181

While we have confirmed that psyllids can survive and establish here, we have yet to observe the stereotypical damaged plant phenology (leaf curl) observed in the lab and in the environments where these species naturally coexist. We suspect that this plant response would be rare in instances where the psyllid populations are low. To date, we have observed a post-release, concentrated psyllid population briefly at only one field site. Challenges to establishment and population growth include potential predation by locally-existing natural enemies, site disturbances, climatic effects and

increasingly erratic weather events. We regularly find insect predators on the knotweeds, though we have not witnessed active predation on psyllids in North Carolina. Our sites have been disturbed by natural processes, including a rare flooding event, and human activities, such as landscape maintenance. Climatically, degree-day models predict that psyllids should break winter diapause in this region in March, as host plants emerge. Our first psyllid releases followed this model. However, unseasonably late Spring frosts tend to kill the tender new plant growth, which is where psyllids prefer to lay their eggs. Sensitivity to high temperatures might also limit development of the psyllid during the heat of summer. Heat waves might afford healthy growth by the plant, just as psyllids are metabolically stunted.

To address some of these challenges, this year we established new field sites that have been less subject to site disturbance. We also conducted pilot releases in field cages, in an attempt to mitigate predation, disturbance, and climatic factors, while concentrating first-generation psyllids to prevent dispersal. Surveys in the Spring of 2023 should elucidate the effectiveness of this strategy in protection of an initial release population, which should allow for detection of overwintered psyllids, and assessment of plant response. We anticipate that these efforts will provide an ability to more clearly address the potential for this biocontrol agent in this region and its inclusion within a developing knotweed management strategy.

This work has been supported by the USDA and NCDA&CS Plant Industry Division. Psyllids were initially supplied by Dr. Fritz Grevstad, Oregon State University. We appreciate the cooperation of Raleigh Parks, Recreation, and Cultural Resources, Mecklenburg County Parks and Recreation, City of Charlotte, Charlotte-Mecklenburg Storm Water Services, Ellerbe Creek Watershed Association, Campbell University Cape Fear River Initiative, North Carolina Department of Transportation, Duke Energy, and private property owners. Our work has been presented at the 2022 NC-SC Invasive Pest Councils Joint Symposium and at the USDA Interagency Research Forum on Invasive Species.

Nancy Oderkirk

Assessing Biological Controls of Alligatorweed in North Carolina

Alligatorweed, *Alternanthera phyloxeroides*, is an invasive aquatic weed native to South America. It was first reported in the U.S. in the late 1800's and spread throughout waterways along the coast of the southeastern U.S. Alligatorweed is now found in 12 states, including North Carolina, where it was first documented in 1967. Alligatorweed can grow to dense populations and can sometimes grow across an entire waterway or channel, restricting access and creating navigation hazards. Additionally, floating mats of alligatorweed vegetation can be dislodged by flooding and obstruct dams and other structures. Because alligatorweed can grow terrestrially as well, it has the potential to outcompete and displace native riparian and aquatic vegetation.

To mitigate the impact of alligatorweed in the U.S., a biological control program was initiated in the 1960's. This program included releasing a species of flea beetle, *Agasicles hygrophila* (Coleoptera: Chrysomelidae) (Fig. 2.13A), a thrips species, *Amynothrips andersoni* (Thysanoptera: Phlaeothripidae) (Fig. 2.13B), and a moth species, *Arcola malloi* (Lepidoptera: Pyralidae). These species established in areas along the Gulf and Atlantic Coasts of the U.S., in many cases suppressing alligatorweed to reasonably low levels. However, despite multiple releases in North Carolina in the 1970's and 1980's, none of these biological control species were documented to establish, as winter temperatures were too low for these species to survive.

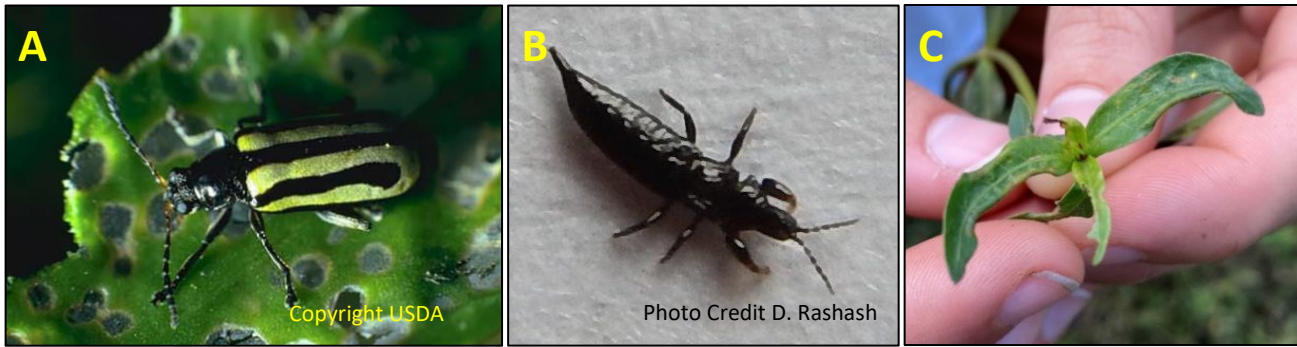


Figure 2.13. Biological control agents of alligatorweed studied in North Carolina: **A)** alligatorweed flea beetle, *Agasicles hygrophila*; **B)** alligatorweed thrips, *Amynothrips andersoni*, **C)** alligatorweed leaves deformed by thrips feeding.

Recently, there have been observations of *A. andersoni* and *A. hygrophila* seeming to overwinter in coastal areas of North Carolina. In 2021, both *A. andersoni* and *A. hygrophila* were observed in locations where NCDA&CS had releases during 2019. The flea beetles were found only near areas of release in the Wilmington area. The thrips were found as far inland as Apex Lake in Wake County.



Figure 2.14. Locations of alligatorweed populations surveyed during this study, Apex Lake, 2022.

While documentation of established populations is a positive step in the biological control of alligatorweed, impacts of these species in areas of establishment are important to quantify. During Summer 2022, a study was conducted at Apex Lake to document the seasonality of *A. andersoni* from July through November and to quantify the impact of these thrips on alligatorweed populations. Monthly surveys of seven alligatorweed populations were conducted at Apex Lake July to November 2022 (Fig. 2.14). Each population was georeferenced, and the area (m²) estimated. On each sampling date, a 32x32cm PVC sampling square was used to take four samples at each site. Samples were proportionally distant from each other based on the size of the site. The number of deformed plants and the total number of healthy plants inside the square was recorded, along with the water depth (cm). Deformities were identified in the field based on host-specific apical stem deformities (Fig. 2.13C). To standardize the estimate of frequency of deformed plants across all sites and samples, the number of deformed plants was divided by the total number of plants in each sample. Additionally, four deformed and four healthy plants were collected from within each square, and all collected plants were taken to the laboratory to examine for thrips. In the laboratory, number of thrips from each collected stem were counted and recorded. Larvae and adults were differentiated by their distinctive coloration to see how far into the fall season both life stages persisted.

The influence of exposure to direct sunlight on frequency of deformed plants was assessed using the Area Solar Radiation (ASR) index tool in ArcGIS Pro. This index averages the amount of exposure of a given location to direct sunlight as watt hours per square meter (WH/m²) based on the topographic position over time. The exposure for each study population was calculated from 28 July through 1 November 2022, and the resulting values were cumulative WH/m².

To depict the seasonality of frequency of deformed plants and the number thrips, we calculated the mean percent deformed plant and the total of larval and adult thrips for all sites for each sampling date. To assess significant factors that may influence the frequency of alligatorweed leaf deformation, we conducted a linear regression model analysis with the dependent variable of percent deformed plants, and the independent variables of water depth, number of adult thrips, and the ASR values. One-way analysis of variance (ANOVA, $p \leq 0.05$) was used to assess the significance of the model. We also generated individual scatter plots for the statistically significant dependent-independent variable combinations and present the line of best fit and the R² values for each.

When we examined the seasonality of damage frequency and number of thrips, we observed the greatest peak for both in August. Both larval and adult thrips persisted into November, with October being the only month where more larval thrips than adults were observed (Fig. 2.15).

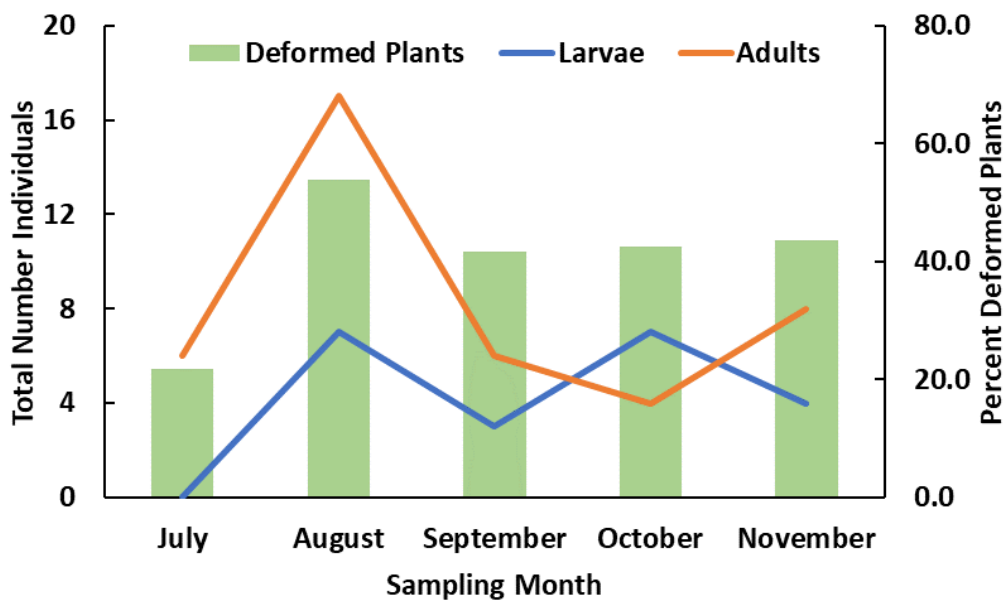


Figure 2.15. Seasonality of thrips (left vertical axis) and deformed plants (right vertical axis), Apex Lake, 2022.

Based on our regression analysis, the number of adult thrips was the only significant variable ($F_{(3, 136)} = 2.7600$, $p = 0.0446$) that influenced the percent of deformed plants during the study (Fig. 2.16). This association is expected, since thrips are a specialized herbivore that have established in the area, and greater number of thrips should equate to greater percent damage of their host plants. Neither water depth nor ASR had a significant influence on plant deformity.

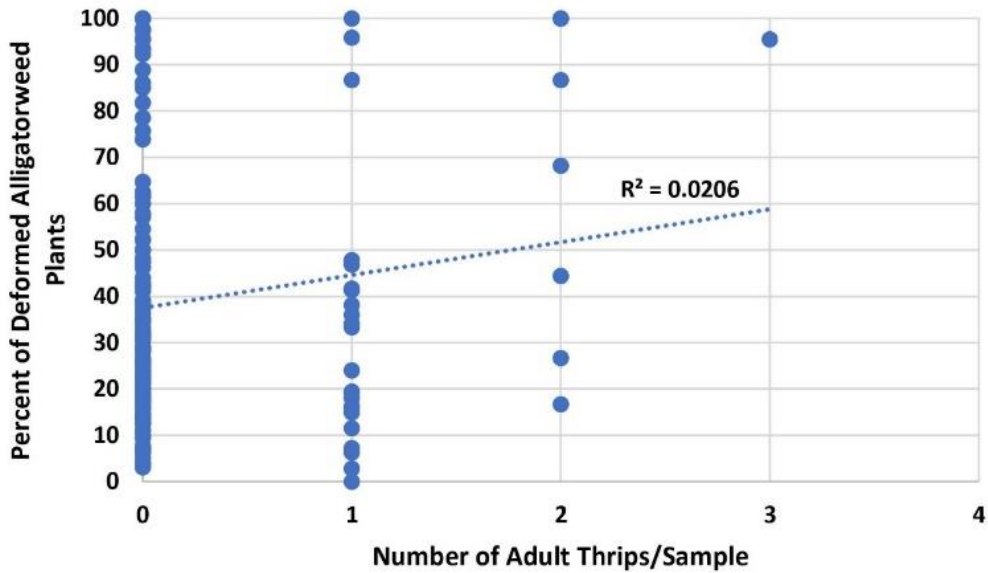


Figure 2.16. Correlation of influence of number of adult thrips on percent deformed plants ($p = 0.0493$).

These findings show that at current population levels, *A. andersoni* have a small influence on the health of alligatorweed plants at Apex Lake. Additional releases of this species may be necessary for thrips population levels to grow large enough to have a stronger impact on these plants. Future efforts may include collecting *A. andersoni* from other areas with larger populations to supplement the existing populations at Apex Lake. Further monitoring is necessary to gain insight into the impact of overwintering generations of thrips on alligatorweed in other areas.

Rose Riggs and Greg Wiggins

Cooperative Agricultural Pest Survey (CAPS) Program

Prepared by Amy Michael

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. Data collected from these surveys are entered into the National Agricultural Pest Information System (NAPIS). The 2022 North Carolina CAPS program was successful in procuring funding for CAPS and PPA §7721 surveys for early detection of exotic

plant pests. Nine independent surveys were conducted throughout the state, covering 81 counties. Surveys included mollusk, forest pests, oak commodity, Asian defoliators, grape commodity, solanaceous commodity, a *Phytophthora* spp. survey, box tree moth, and spotted lanternfly. Additionally, the Invasive Species Outreach program shifted from Entomological Programs to the CAPS Program responsibilities in July 2021 and remained within the CAPS program for 2022.

Four seasonal plant pest aide positions were initially filled to conduct trapping throughout the state. Three of the employees (eastern, western, and north-central regions) successfully stayed on through the entirety of the season. Unfortunately, we ran into several issues filling and retaining the south-central region position. In order to meet our goals, the other 3 trappers took on extra locations for CAPS and several of the PPA-7721 funded projects. However, this left us with a blind spot in the areas surrounding Charlotte, which are rife with potential introduction pathways. We were able to fill the position on August 8th, 2022. While this did mean that we missed the trap-based survey window for this region in 2022, the new employee contributed tremendously to Spotted Lanternfly response and survey efforts (see Entomological Programs) and received training from the CAPS Coordinator and north central region trapper to prepare for the 2023 trapping season. One additional field-based temporary employee was hired to assist with spotted lanternfly response efforts including survey, treatment, and outreach, and one taxonomic specialist was hired to assist with dissection-based insect identification as required for some of our samples.

A total of thirty-six different exotic plant pests were surveyed from March through late October. All surveys were completed following the 2022 CAPS guidelines, so that negative data were reportable. Several PPA 7721/ 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, eggplants, etc.), *Phytophthora* spp. (important plant pathogens affecting nursery and natural areas), grape commodity, Asian defoliators (largely surveyed at ports of entry), box tree moth, and spotted lanternfly (early detection/ host mapping). Many of these surveys follow CAPS guidelines for how they are conducted. Survey priorities for 2022 were determined with help from the CAPS advisory committee and new survey proposals were submitted through CAPS and Farm Bill (PPA 7721). All grant proposals were funded for 2022 surveys, while proposals for the 2023 survey season were successfully submitted in early August 2022.

CAPS Surveys

Mollusk Survey

The mollusk survey was conducted at three locations within the state in 2022 (Figure 3.1), exceeding our survey goal. Nine exotic taxa of mollusk were surveyed: giant African snail (*Lissachatina fulica*), Chinese slug (*Meghimatium pictum*), Hygromiid snails (*Ceratomyxa* spp.), Cochlicellid snails (*Cochlicella* spp.), and Leatherleaf slug spp. (*Veronicella* spp., *Belocaulus* spp., *Colosius* spp., *Laevicaulis* spp., and *Sarasinula* spp.). Both the Pest Survey Specialist (PSS, USDA-APHIS-PPQ) and CAPS Coordinator completed the surveys at four stone and tile importing locations within the state. No target pests for this survey were recovered.

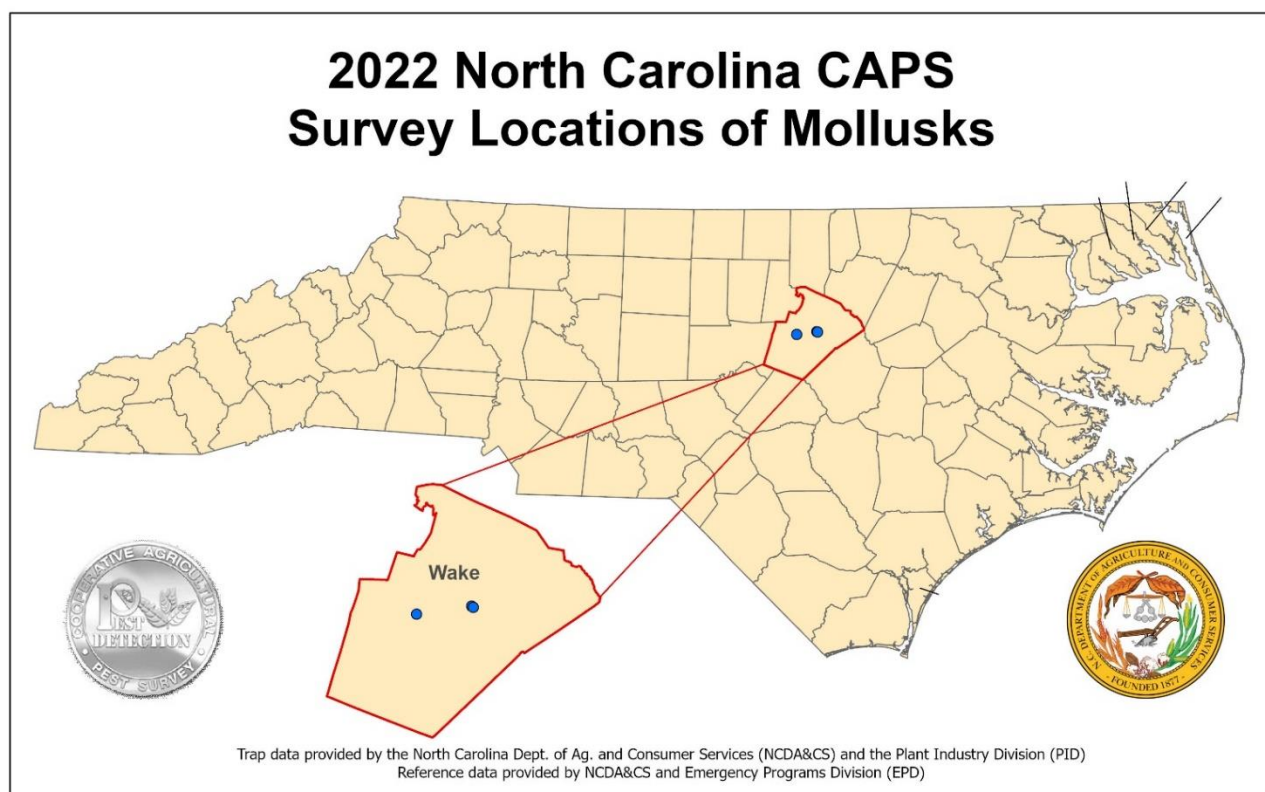


Figure 3.1, Map of Mollusk Survey sites, 2022

Oak Commodity Survey

North Carolina completed the 2022 oak commodity survey at 38 locations (Figure 3.2), surpassing the goal of 20. This survey included the following species: oak processionary moth (*Thaumetopoea processionea*, OPM) and oak ambrosia beetle (*Platypus quercivorus*, OAB). Oak processionary moth is a defoliating pest that can kill host trees through heavy feeding. The oak ambrosia beetle carries an additional threat in the form of the pathogen Japanese oak wilt (*Raffaelea quercivora*). Trapping for the insects included in this survey began in late March and ended in early October. Monthly visits were conducted at all locations for lure replacement, sticky card collection or trap replacement. Bi-weekly visits for the OAB multi-funnel trap were accomplished to limit the decomposition rate of beetle specimens so identification could be possible. No target pests for the Oak Commodity Survey were recovered.

Forest Pests Survey

The Forest Pest survey throughout the state concentrated on Asian Longhorned beetle (*Anoplophora glabripennis*; ALB) and Oak Splendor Beetle (*Agrilus biguttatus*; OSB). ALB is capable of infesting and killing healthy trees across 12 genera. The primary impact of this pest in infested areas of the US has been in maples (*Acer* spp.), which is the second-most abundant genus in North Carolina.

ALB surveys began in March and concluded in October. In total, 75 sites were inspected throughout the course of the survey (Figure 3.2). 30 of the sites surveyed are shared with the Oak Survey, as the rest stops, campgrounds, and sawmills share the pathway risk of infested log introduction. The SSC met with each trapper individually to provide training on signs of ALB infestation at various points in

the year. Maple trees were surveyed at each of the 30 shared sites 3 times per year coinciding with key points in ALB phenology: once at the beginning of the survey season before maple trees have fully leafed out, once during predicted adult emergence (May-July), and once in the month prior to leaf fall to target stressed trees. The remaining 39 locations were visited only once either as a response to suspect ALB reports or suspicious damage noticed by the surveyor. No evidence of ALB infestation was observed.

OSB sampling had previously been conducted through native *Cerceris* wasp sampling in the state from 2016-2019. This sampling method is incredibly efficient, as the wasps bring buprestid beetles back to their burrows, and are easily separated from their prey by sweep-netting or burrow exclusion. While we had pivoted to the combined visual and sweep net survey methods in 2021 due to concerns over restricted access to baseball fields as a result of the COVID-19 pandemic, feedback from employees overwhelmingly favored *Cerceris* wasp biosurveillance survey method is both more accurate and more straightforward to conduct, and we were successfully able to sample using this method in 2022. CAPS personnel coordinated with Biological Control Programs to select 7 baseball fields with high *Cerceris* populations in the eastern and central regions of the state for sampling (Figure 3.2). Over 70 specimens were recovered and are currently being screened. Additionally, eight locations in six western NC counties were scouted for *Cerceris* presence, but wasp burrow density was not sufficiently high to conduct OSB survey at any of these locations.

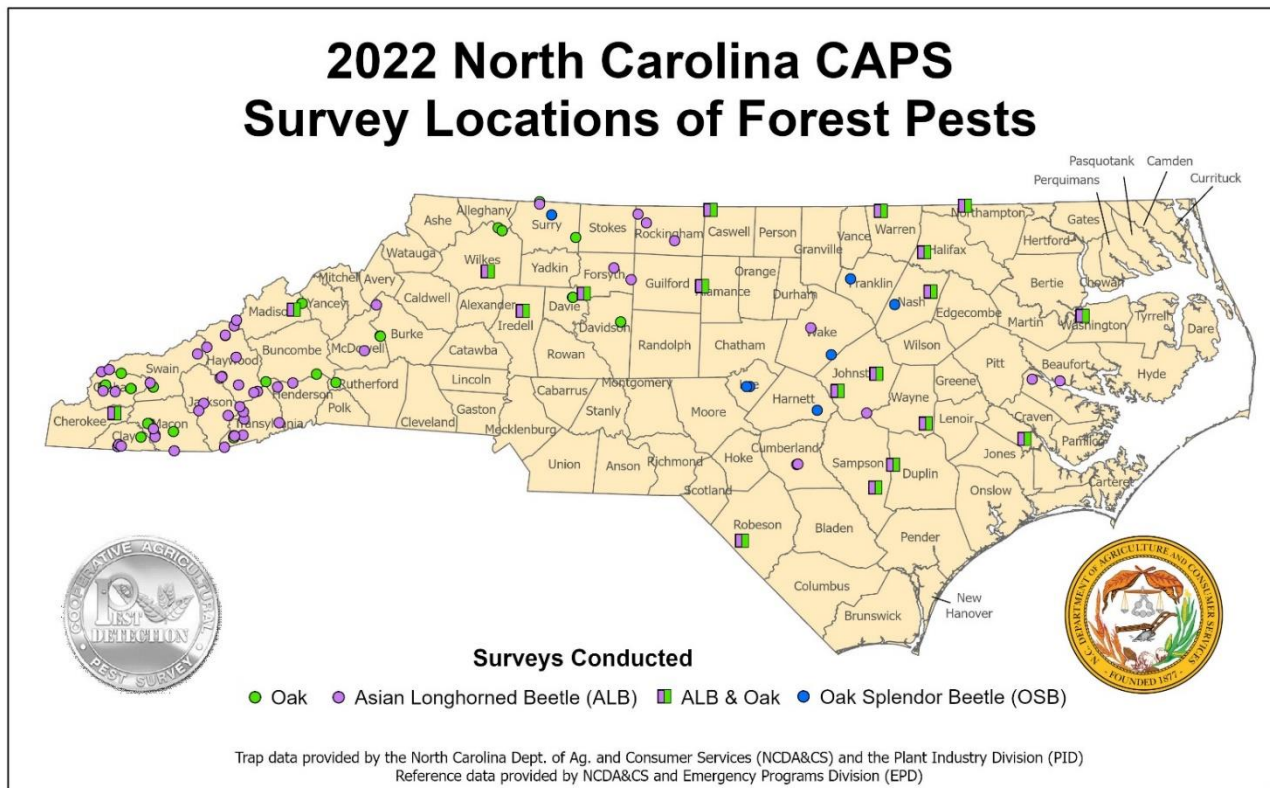


Figure 3.2. Map of Oak and Forest Pest Survey sites, 2022

PPA 7721 Surveys

The SSC annually applies for Federal assistance for the state to conduct exotic plant pest surveys. In 2021, money for 7 cooperative agreements funded by the Plant Protection Act §7721 were awarded to

NC. These included 6 early detection surveys and 1 outreach program; Box tree moth, Asian defoliators, grape commodity, solanaceous commodity, a *Phytophthora* spp. survey (see Plant Pathology Programs), and spotted lanternfly early detection/ host mapping (see Entomological Programs).

Asian Defoliators Survey

Nine exotic plant pests were surveyed under Asian defoliators; Asian Gypsy Moth (*Lymantria dispar asiatica*), Okinawa gypsy moth (*L. albescens*), Japanese gypsy moth (*L. dispar japonica*), Hokkaido gypsy moth (*L. umbrosa*), Rosy Moth (*L. Mathura*), Nun Moth (*L. monacha*), Pine Tree Lappet (*Dendrolimus pini*), Masson Pine Moth (*D. punctatus*) and Siberian Silk Moth (*D. sibiricus*). Locations included rest areas, ports of entry, and military installations. An introduction of any of these exotics would have serious implications for North Carolina forests. Host trees for these pests are considered economically important and include oak, pine, ash, elm, maple and walnut.

A total of 16 trapping locations were placed at ports of entry over a four-month period from late May to late September (Figure 3.3), meeting our survey goal of 15-20 locations. Monthly site visits were used to replace sticky cards and/or lures. Typical survey sites include rest areas, deep water ports, and military installations. Multiple survey locations exist on larger installations which may include a combination of several forms of conveyance including deep water ports with rail yards, airstrips or a combination thereof. These are important pathways for this survey and are prioritized accordingly. All samples were collected at the servicing of each trap and screened for the presence of target pests. No target pests for this survey were recovered.

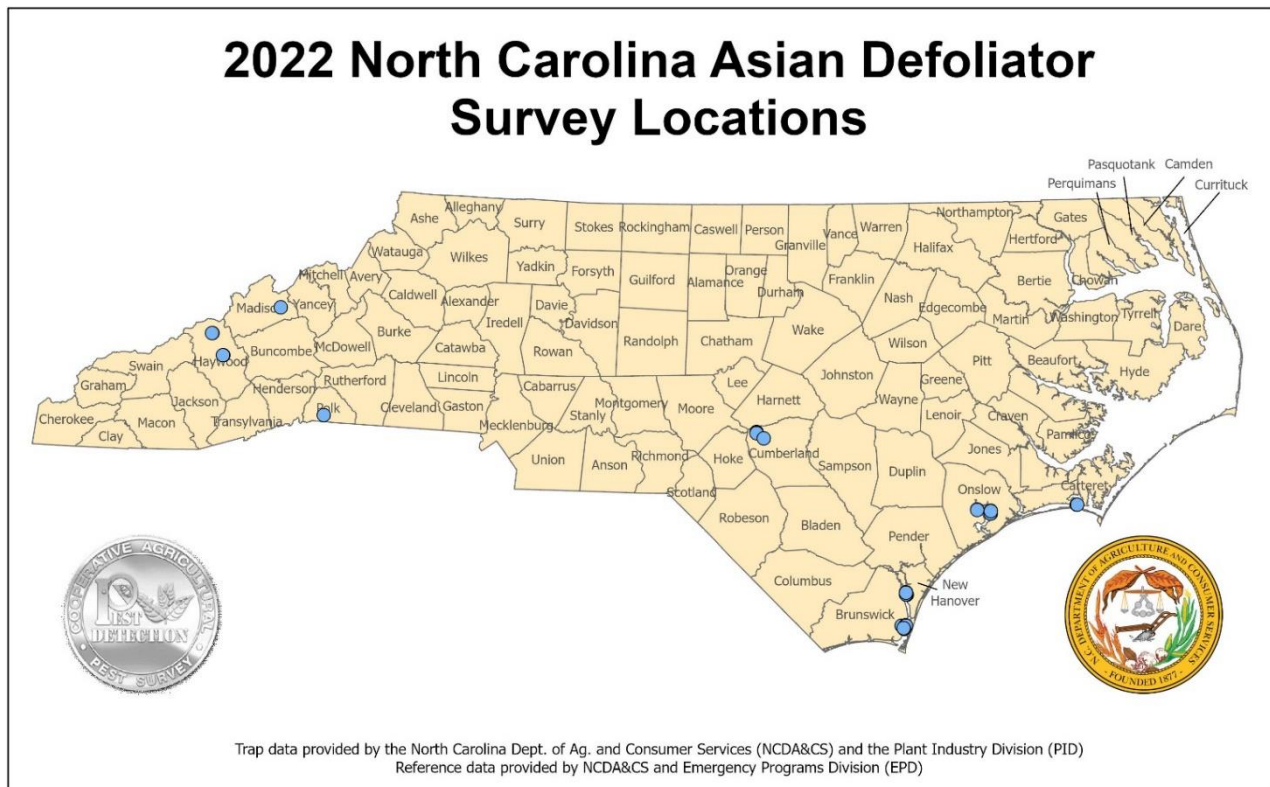


Figure 3.3 Map of Asian Defoliators Survey sites, 2022

Grape Commodity Survey

The Grape Commodity survey was completed at 23 locations (Figure 3.4), exceeding our goal of 20 sites. Vineyards surveyed included both European (*Vitis vinifera*) and native muscadine grapes (*Vitis rotundifolia*). We surveyed for four exotic species; Christmas berry webworm (*Cryptoblabes gnidiella*), spotted lanternfly (*Lycorma delicatula*; SLF), light brown apple moth (*Epiphyas postvittana*, LBAM), false codling moth (*Thaumatotibia leucotreta*), and European grapevine moth (*Lobesia botrana*). Traps were set beginning in late May and were pulled in October (Figure 4). Visual surveys for spotted lanternfly were conducted within vineyards at each visit in accordance with the approved guidelines.

No target pests for this survey were recovered within vineyards, although an SLF infestation was found in Kernersville on June 23rd (see Entomological Programs for more details). Outreach to grape producers has subsequently been a larger part of activities in this agreement year. Fortunately, no vineyards were present within a 5-mile radius of the initial report site. However, this means that our most prominent grape-producing region in the state (Yadkin Valley American Viticultural Area) is now flanked by 2 active infestations of SLF along major interstates. Interstate 40 runs through the Kernersville infestation area and I-77 runs through the infested Carroll and Wythe Counties in Virginia into Surry County, NC. The North Carolina Winegrowers Association and the North Carolina Muscadine Grape Association had partnered with NCDA&CS to help prepare their members for SLF by allowing us to give presentations and host booths at multiple events in the first quarter of 2022. Following confirmation of the Kernersville SLF infestation by USDA identifiers, these associations were among the first producer groups to be notified.

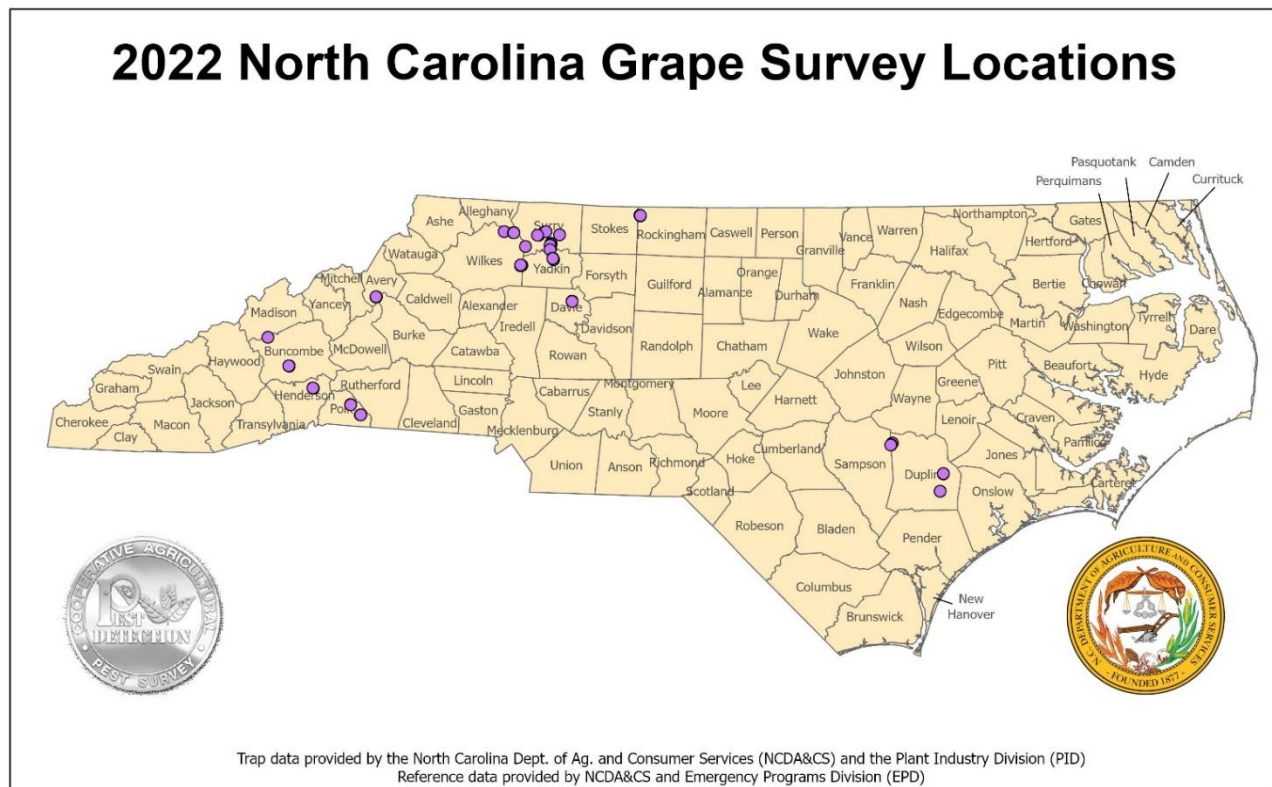


Figure 3.4 Map of Grape Survey sites, 2022

Solanaceous Commodity Survey

Insect pests (field survey)

We surveyed 24 host sites that included commercial tomato, eggplant, tobacco and pepper production fields (Figure 3.5) for insect pests, exceeding our goal of 20 sites. Six exotic insect pests of solanaceous plants were surveyed from May-October 2022: tomato leaf miner (*Tuta absoluta*), old world bollworm (*Helicoverpa armigera*), golden twin spot moth (*Chrysodeixis chalcites*), tomato fruit borer (*Neoleucinodes elegantalis*), silver Y moth (*Autographa gamma*), and cotton cutworm (*Spodoptera litura*). All are regarded as being highly destructive pests of solanaceous crops and pose a significant threat to North Carolina agriculture as the state has host material and climate conducive to supporting these exotics.

Old world bollworm is known for quickly developing levels of resistance to commonly used insecticides, including resistance to transgenic crops using *Bt*. Capable of long-distance migration, it may adapt to environmental conditions if it becomes too warm or dry. Economically, it is one of the costlier pests and reports of serious losses up to 100% are common in infested areas. It has also shown a propensity to hybridize with native bollworm, *H. zea*, in South America and Puerto Rico. *H. zea* is already a leading pest in several NC commodity systems, and there would be potential for rapid sharing of resistant genes between these species if *H. armigera* becomes established. Early detection and identification of this pest will limit spread to the natural environment and aid in eradication. Invasive *Helicoverpa armigera* and native *H. zea* are impossible to distinguish by their external appearance.

A taxonomic specialist was hired to conduct genitalic dissections on all *Helicoverpa* spp. collected in this survey to rule out positive identifications for *H. armigera*. As observed in many other states, bycatch of *H. zea* was much higher in 2022 compared to previous years, with 2,281 *Helicoverpa* spp. captured compared to 432 in 2021. Screening thus took longer than usual, but fortunately all specimens turned out to be the native *H. zea*. No other target insect pests were recovered as a result of this field survey.

Tomato Brown Rugose Fruit Virus (greenhouse survey)

In summer 2020, USDA issued a call for a new pest to be added to solanaceous surveys. Tomato Brown Rugose Fruit Virus (ToBRFV) is a relatively new tobamovirus that was first discovered in Israel in 2015. It has since been detected in several countries including Mexico and has been intercepted in several US states. This virus can affect several solanaceous crops. Symptoms tend to appear in foliage first, and lead to brown lesions on the fruit that can render the product unmarketable. While it can be seedborne, this virus spreads mechanically and can quickly contaminate entire production systems. Greenhouse-grown tomatoes appear to be the most susceptible.

2022 was the first full calendar year of ToBRFV surveys being conducted throughout the state. Surveys were led by the Plant Pathologist and CAPS Coordinator, often with help from the area Plant Protection Specialist. A total of 16 surveys were conducted at 8 locations from early March – early June 2022. ToBRFV-specific field testing kits were utilized to screen any potentially symptomatic plant material. 14 samples were taken across all locations and all tested negative for ToBRFV.

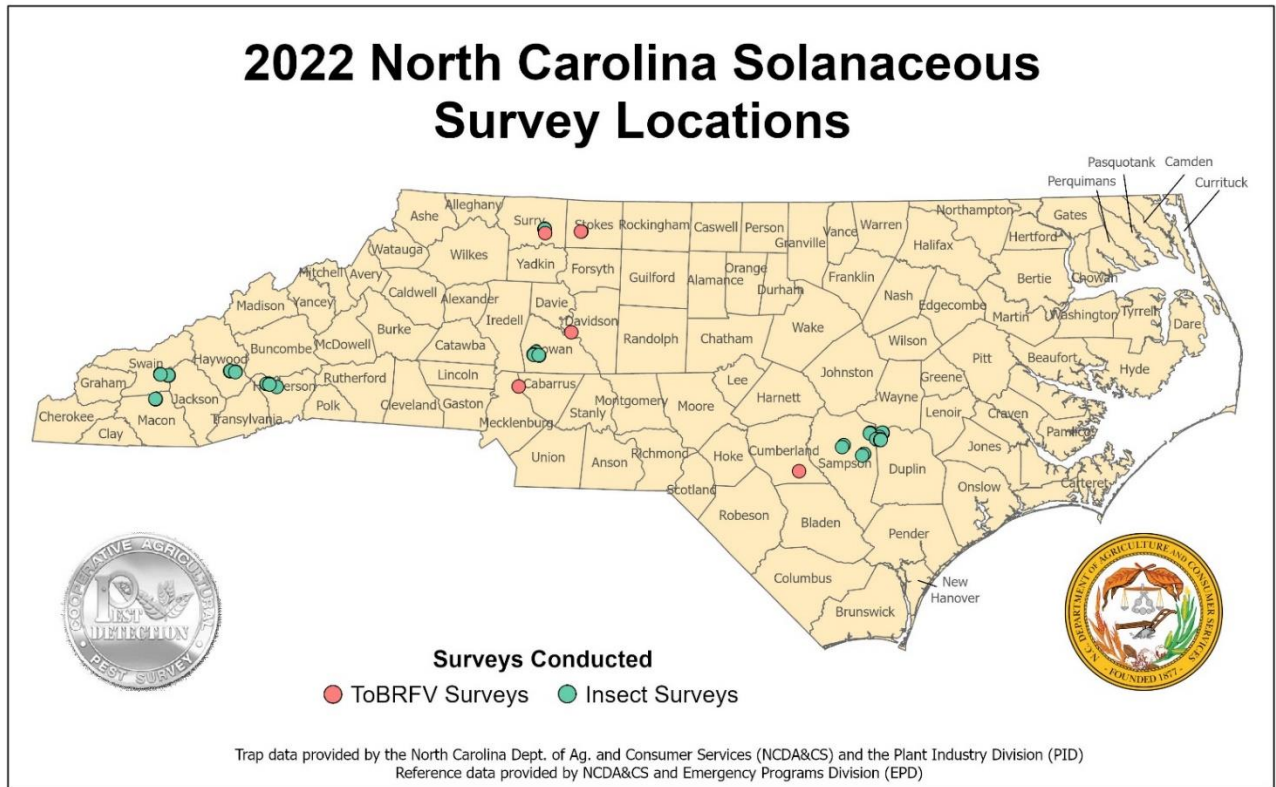


Figure 3.5 Map of Solanaceous Survey sites, 2022

Box Tree Moth Survey

The Box Tree Moth (*Cydalima perspectalis*, BTM) is an emerging pest of boxwood (*Buxus* spp.) throughout Europe, and was recently detected in Ontario, Canada in 2018. After completing a successful pilot trapping program for early detection at nurseries and coordinating with USDA-APHIS-PPQ to confiscate plants related to a BTM trace-forward from 8 locations in 2021, we petitioned to repeat this survey in 2022. The residences related to the trace forwards in 2021 were surveyed by USDA-APHIS-PPQ and are not reflected in our survey data.

Traps were placed at 20 boxwood-producing locations with a priority given to large wholesale operations beginning in April 2022, meeting our stated survey goal. Traps were checked once every 4 weeks through the end of October. The target pest was not detected as a result of our surveys anywhere in the state.

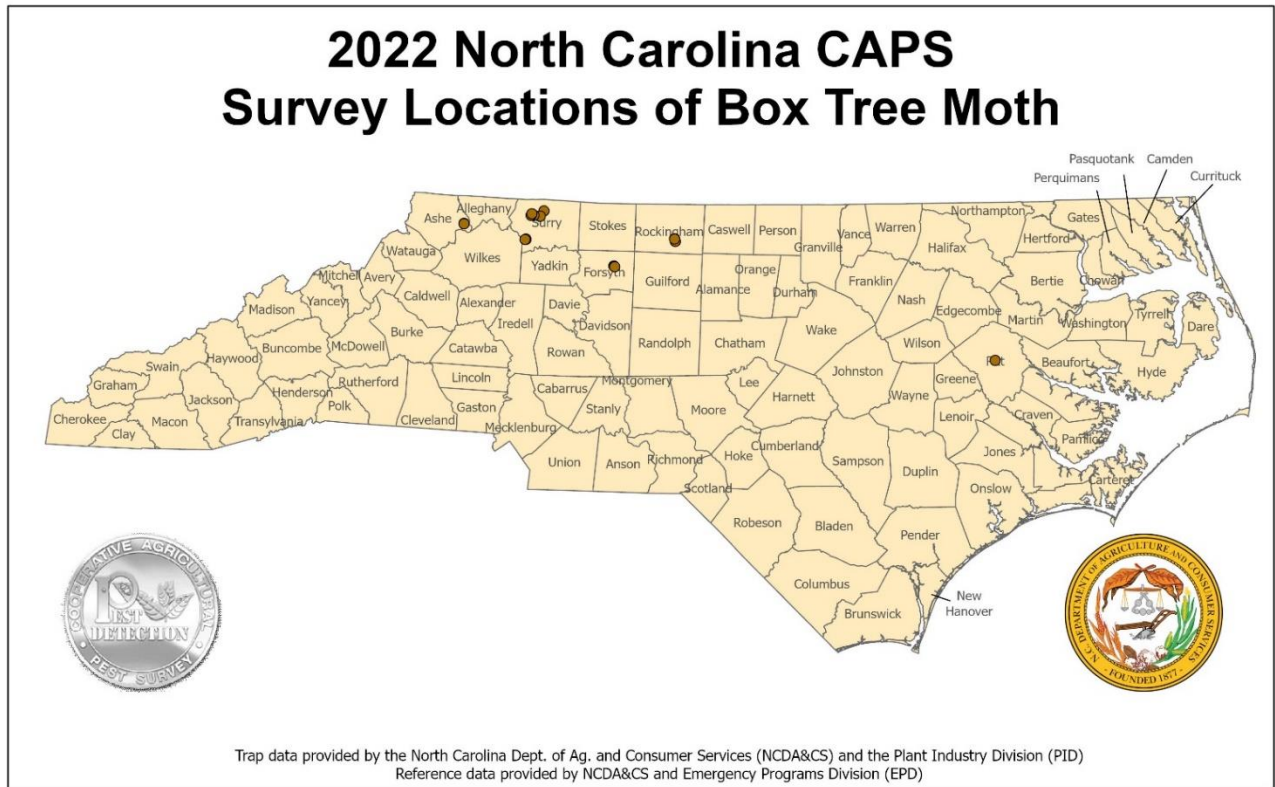


Figure 3.6 Map of Box Tree Moth Survey sites, 2022

Invasive Species Outreach

The Invasive Pest Outreach Program (funded by USDA PPA7721) supports public outreach centered on invasive pests. An ongoing central goal of this program is to help prevent the spread of invasive pests throughout North Carolina. The impacts and benefits from conducting statewide invasive pest outreach will result in quicker detection of incipient populations of pests, lead to a greater number of individuals reporting pests, and cause positive behavioral changes from the public that reduce the negative impacts of invasive pests and aid with slowing their spread. This in turn will help protect million- to billion-dollar nursery, forest, and agricultural industries. Following the detection of spotted lanternfly in Kenersville in late June, all printed outreach materials were updated to reflect this development, and we worked closely with extension and grower organizations to ensure that accurate and consistent messaging was shared. There was also a renewed focus to raise awareness of invasive species and reporting guidance by extending outreach efforts to farther-flung areas of the state and move beyond agriculture and nursery-focused events to reach a more of the general public. Through a combination of presentations, advertising, and in-person events, messaging reached an estimated greater than 2.47 million North Carolinians in 2022 (Table 3.1) compared to an estimated 1.4 million in 2021.

Large outreach events are back in full swing for the first time since the COVID-19 pandemic began, and we returned to many of the events we had regularly attended in previous years. (e.g., the State Fair and Mountain State Fair, Bug Fest, Green & Growin’ tradeshow). Messaging was spread more broadly throughout the state both geographically and to residents that may not be engaged with plant industries

through events like the Autumn Leaves Festival in Mt. Airy and at home exposition shows in Raleigh, Wilmington, and Greensboro. At these events and through partnerships with extension offices and other organizations we were able to distribute an estimated 24,405 units of educational materials including several outreach tools that were printed in previous agreement years (Table 3.2). Several items were updated and reprinted to replenish stock and/or to reflect our new status as a state with an SLF infestation.

The home shows helped us to further messaging for our Poolside Pests program, a combined early detection/ outreach program that encourages folks who find suspect ALB or SLF in their pool filters to use our reporting tool and engage with both statewide and local extension programs. Poolside Pests is a collaborative project between NCDA&CS Plant Protection Section, North Carolina State University Cooperative Extension, and the NC Forest Service Forest Health section (<https://www.poolsidepests.com>). As a result of the successes of this program, members of the Poolside Pests working group were invited to present at the National Plant Board – Safeguarding American Plant Resources Meeting in Charleston, SC in late May. The CAPS Coordinator ultimately gave the presentation (Cooperative Outreach for Invasive Species) and shared our successes and lessons learned through this program with regulators from several states in attendance, and shared materials for states to adapt to their own invasive species outreach efforts.

In addition to utilizing print advertisements as in years past, we initiated our first ever paid social media campaign. Our first carousel targeting Kernersville only encouraged viewers to prevent the spread of SLF, while campaigns in the greater Piedmont-Triad area and Surry County encouraged early reporting (Figure 3.7). This campaign ran from Labor Day weekend through mid-October to get this information in front of users to coincide with both peak SLF adult mating season and peak leaf-change tourism travel dates for these areas. Target audiences included but were not limited to farmers, outdoor enthusiasts, gardeners, transportation and moving professionals, and homeowners. This campaign amassed 187,792 impressions primarily on Facebook with a Click Through Rate (CTR) of 6.19%, greatly surpassing the industry average CTR of 0.93% (Table 3.3). This messaging was reinforced through several television interviews with local news stations given by NCDA&CS personnel, through one-on-one interaction with homeowners at the Greensboro Home Show, and collaborative presentations with Forsyth County Extension. Given the tremendous success of this awareness campaign, we plan to use targeted social media campaigns again in the future.

Table 3.1 Summary of Events and Advertisements in 2022

Outreach Type	No. of Events	Estimated No. Impressions/ Attendees
Banner Display only	2	359,575
Outreach Booth	15	1,043,542
Presentation	13	538
Virtual Presentation	2	124
Print Advertisement	13	886,000
Social Media Campaign	3	187,792
Total Reached	48	2,477,571

Table 3.2 Summary of Outreach Materials Produced and Distributed in 2022

Title	No. Printed	Estimated No. Distributed
Children's Activity Packs*	N/A	1,035
SLF Origami instructions**	500	1,035
ALB Pencils**	N/A	2,585
ALB Pest Alert**	300	1,585
ALB Look-alike guide	500	204
BTM Pest Alert	300	200
SLF Banners	N/A	6
SLF Poster	600	140
TOH Poster	N/A	103
DOT Poster	200	67
SLF Pest Alert**	2300	3,664
SLF Look-alike guide	600	767
SLF ID Cards	2,500	2,839
SLF sticky notes**	5,000	2,394
SLF Pens	2000	1,010
Webcam covers	N/A	190
Winestopper Coaster	N/A	2,616
Trouble's Brewing Coaster	N/A	2,230
Poolside Pests flyer	3,000	1,549
Poolside Pests magnets	N/A	1,186
Poolside Pests keychains	N/A	105
TOTAL	17,800	25,405

*Children's activity packs include pest alerts for both SLF and ALB, one ALB pencil, and additional materials produced in prior agreement years (e.g., SLF search-and-find activity). Materials included in the pack are counted again under each separate line (e.g.; 1,035 ALB pencils in packs + 1,550 individually distributed pencils = 2,585 pencils total distributed).

**Activity pack item

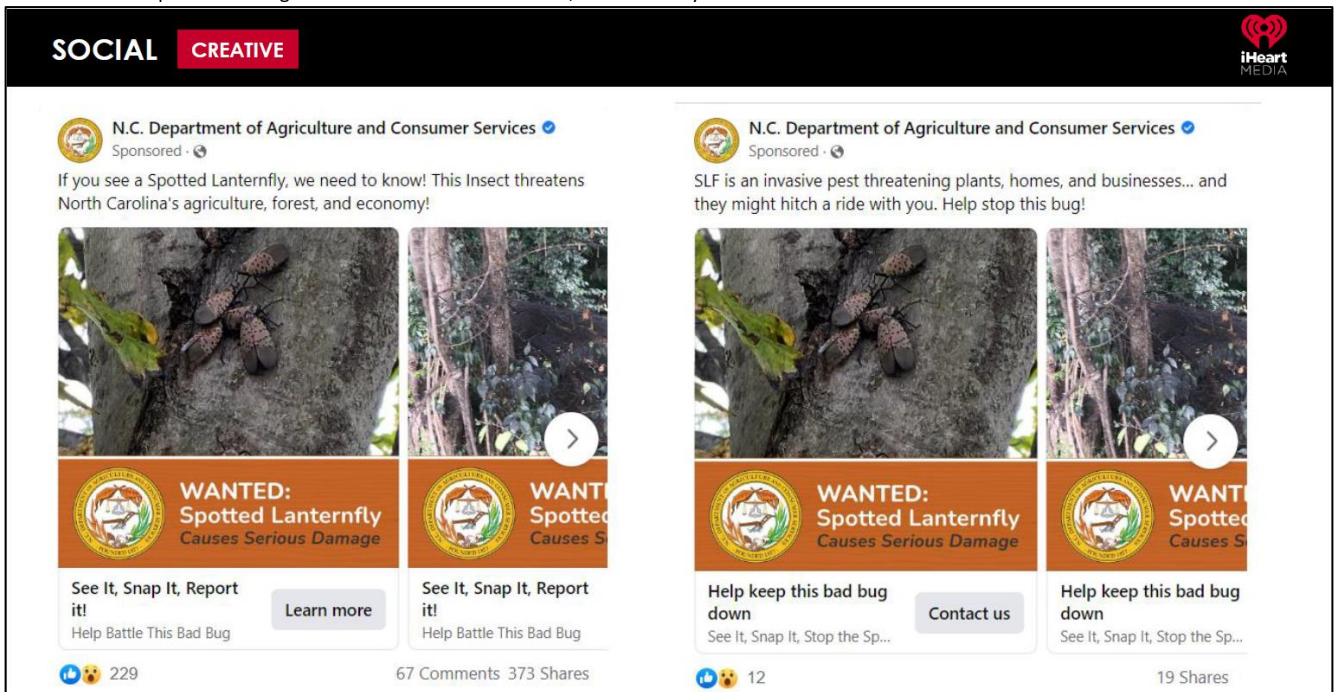


Figure 3.7 Social media campaign messaging. Carousel 2 (left, “Early Detection”) was shared where SLF infestations are not known to occur, and Carousel 1 (right, “Stop the Spread”) was shared in the Kernersville infestation area.

Table 3.3. Social Media Campaign Metrics

Title	Run Time	Total Impressions	Creative	Target Area	Total Clicks	Click Through Rate
Early Detection	8/29-9/30/2022	100,391	Carousel 2	Greater Triad area (Greensboro, Winston-Salem, High Point)	8,982	8.97%
Stop the Spread	8/29-9/30/2022	25,023	Carousel 1	Kernersville	748	2.99%
Early Detection	9/30-10/15/2022	62,378	Carousel 2	Surry County	1901	3.05%
TOTAL	8/29-10/15/2022	187,792	-	-	11,631	6.19%

Entomological Programs

Prepared by Paul Adams- Entomological Programs Manager, Amy Michaels- CAPS Program Coordinator, Sara Lalk-Forest Health Research Operations Manager, James Goethe- GIS Analyst and Joy Goforth- Plant Pest Administrator

The following report summarizes the primary activities and accomplishments of the NCDA&CS Entomological Programs in 2022.

SWEET POTATO 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 sweet potato 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 sweet potato 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 sweet potato weevil are found. Traps are also deployed in the NC sweet potato weevil quarantine area in New Hanover and Brunswick counties to monitor potential movement of sweet potato weevils into the production areas and to conduct research.

Field Surveys

Field surveys were conducted from September through mid-October 2022 in 47 counties, primarily in eastern North Carolina. 10,785 traps were set in 9,477 fields in approximately 78,254.4 reported acres (Table 4.1). 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 4.1a). Traps were deployed at an average density of one trap for every 7.26 acres and left in the field for an average of 30 days. These values are in accordance with the established SPB sweet potato 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 2022.**

Table 4.1: Number of Traps set per county and the reported number of fields and acres in 2022.

County	Traps Set	Reported Fields	Reported Acres	County	Traps Set	Reported Fields	Reported Acres
Beaufort	173	125	586.5	Lenoir	363	335	2,850.2
Bertie	76	42	436.2	Macon	--	1	0.8
Brunswick	2	1	4.0	Martin	209	155	1,517.7
Camden	2	1	3.4	McDowell	1	1	0.3
Carteret	2	2	4.0	Montgomery	--	1	7.0
Chowan	56	29	328.1	Moore	3	4	13.7
Clay	--	1	0.4	Nash	684	785	5,326.8
Columbus	33	20	187.5	Onslow	15	10	48.4
Craven	35	29	154.7	Orange	--	4	7.2
Cumberland	98	68	723.7	Pasquotank	4	2	7.4
Davidson	2	2	4.9	Pender	6	2	11.5
Duplin	228	150	1,714.9	Pitt	532	455	4,689.7
Edgecombe	998	1,020	9,300.2	Richmond	13	11	99.5
Forsyth	1	1	0.5	Robeson	27	18	412.7
Franklin	112	88	649.9	Rockingham	--	3	3.0
Graham	1	1	0.3	Rutherford	3	3	0.3
Granville	39	53	190.7	Sampson	2,049	1,406	14,957.1
Greene	568	456	4,490.6	Scotland	33	10	280.0
Guilford	--	16	110.8	Stokes	2	1	0.7
Halifax	131	119	834.2	Surry	1	--	--
Harnett	336	396	2,084.7	Vance	2	2	1.1
Henderson	--	1	0.1	Wake	129	154	895.5
Hertford	62	38	368.8	Warren	5	3	31.5
Johnston	1,544	1,340	9,497.7	Wayne	1,010	839	7,381.7
Jones	44	33	399.6	Wilson	1,130	1,221	7,524.9
Lee	19	18	107.2	Yadkin	2	1	2.3
Lenoir	363	335	2,850.2	--	--	--	--
Totals					10,785	9,477	78,254.4

Regulatory Sites

Sweet potato regulatory sites include but are not limited to storage facilities, processing plants, micropropagation units and greenhouse operations growing ornamental sweet potatoes and were surveyed all year long. Because of the inter- and intra-state movement of sweet potatoes these regulatory sites are a high-risk pathway for the introduction of sweet potato 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 4.1b). 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 where sweet potatoes are loaded or unloaded. Lures were changed in each trap once a month and data collection was accomplished using the same procedure detailed for the field surveys. A total of 207 regulatory sites (totaling 6,710 inspections) were surveyed and **no weevils were found in storage facilities during the 2022 season.**



Figure 4.1. a) Green boll weevil trap baited with sweet potato weevil lure used to survey sweet potato fields; b) bucket traps used to survey storage facilities

Sweet Potato Weevil Quarantine

North Carolina, despite leading the U.S. in sweet potato production, has an infestation of sweet potato weevil (*Cylas formicarius*). Fortunately, these infestations are confined to two coastal communities of North Carolina in Brunswick and New Hanover counties where a quarantine has been established to protect sweet potato production areas. Since the discovery of these populations the goal has been, and continues to be, eradication. NCDA&CS was awarded Specialty Crop Block Grant funding for a two phase project with phase 1 being dedicated to understanding spatial and temporal distribution of the populations of sweet potato weevil in both counties and phase 2 being dedicated to an eradication effort using male annihilation technique (M.A.T.) through “super” efficient traps pictured and described below in Figure 4.2a and 4.2b. This project has experienced a fair share of setbacks with inconsistent temporary labor, funding issues, the COVID-19 pandemic, and environmental conditions to name a few. However, progress has been made.

In 2022, all traps were in place and checked consistently 1 time per month. As it stands, since 2018 we have used the same 10 delimiting grids (labeled A-J) for monitoring and eradication purposes. Of the 7,416 weevils caught this year 97.2% were caught in Brunswick County (delimits H-J) and more specifically in delimit area I which accounted for 89.9% of all weevils caught (Figure 4.3). This trend is consistent with previous years data for both county and delimit area. Brunswick county has always produced significantly more weevils and those weevils have always been most localized to the I delimit grid which is both the largest delimit and has the highest host density. The host in this case is Seaside or Beach Morning Glory (*Ipomoea imperati*), a perennial flowering vine and relative of the sweet potato, that is found on the dunes of Caswell Beach in Brunswick County. In contrast, sweet potato weevils in New Hanover County are subsisting on an assemblage of other annual morning glory

species growing in disturbed habitats like roadsides and undeveloped residential lots. As is typical, we see weevil populations expanding rapidly in late summer (August-September) and often rise through December when cold temperatures force both the weevil and its host to recede, bottoming out in late winter to early spring (February-April) (Figure 4.4).

In early 2023 the data collected during this project will be harmonized and basic analyses can be performed to understand how this population has behaved over time within and across years spanning from 2015 to present day. Consistent monitoring will continue in 2023 and, given that host destruction is not available as a control method, M.A.T. will be used and the use of entomopathogenic fungi will continue to be explored and if possible, implemented in 2023.

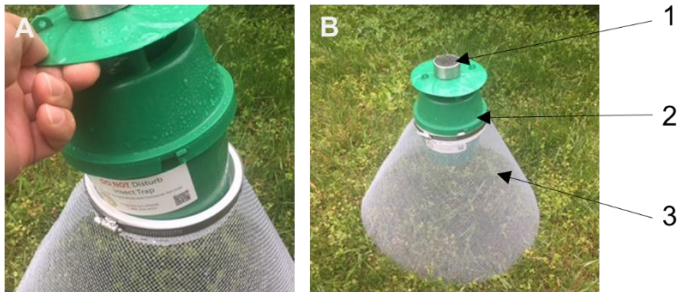


Figure 4.2. a. Details of the sweet potato weevil trap to use in the MAT. b. The base of the trap is a funnel made with galvanized mesh (3). This allows weevils to walk to the bucket trap fitted within a PVC ring that holds the funnel (2). The bucket trap includes a solar cell (1) that charges an LED 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.

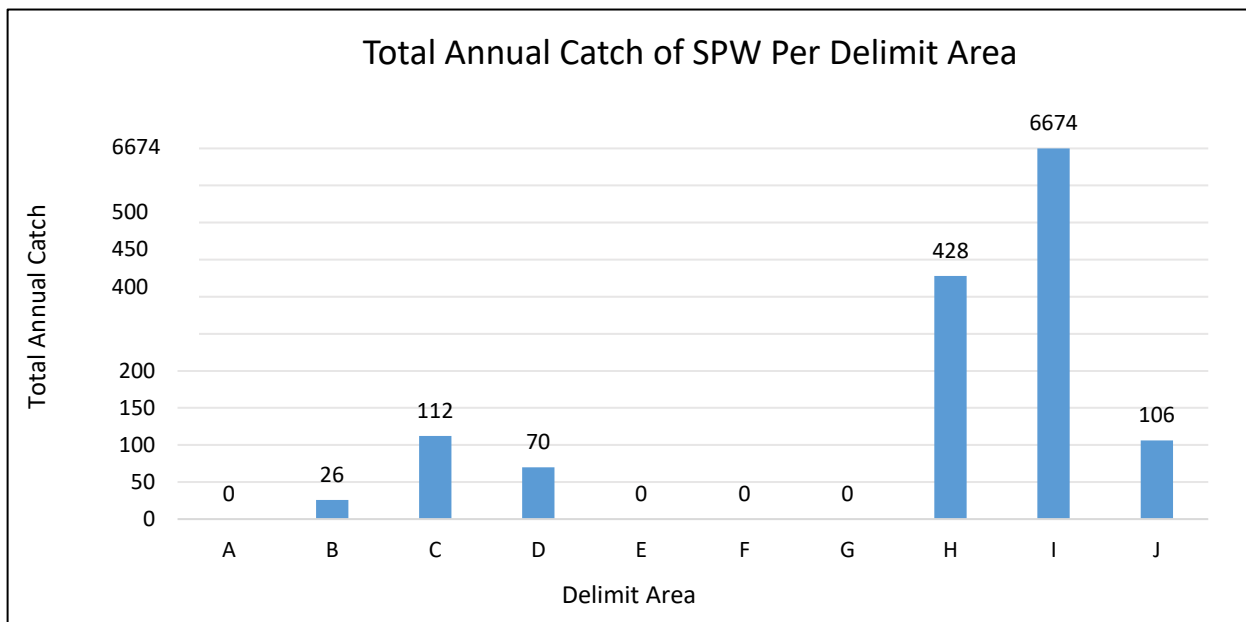


Figure 4.3: Total annual catch of sweet potato weevils within each of the 10 delimit areas. Delimits H-J are in Brunswick Co. at Caswell Beach while the others are in southern New Hanover Co.

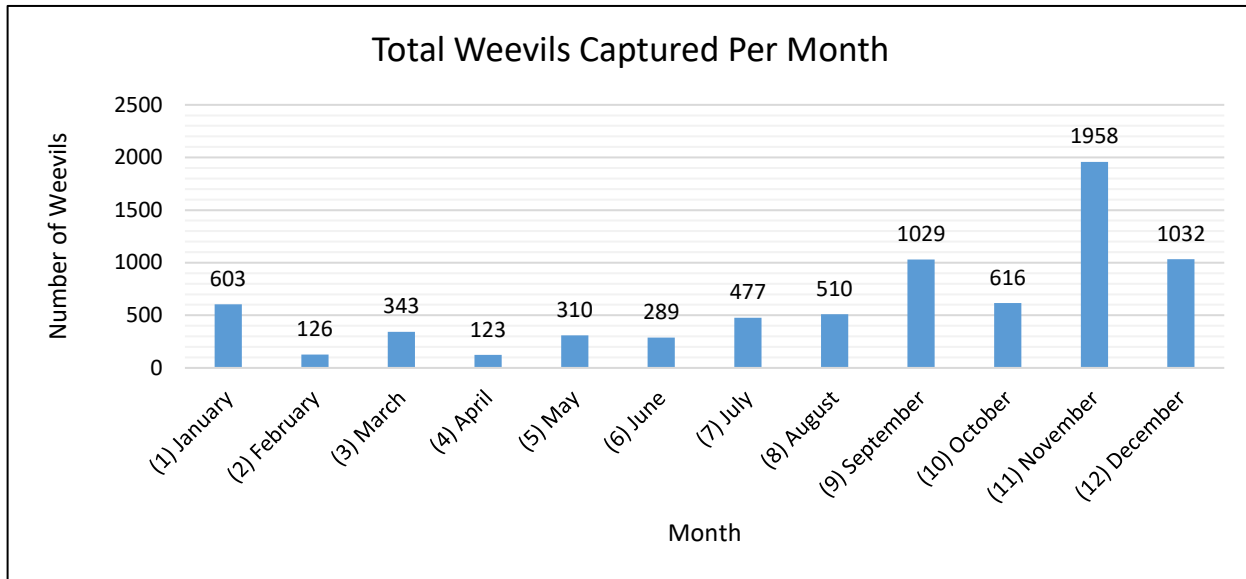


Figure 4.4: Total weevils capture per month across delimits.

SPONGY MOTH SLOW THE SPREAD AND ERADICATION PROGRAM

In 2022, NCDA&CS in cooperation with USDA-APHIS-PPQ, USDA-Forest Service (USFS), and the Slow the Spread (STS) Foundation, carried out an extensive trapping, treatment and regulatory program aimed at detection and eradication of spongy moth (*Lymantria dispar*), a major invasive pest of hardwood trees. The program in North Carolina is divided into the Slow the Spread Foundation-funded slow the spread action area (STS) and the USDA APHIS-funded eradication area (EGM) (Figure 4.5).

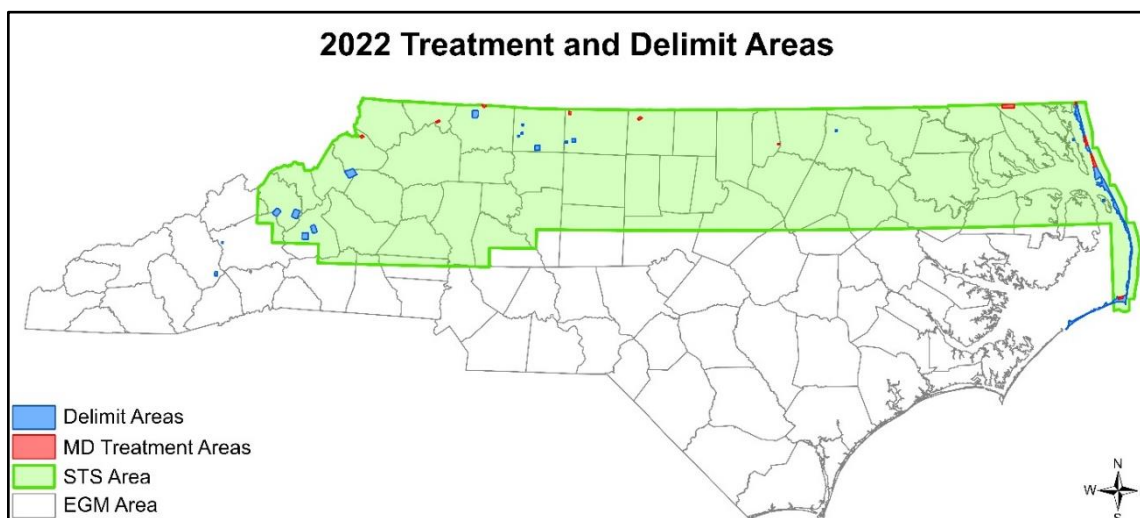


Figure 4.5: Spongy moth program areas and 2022 spongy moth treatment site and delimiting grids.

Trapping

A total of 17,248 traps were set across North Carolina between April and May 2022 and removed between July and September 2022 (Table 4.2). 9,720 traps were set in the slow the spread action area (highlighted in green in Figure 4.5) by 7 contractors, and 7,528 traps were set in the eradication area by NCDA&CS personnel along with an additional 398 traps at high risk/regulatory sites. Traps were baited with Disparlure, the female-produced sex pheromone of spongy moth (2-methyl-7R, 8S-epoxy-octadecane). Trap locations and data were recorded in iPad units. Trapping resulted in 1,433 adult spongy moth males captured in 826 positive traps (Table 4.2).

Table 4.2: North Carolina spongy moth trap catch numbers by county.

County	Traps Placed	Positive Traps	Moths
	10	5	11
Yancey	124	8	20
Yadkin	189	27	28
Wilson	117	2	2
Wilkes	431	17	19
Wayne	165	0	0
Watauga	172	18	21
Washington	99	5	6
Warren	295	3	3
Wake	247	3	3
Vance	189	7	7
Union	183	0	0
Tyrell	89	5	5
Transylvania	64	1	1
Swain	44	0	0
Surry	364	78	97
Stokes	332	61	97
Stanly	117	0	0
Scotland	91	3	3
Sampson	279	0	0
Rutherford	159	1	2
Rowan	151	1	1
Rockingham	397	26	46
Robeson	271	0	0
Richmond	136	3	3
Randolph	216	3	3
Polk	65	8	10
Pitt	186	0	0
Person	246	6	16
Perquimans	146	11	11
Pender	224	0	0
Pasquotank	148	13	17
Pamlico	89	0	0
Orange	177	2	3
Onslow	168	0	0

Northampton	357	6	6
New Hanover	66	0	0
Nash	169	0	0
Moore	199	0	0
Montgomery	123	0	0
Mitchell	63	7	8
Mecklenburg	171	2	2
Martin	127	2	2
Madison	109	1	1
Macon	92	0	0
McDowell	158	17	18
Lincoln	87	0	0
Lenoir	112	0	0
Lee	74	0	0
Jones	114	0	0
Johnson	222	0	0
Jackson	103	0	0
Iredell	176	6	6
Hyde	147	25	33
Hoke	107	0	0
Hertford	226	11	11
Henderson	102	1	2
Haywood	116	14	29
Harnett	174	0	0
Halifax	452	4	4
Guilford	266	3	3
Greene	77	0	0
Granville	328	2	2
Graham	35	0	0
Gates	231	34	43
Gaston	111	2	2
Franklin	211	3	3
Forsyth	206	13	15
Edgecombe	148	1	1
Durham	120	0	0
Duplin	234	0	0
Davie	79	4	4
Davidson	167	3	3
Dare	273	127	395
Currituck	193	49	124
Cumberland	189	0	0
Craven	175	0	0
Columbus	259	0	0
Cleveland	134	3	3

Clay	39	0	0
Chowan	82	6	7
Cherokee	99	0	0
Chatham	198	0	0
Catawba	122	4	4
Caswell	271	10	10
Carteret	113	2	2
Camden	132	11	11
Caldwell	158	8	42
Cabarrus	105	2	2
Burke	146	7	7
Buncombe	182	13	29
Brunswick	241	3	3
Bladen	253	0	0
Bertie	304	21	21
Beaufort	217	0	0
Avery	84	21	42
Ashe	279	21	23
Anson	151	0	0
Alleghany	156	30	64
Alexander	78	2	3
Alamance	176	8	8
Total	17248	826	1433

Since 2001 trap deployment has oscillated around roughly 17,100 traps placed each year, an average trap positivity rate of 5%, and an average of 2,967 moths captured each year (although moth capture numbers are highly variable from year to year). This suggests that NCDA&CS spongy moth activities have remained approximately stable over the past 20 years, although within the past 5 years North Carolina has seen a slight increase in both the number of positive traps and total moth detections, and a slight decrease in the number of traps deployed (Figure 4.6).

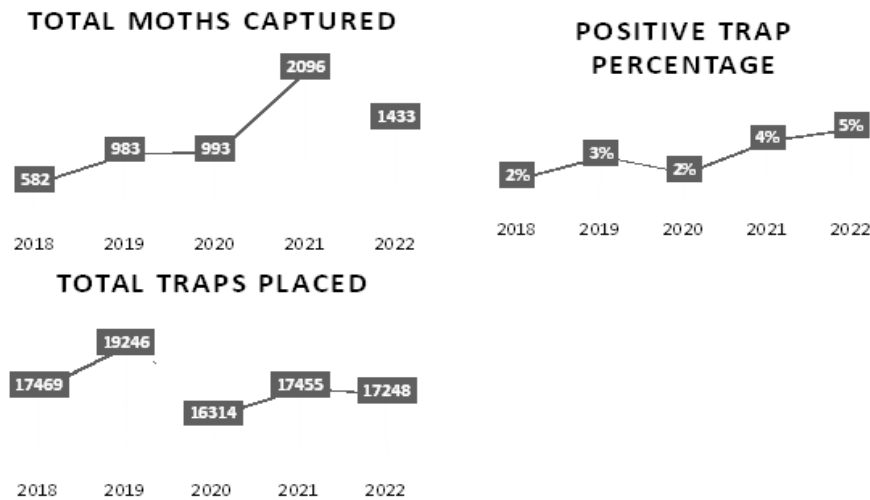


Figure 4.6: Spongy moth trap placement, trap positivity, and total moth capture rates from 2018-2022.

More moths were detected along the Virginia-North Carolina border, along the Outer Banks, and in the Blue Ridge Parkway area (Figure 4.6). Seven mating disruption (MD) treatments totaling 19,223 acres and multiple delimiting grids are proposed for 2023 to follow up in high-capture locations (Table 4.3).

Table 4.3: Locations and areas of mating disruption treatments planned for 2023

Block Name	County	Product	Dosage	Acres
Cruso	Haywood	SPLAT GM-O	6g	2,296
Grandfather Mountain	Caldwell	SPLAT GM-O	6g	1,417
Belews Lake	Rockingham	SPLAT GM-O	6g	1,004
Corolla	Currituck	SPLAT GM-O	6g	3,128
Oregon Inlet	Dare	SPLAT GM-O	6g	2,184
Roanoke Island	Dare	SPLAT GM-O	6g	742
Kitty Hawk	Dare	SPLAT GM-O	6g	8,362
TOTAL				19,223

Trapping surveys were conducted in the eradication area as stipulated in Cooperative Agreement AP21PPQFO000C230. Delta traps were set in an area-wide grid of 1 trap per 3 kilometers, with some delimit areas where one trap is placed at 1-kilometer intertrap density to closely monitor a suspected reproducing spongy moth population. Funding provided by USDA-APHIS-PPQ was used to employ 8 temporary employees, purchase survey supplies (including traps, lures, trap assembly supplies, and office supplies), and for operational expenses (including fuel and maintenance for survey vehicles).

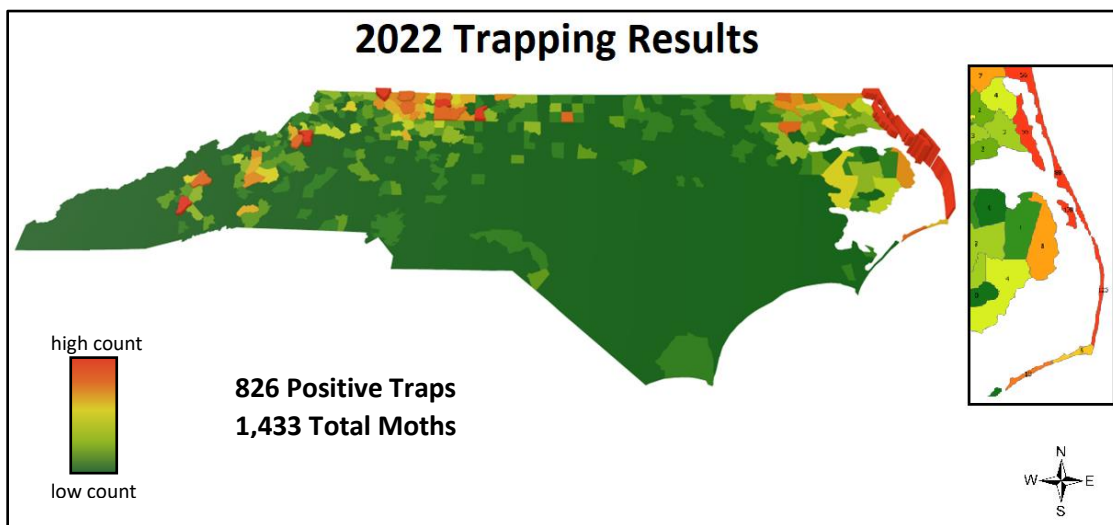


Figure 4.6: 2022 spongy moth trapping results

In the STS area, six contractors set traps in 30 bid units according to trap placement targeting provided by the STS Foundation in cooperation with Virginia Tech. Delta traps were set at an inter-trap density 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 during the prior year and areas under treatment evaluation were surveyed using a 1-kilometer inter-trap density grid with either high catch capacity milk carton traps or delta traps. Temporary personnel and permanent NCDA&CS staff performed quality control inspections at a minimum of 10% on traps set by contractors, and no significant quality issues were noted.

Treatment

In June 2022, eleven mating disruption treatments were performed within the STS area of North Carolina (Figure 4.5). A total of 16,909 acres were treated with 6g dosage of SPLAT GM-O (Table 4.4). Evaluation of the efficacy of these treatments will take place in 2023 and 2024.

Table 4.4: Locations and areas of mating disruption treatments in 2022.

Block Name	County	Product	Dosage	Acres
Glade Valley	Alleghany	SPLAT GM-O	6g	802
Lake Drummond	Camden	SPLAT GM-O	6g	5,673
Park Spring	Caswell	SPLAT GM-O	6g	949
Knotts Island	Currituck	SPLAT GM-O	6g	311
Mossey Island	Currituck	SPLAT GM-O	6g	1,933
Buxton	Dare	SPLAT GM-O	6g	1,194
Martin Point	Dare	SPLAT GM-O	6g	3,168
Price	Rockingham	SPLAT GM-O	6g	812
Cana	Surry	SPLAT GM-O	6g	915
Vicksboro	Vance	SPLAT GM-O	6g	285
Zionville	Watauga	SPLAT GM-O	6g	867
TOTAL				16,909

Regulatory

Regulatory management is the final component of the spongy moth control programs in North Carolina. The risk of additional movement and establishment of spongy moth beyond their natural spread is reduced by strategically restricting movement of high-risk regulated articles such as timber products, outdoor household articles, recreational vehicles, and trees and woody shrubs out of generally infested areas pursuant to North Carolina and USDA regulations (02 N.C.A.C. 48A.1500 *et seq.*, C.F.R. 7 §301.45(e)). In North Carolina, all of Currituck County and a small portion of Dare County were quarantined in 1988 and remain our only federally quarantined spongy moth areas (Figure 4.7).

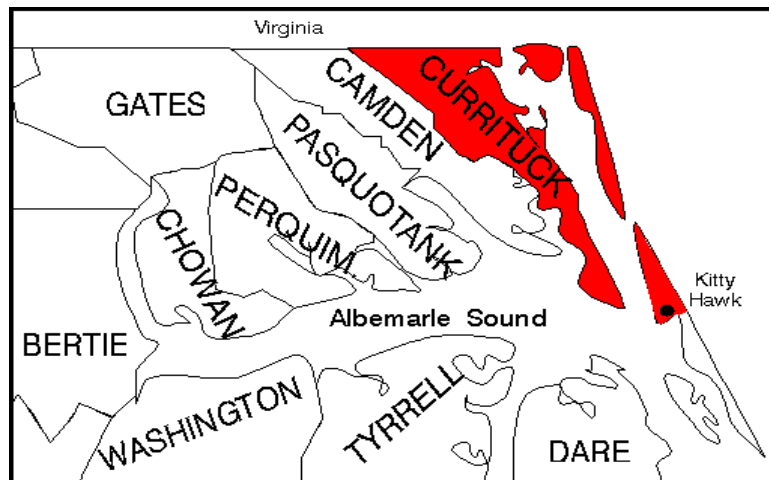


Figure 4.7: Spongy moth quarantine area in North Carolina, shown in red.

Regulated articles may be moved from quarantined to non-quarantined areas if the appropriate personnel within organizations 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 spongy moth life stages. Several businesses and individuals received training for new staff in 2022 and one new compliance agreement is in process. The spongy moth compliance agreement issuance process is currently being restructured to reduce personnel burden and streamline overall compliance levels.

Outreach

Opportunities for public interactions are an important part of spongy moth management success. Meetings with NC Forest Service, NC SWCD, and tribal personnel are planned for updating and receiving feedback on anticipated 2023 program activities. The adoption of a new common name for this pest in 2022 by other state, federal, and non-government entities has rendered all printed materials on hand obsolete, necessitating redevelopment of all print products. New and updated digitally available spongy moth resources are being created for outreach events, and materials will be printed as needed. Additionally, the spongy moth program has developed outreach materials for the NC public education system in collaboration with NC Department of Public Instruction (NC DPI). The first trial of a presentation supporting NC 5th grade Core Learning Standard 2- Ecosystems was conducted in December. This effort supports the NC DPI drive to deliver standards-based instruction that showcases relationships between classroom experiences and student's environments as well as NCDA&CS's initiative to inform the public about spongy moth treatment activities that happen in their area.

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 fourteen states. North Carolina is on the leading edge of the expanding range of fire ants. Currently, 77 of North Carolina's 100 counties are either partially or entirely infested. NCDA&CS' objective is to prevent the artificial spread of IFA from infested areas to non-infested areas through regulatory actions.

The following report summarizes the NCDA&CS survey and regulatory activities conducted for the Imported Fire Ant Program from January 1 to December 31, 2022:

Survey

Drive-by surveys were conducted in 16 counties (Alexander, Avery, Buncombe, Caldwell, Davie, Forsyth, Graham, Haywood, Iredell, Macon, Madison, Mitchell, Swain, Watauga, Yadkin, Yancey) in NC (Figure 4.8; Table 4.5). Data was collected using iPads and the ESRI Survey 123 for ArcGIS application and included new IFA mounds and established sites. The option to choose '0 mounds' was included and indicates sites with no mounds reported. This was used to show the areas surveyed in all counties (negative controls). Based on the results of the 2022 IFA survey we have not elected to expand our quarantine. However, the data seems to indicate that IFA may be established in parts or all of several western counties not previously quarantined and successive years of data will lead to their quarantine. 2022 data also confirms our suspicions from 2021 that IFA are present in far western counties but was not previously supported by survey data due primarily to the lack of available temporary labor in the western regions of the state. Survey plans for 2022 and subsequent years have corrected this issue. Virginia has expanded their IFA quarantine along the North Carolina border extending beyond our current NC IFA quarantine boundaries. In 2023, we will continue to survey the NC-VA border along the newly expanded VA IFA quarantine line and to address the survey needs of the above listed counties a few of which are adjacent to the counties quarantined in Tennessee.

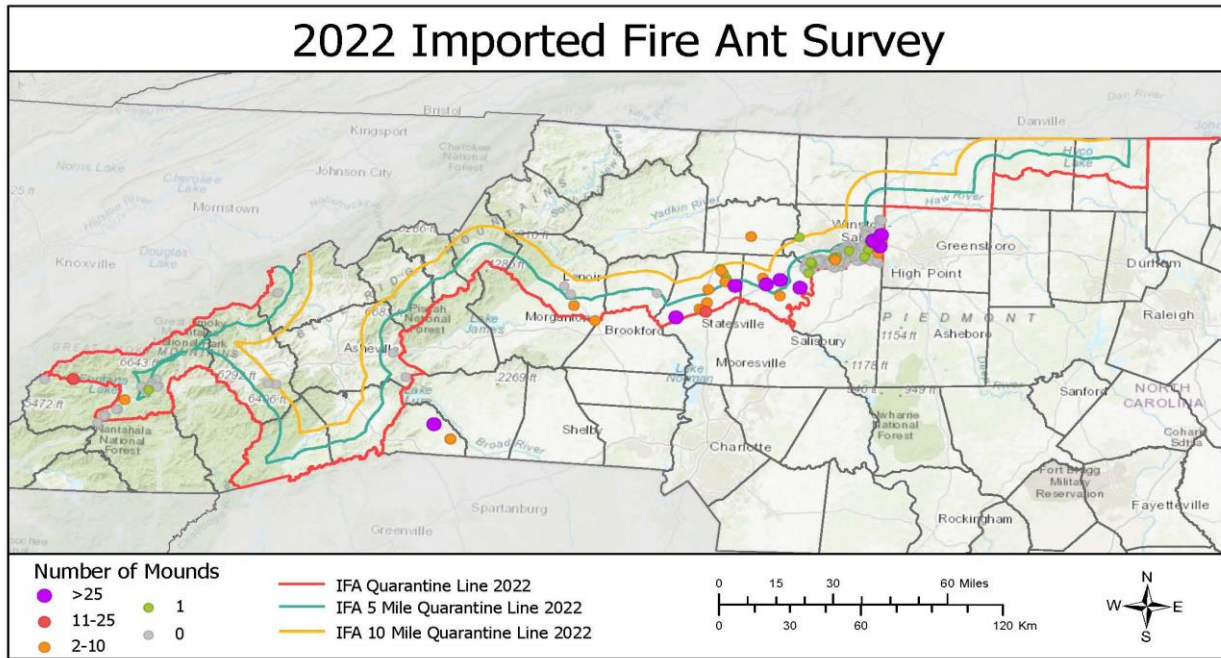


Figure 4.8: NC Imported Fire Ant survey results (March-October 2022). 238 data points were collected, 163 of which were reported as ‘0 mounds observed’.

Table 4.5. 2021 NC Imported Fire Ant survey summary.

County	Areas Surveyed	Regulatory Action Recommended ¹	Absent	Established Sites	New Observation ²	Total Sites
Alexander	5-mile strip from the quarantine line	No action	3	0	3	5
Avery	5 & 10 miles from the quarantine	No action	1	0	0	1
Buncombe	5 & 10 miles from the quarantine	No action	2	0	0	2
Caldwell	10-mile strip from quarantine line	No action	2	0	2	4
Davie	10-mile strip from quarantine line	No action	1	0	9	10
Forsyth	5 & 10 mile from quarantine line	No action	132	0	44	176
Graham	5 & 10 mile from quarantine line	No action	1	0	0	1
Haywood	5 & 10 mile from quarantine line	No action	2	0	0	2
Iredell	5-mile strip from the quarantine line	No action	1	0	12	13
Macon	5 & 10 mile from quarantine line	No action	1	0	0	1
Madison	5-mile strip from the quarantine line	No action	1	0	0	1
Mitchell	5 & 10-miles from quarantine line	No action	2	0	0	2

Swain	5-mile strip from the quarantine line	No action	12	0	4	16
Watauga	5-mile strip from the quarantine line	No action	1	0	0	1
Yadkin	Greater than 20 miles from quarantine line	No action	0	0	1	1
Yancey	5-mile strip from the quarantine line	No action	1	0	0	0
Total			163	0	75	238

¹“No action” when numbers are not enough to justify a regulatory action. “Expand” when partially quarantined counties have shown significant numbers of IFA mounds above the quarantine line. “Add” when there is conclusive evidence that a significant number of IFA mounds are detected in a county where no previous mounds have been reported.

²For the purposes of this table new observations are only recorded for presence of mounds. If a new observation was recorded but there were no mounds present that is recorded on the ‘Absent’ column of this table.

Regulatory

As part of the IFA program’s regulatory activities, 16 blitzes were scheduled to be conducted in three locations across the state to ensure that operations moving regulated articles outside the quarantine area in NC are in compliance with federal and state regulations. A total of sixteen blitzes were to be held in 2022 with 8 days in the spring and 8 days in the fall. Dates and locales are given in Table 4.6 below. NCDA&CS stopped a total of 23 trucks to inspect their load and review/record their paperwork in Spring of 2022. Of those 23 trucks we collected 10 soil samples. The Henderson Co. blitzes were canceled in spring due to construction on I-26. In Fall of 2022 7 of the 8 days were completed with one blitz being canceled due to an unforeseen calibration of the scales at the weigh station. On those 7 days, 9 trucks were stopped, and 5 samples were taken. Four of the five samples were taken at Halifax weigh station days and the other in Iredell County.

Table 4.6. IFA Blitz Spring 2022 Results

Date	Location	Trucks Stopped	Sample Taken
03/08/22	Halifax Co. (I-95 North Bound)	4	0
03/09/22		5	3
03/15/22		5	3
03/16/22		8	4
03/22/22	Iredell Co. (I-40 East Bound)	1	0
03/23/22		0	0
03/29/22	Henderson Co. (I-26 East Bound)	Cancelled	Cancelled
03/30/22		Cancelled	Cancelled
10/04/22	Halifax Co. (I-95 North Bound)	2	2
10/05/22		2	0
10/11/22		2	1
10/12/22		1	1
10/18/22	Iredell Co. (I-40 West Bound)	2	1
10/19/22		0	0
10/25/22	Buncombe Co. (I-40 West Bound)	0	0
10/26/22		Cancelled	Cancelled
Totals		30	13

BLUEBERRY CERTIFICATION PROGRAM

The blueberry maggot (*Rhagoletis mendax*; BBM; Figure 4.9) 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 4.9. Blueberry maggot (*Rhagoletis mendax*): a) adult; b) larva inside blueberry (Photos by Rufus Isaacs, MSU)

In North Carolina, we currently have 48 blueberry farms located in four southeastern NC counties (Bladen, Duplin, Pender, and Sampson) participating in the Blueberry Certification Program. In May 2022, 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 4.10; the complete method can be found at

<http://www.ncagr.gov/plantindustry/Plant/entomology/BlueberryCertificationProgram.htm>).

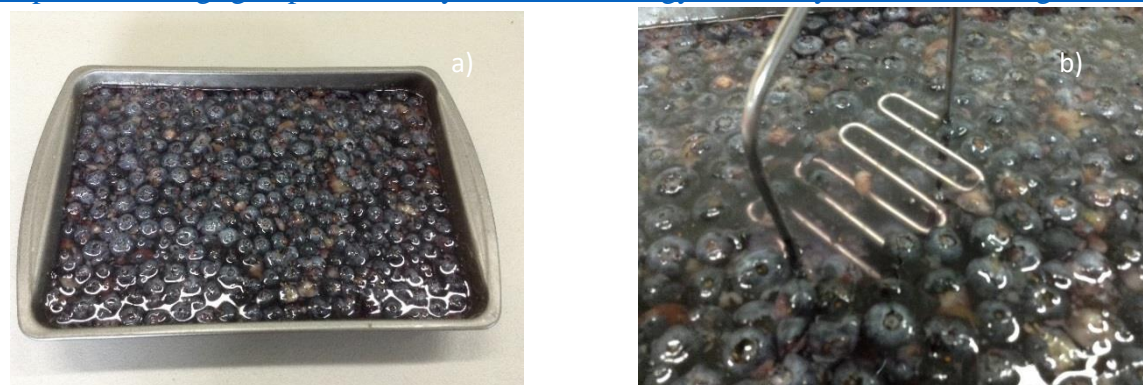


Figure 4.10. Salt flotation test: a) blueberries soaking in salt water solution for 10 minutes; b) close-up of flotation test showing potato masher used to gently crush berries. (Photos by Whitney Swink, NCDA&CS)

In late May and Early June, 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). A total of 36 inspections were conducted this year for 23 farms. All 23 farms opted to use calendar spray treatments at all inspected locations. There were 126 spray treatments done by these 23 farms and 213 salt/sugar flotation tests all of which were negative for blueberry maggot.

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 continue to utilize Survey 123.

COTTON BOLL WEEVIL PROGRAM

Field surveys for the cotton boll weevil (*Anthonomus grandis*) were coordinated and carried out by the NC Cotton Boll Weevil Eradication Foundation. In 2022, a total of 457,179 acres were reported in 60 counties (Table 4.7). Plant Industry Division personnel surveyed cotton gins, cotton processing facilities, and ornamental cotton at 50 unique locations in approximately 30 counties using conventional cotton boll weevil traps (Table 4.8). Traps were baited with a male specific sex pheromone and checked once a month.

Table 4.7. Cotton acreage by county in North Carolina for 2022.

County	Acreage	County	Acreage	County	Acreage
Anson	1,623.06	Granville	0.0	Pamlico	760.92
Beaufort	13,257.93	Greene	10,112.6315	Pasquotank	377.67
Bertie	36,050.1911	Halifax	60,565.721	Pender	553.6
Bladen	5,563.4975	Harnett	7,716.99	Perquimans	9,707.7458
Brunswick	0.0	Hertford	12,759.7025	Pitt	17,814.007
Cabarrus	1,120.002	Hoke	4,996.945	Randolph	0.0
Camden	232.21	Hyde	12,020.5671	Richmond	2,417.2375
Carteret	1,097.19	Iredell	1,505.6	Robeson	19,607.8555
Chowan	9,261.08	Johnston	8,213.484	Rowan	0.0
Cleveland	0.0	Jones	8,069.7	Rutherford	107.68
Columbus	1,248.03	Lee	0.0	Sampson	12,312.036
Craven	10,042.08	Lenoir	11,705.94	Scotland	6,301.832
Cumberland	8,033.32	Lincoln	125.96	Stanly	12,496.253
Currituck	0.0	Martin	27,483.0154	Tyrrell	3,865.69
Davidson	1,529.14	Mecklenburg	0.0	Union	2,663.0025
Duplin	4,625.93	Montgomery	728.735	Wake	32.96
Durham	0.0	Moore	486.95	Warren	165.4
Edgecombe	23,374.9304	Nash	10,126.305	Washington	6,260.5288
Franklin	175.97	Northampton	33,892.9242	Wayne	11,583.9459
Gates	13,326.3992	Onslow	4,276.58	Wilson	4,801.8750
				Total	457,178.9499

Table 4.8: Cotton site inspections of traps placed inside and outside facilities per month for the year 2022.

Month	# of Inspections	Location			Total Traps
		Inside	Outside	Other	
January	28	1	46	0	47
February	24	1	39	0	40
March	18	2	31	0	33
April	19	2	33	0	35
May	14	1	22	0	23
June	13	0	21	0	21
July	5	0	5	0	5
August	7	0	9	0	9
September	1	0	1	0	1
October	35	1	50	0	51
November	36	3	51	0	54
December	31	6	53	0	59
Totals	231	17	361	0	378

SPOTTED LANTERNFLY PROGRAM

Spotted Lanternfly Overview

Spotted Lanternfly (*Lycorma delicatula*) (SLF) is a relatively new pest in North America. Discovered in Berks County, Pennsylvania in 2014, SLF has since spread to 14 states which include: Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Ohio, Michigan, Indiana, West Virginia, Maryland, Delaware, and Virginia, and since June 23, 2022 known to infest parts of North Carolina. At present, there are over 100 host species for this insect including things like maples, birches, oaks, sycamores, roses, grapes, apples, and many other hosts. Two preferred hosts for this pest that North Carolina has in abundance are Tree of Heaven (TOH, *Ailanthus altissima*) and Chinaberry (CB, *Melia azedarach*), both of which support SLF populations in their native range and are generally considered invasive in the U.S., thrive in disturbed habitats like railway and highway right of ways. That being said, the greatest risk of spread for SLF is through human assisted means via trucking, rail, and generally via interstate commerce and shipping. Accordingly, there are clear patterns indicating that SLF has reached these 14 states in a short 8-year span in this manner. Seeing this threat expanding, North Carolina was very proactive and received both specialty crop and PPA-7721 funding to do work related to spotted lanternfly preparedness like outreach to vulnerable industries, surveys for Tree of Heaven, and the acquisition of materials that would be needed to treat an infestation.

Citizen SLF Reports

In Fall of 2021 an SLF citizen report came in from a Pennsylvania resident visiting one of North Carolina’s most visited tourist destinations in western North Carolina. While no photograph or specimen was submitted, the proximity of the report to vineyards on the property elicited an immediate investigation and no SLF, living or otherwise, were located. The citizen report did however give cause for NCDA&CS to both re-visit the location to speak with the vineyard staff and key representatives (late January) and to host an on-site training session with targeted staff to be prepared for this pest given the winery, broad array of host plants, and known interstate tourism which kicked off 2022 in mid-February. Concurrently we were working on a “special local needs” (SLN) exemption (24(c) registration) for the use of Transtect on TOH to treat spotted lanternfly in the event of an infestation. Additionally, late January saw our first Spotted Lanternfly report. A single dead adult was found

trapped in some packaging of a manufacturing facility. The ensuing investigation turned up no additional insects and a circle trap was placed in front of the facility and monitored monthly in 2022. Early February was the first significant threat of SLF in North Carolina when one of our two detector canines hit on a tree in the Corolla, NC area which was not far from a report that came in in 2021. At our training in Asheville, we received another report of SLF in Weaverville, NC which upon subsequent investigation also turned up no evidence suggesting the presence of an SLF population.

March opened with a joint operation between Virginia and North Carolina helping to further delimit and survey an infestation in Hillsville, VA with extra personnel and the additional aid of our two detector dogs. Given the influx of SLF reports NCDA&CS developed a threat evaluation report which is submitted through ESRI Survey123 Application such that subsequent investigations and reports could be quantified, prioritized, and available for all NCDA&CS field staff to see at moment's notice. We also developed a more robust reporting tool using Survey 123 for citizens to reports spotted lanternfly. In late July we finally received a response from an iNaturalist user who had posted a spotted lanternfly sighting in Fayetteville, NC in late 2021. After speaking with the individual, we established that the image was not taken in North Carolina but rather along her route from up north in New Jersey. Work in April included finalizing the development of our SLF Standard Operating Procedure and finalizing our submission for the SLN exemption.

May opened with another suspected spotted lanternfly in Weaverville. Subsequent investigations resulted in no evidence of SLF in the area. May was also the month that 2 regional trainings were set up for NCDA&CS field staff to better understand SLF hosts, SLF identification, and how to use the iPad reporting software if they investigate a site for SLF or find one. The third and final training was held on June 6th and that same day our special local needs registration was granted for Transtect use on TOH. The day prior we had a report of SLF nymphs all over a home with picture documentation to support that it was SLF. However, on June 6th we found out this was a Pennsylvania resident who used our website by mistake in efforts to report her find to Pennsylvania Department of Agriculture. On June 8th we had another report of SLF, this time in Cooleemee, NC where a citizen noticed what she believed to be SLF. This area was investigated but no SLF, living or dead, were found. On June 23rd NCDA&CS received our first report of an active SLF infestation in Kernersville which is detailed further in this report. June 25th we received an additional legitimate report of SLF which highlighted that citizens in the Kernersville area were noticing SLF after the increased awareness campaigns following the initial discovery.

In the months following the press release of spotted lanternfly's presence in North Carolina, coupled with our increased outreach efforts, a significant number of reports came in through our new Survey123 reporting mechanism. Most of these were just misidentified insects and thankfully not spotted lanternfly. Some of the look-alikes that were reported included Florida Predatory Stinkbug, Hibiscus Scentless Plant Bug, Various species of Tiger Moth, the Giant Leopard Moth, Tiger bee fly, Lady bug species, milkweed bug, boxelder bug, and others. Of the reports that came in (approximately 197), only 13 were spotted lanternfly. Of those, a significant portion were within the Kernersville infestation area. However, there were a few notable exceptions. First, a commercial truck driver reported an adult spotted lanternfly on his windshield wiper in the High Point area, approximately 8.5 mi from the nearest known SLF in Kernersville. Upon investigation of the immediate area no SLF were found. However, a patch of TOH on a nearby railway did result in the finding of one SLF adult that appeared sluggish and unhealthy. The area surrounding these finds were visited multiple times by our SLF detector canines and locations throughout High Point were visually surveyed by a temporary employee on a near weekly basis through the end of the season. It is not believed that a population is currently present at this location. Two other credible reports came in for SLF in Winston-Salem and Archdale, North Carolina. Both sites were visited by detector canines and the surrounding areas

surveyed but no SLF living or otherwise were detected. Lastly, at the I-77/74 southbound Welcome Center coming out of Virginia an NCDA&CS temporary discovered an adult spotted lanternfly. NCDA&CS personnel investigated and found a number of other SLF adults and one egg mass. The Tree of Heaven at the site were treated with Transtect to kill any adults feeding on or moving to Tree of Heaven. The site continues to be monitored and has not shown further evidence of SLF infestation at this time.

Kernersville Infestation- First Active Infestation of Spotted Lanternfly in North Carolina

On Thursday June 23rd, 2022, a report came in from a business in Kernersville, NC stating they had spotted lanternfly and had for some time. Images provided by an employee of this business seemed to clearly confirm SLF were present. Paul Adams, Regulatory Entomologist and Sara Lalk, Forest Health Research Operations Manager were dispatched to immediately investigate the report. The investigation team reached the business at approximately 11 AM. and were escorted by an employee to the back edge of the property where both tree of heaven and red maple were in abundance. With very little effort dozens, if not hundreds, of live, active SLF were found. The majority of the SLF were 4th instar nymphs, but 3rd instars were also present (Figure 4.11a, 4.11b). It was clear this infestation had been present for an estimated 2 to 3 years based on the population size and multiple classes of egg masses present on the trees (Figure 4.11c).

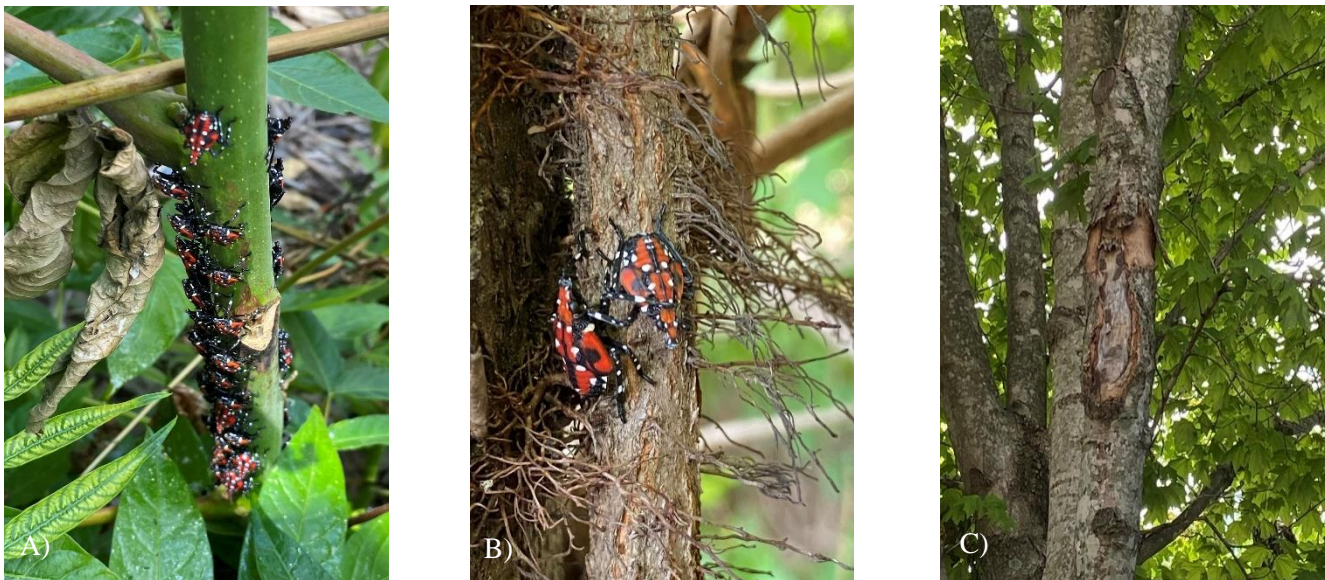


Figure 4.11: A) cluster of 4th instar nymphs on small tree of heaven; B) two 4th instar nymphs on poison ivy vine; C) multiple egg masses of varying age on red maple.

On Friday June 24th additionally field staff, management staff, and USDA were brought in to further assess the extent of the infestation and to discuss treatment protocols. An official press release was published on June 29th.

Treatment

Treatment began on Tuesday June 28th and continued through October 14th. Initial efforts involved 5 day per week survey and treatment which included NCDA, USDA, and NCFS personnel. NCDA&CS personnel utilized 3 primary chemistries: Transtect (dinotefuran) systemic insecticide utilized on Tree of Heaven only; Talstar Pro (bifenthrin) a contact insecticide used to knockdown high populations; Garlon (triclopyr) a foliar herbicide used to remove tree of heaven from properties. Most applications

were performed with backpack sprayers although an engine powered sprayer mounted to a side by side was utilized when needed. Beginning August 12th, the work was reduced to 4 days per week with two days dedicated to survey only and two days to treatment only. Primary objectives for early treatment were to use bifenthrin to hit obvious concentrations of SLF and secondarily to begin treating all tree of heaven on all properties radiating out from our assumed ground zero. Survey crews were similarly working to address all properties radiating out from our point of infestation making sure to mark all tree of heaven and provide some indication of the extent of the nymphs or adults that were present or the absence of TOH when appropriate. Initial efforts shied away from the use of herbicide (triclopyr). However, several weeks into treatment we began to prioritize its use for the following reasons: 1) triclopyr is significantly cheaper than dinotefuran; 2) Removing tree of heaven potentially reduces the quality of an area to SLF; 3) Many properties had no structures or aesthetic concerns or the removal of the trees were supported by the property owner. Later in our treatment phase we did add a new formulation of Garlon (triclopyr-4) that we could use as a basal bark treatment on larger DBH tree of heaven. North Carolina Forest Service, with permission from the NC Department of Transportation, removed large swaths of TOH along I-40 and HWY 421 to reduce potential refuge sites for SLF whether newly introduced or in moving away from ground zero. On September 20th we detected the very first egg masses here in North Carolina. Fortunately, this coincided with Northern States, despite having adults emerging over a month ahead of them.

Season Conclusion & 2023 Planning

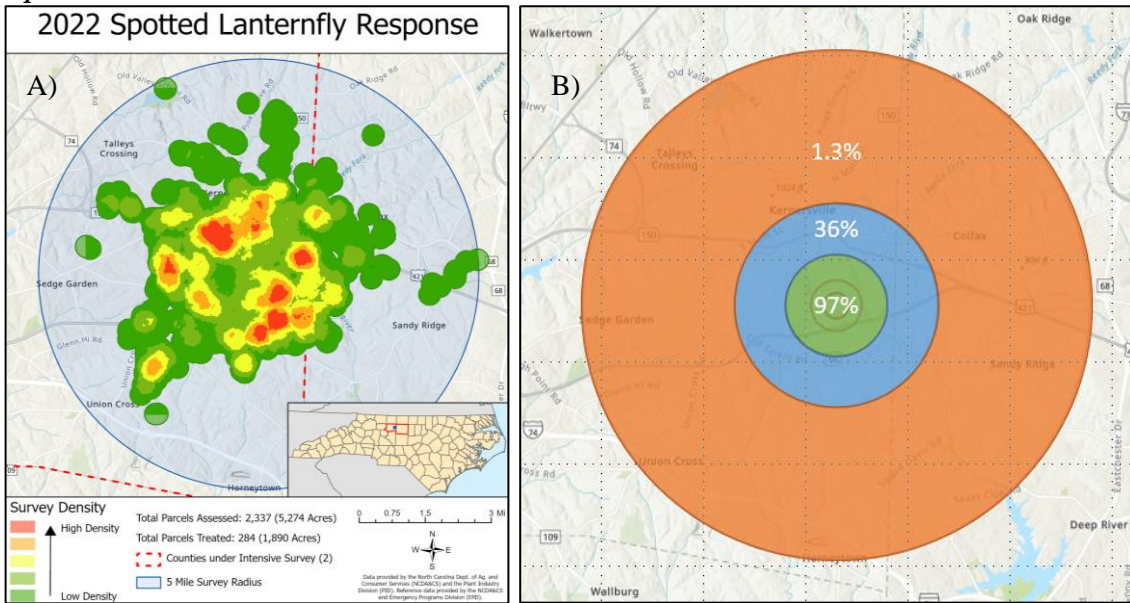
Due to Tree of Heaven senescence and other environmental pressures, NCDA&CS personnel ceased treatment activities on October 14th, 2022. Table 4.9 below summarizes the scope of the work executed by NCDA&CS and its cooperators in the 2022 SLF season.

Table 4.9. Summary of regulatory activities & volume for 2022 SLF season.

Regulatory Activity	Unit	Volume
Survey	Parcels	2,290
Survey	Acres	4,834.43
Treatment	Diameter at Breast Heigh (DBH) of TOH	22,759
Treatment	Acres	>180
Overall Coverage	Square Miles	>3

The result of our work is pictured in Figure 4.12 below. At the conclusion of 16 weeks of work, 9.7% of all 28,205 parcels within the 5 mi radius were surveyed and either cleared of TOH and SLF presence or marked for treatment. Surveys revealed that the SLF infestation was truly concentrated within the first mile radius from the initial report site, and survey crews’ efforts were accordingly concentrated here to maximize SLF suppression through treatment efforts (Figure 4.12B). Only 4.2% of parcels surveyed were positive for SLF, and the live SLF were found at a maximum of 3.8 mi apart from each other, roughly 2 mi out from either side of the initial report site. The area over which the infestation covers contains dozens of businesses involved in interstate commerce and several residential developments, and at this stage it is impossible to trace back introduction to any single source.

Figure 4.12: Summary of 2022 Kernersville SLF surveys (not SLF detections) including A) the densities of surveys conducted and B) the percentage of parcels surveyed within radii (1 mi, 2 mi, and 5 mi) from the report site.



The sheer volume of work done in 2022 was an enormous strain on NCDA&CS personnel. However, daily dedication and tenacity during especially brutal weather yielded an impressive volume of work in a short time.

Statewide SLF Survey

8 PID temporary employees conducted visual surveys for SLF and its preferred host trees, (tree-of-heaven and chinaberry tree) and placed circle traps (serviced monthly) at a total of 63 high-risk locations throughout the state (Table 4.10). All data were collected through an ESRI Field Maps application created by our GIS Specialist James Goethe.

Table 4.10. SLF statewide survey activities 2022 (excluding infested area)

	reporting period	Total (all years)
Infested tree detections	1	1
Tree-of-heaven sightings	1,396	11,210
Chinaberry sightings (TOH present)	99	99
Negative tree of heaven sightings	1,302	2,507
Chinaberry sightings (TOH absent)	1,146	1,146
Circle trap survey locations (thru Nov. 2021)	63	73
Counties surveyed	82	94

Host Tree Visual Survey

Approximately 2,698 sites were inspected for TOH and spotted lanternfly throughout North Carolina while conducting this survey during calendar year 2022. In total, 8 temporary employees and 22 full-time employees participated in this survey in 2022. Since the statewide survey first began in 2020, we have surveyed 94 of our 100 counties. The remaining 6 counties are on the eastern and western extremities of our state, have low climate suitability for TOH, CB, or both, and are either very rural and/or host large wildlife refuges, reducing the likelihood of pest introductions. Changes to survey methods implemented during 2022 included:

- Chinaberry tree presence/ absence was added to the survey form. This is in response to populations of SLF persisting in the natural environment in China at sites where *CB* is present and TOH is absent. While there is anecdotal consensus that chinaberry is plentiful in the eastern region of North Carolina and our existing data show that tree-of-heaven is sparsely populated, there was a lack of maps from either state or federal sources showing chinaberry distribution in North Carolina. This will be the first comprehensive map of this SLF host tree in the state and will allow for a more targeted response in the case of SLF introduction to heavily visited areas in our coastal region. Results are displayed in Figure 4.13.
- Previous year survey locations were shifted to a “background layer” in our Field Maps survey. This was meant to direct surveyors to return to previously visited locations to conduct visual SLF surveys and incorporate the chinaberry survey at these sites.

Circle Traps

Following a pilot trapping project in 2021, circle traps were implemented on a broader scale during the 2022 survey season. We used data collected from previous years in this survey to determine locations with higher SLF introduction and establishment risk to place a minimum of 40 traps. These locations included rest areas, private campgrounds, and transit corridors, and tourism destinations. Traps were set beginning in May and serviced monthly through October. These traps were placed either on TOH or other preferred host trees (chinaberry, maple, walnut) and serviced monthly, and visual surveys were also conducted at each site each month. Ultimately a total of 63 traps were placed. The circle trap distribution was as follows:

- 21 vineyards (17 viniferous grapes, 4 muscadine)
- 34 NCDOT rest areas
- 5 tourism areas
- 3 previous report sites (live SLF interception locations)

During the September 23rd check at the Surry County I-77/ I-74 Welcome Center, one of the trappers found an SLF adult within 3 feet of the trap, prompting a next-day response by Plant Protection staff (see “**Citizen SLF Reports**” above).

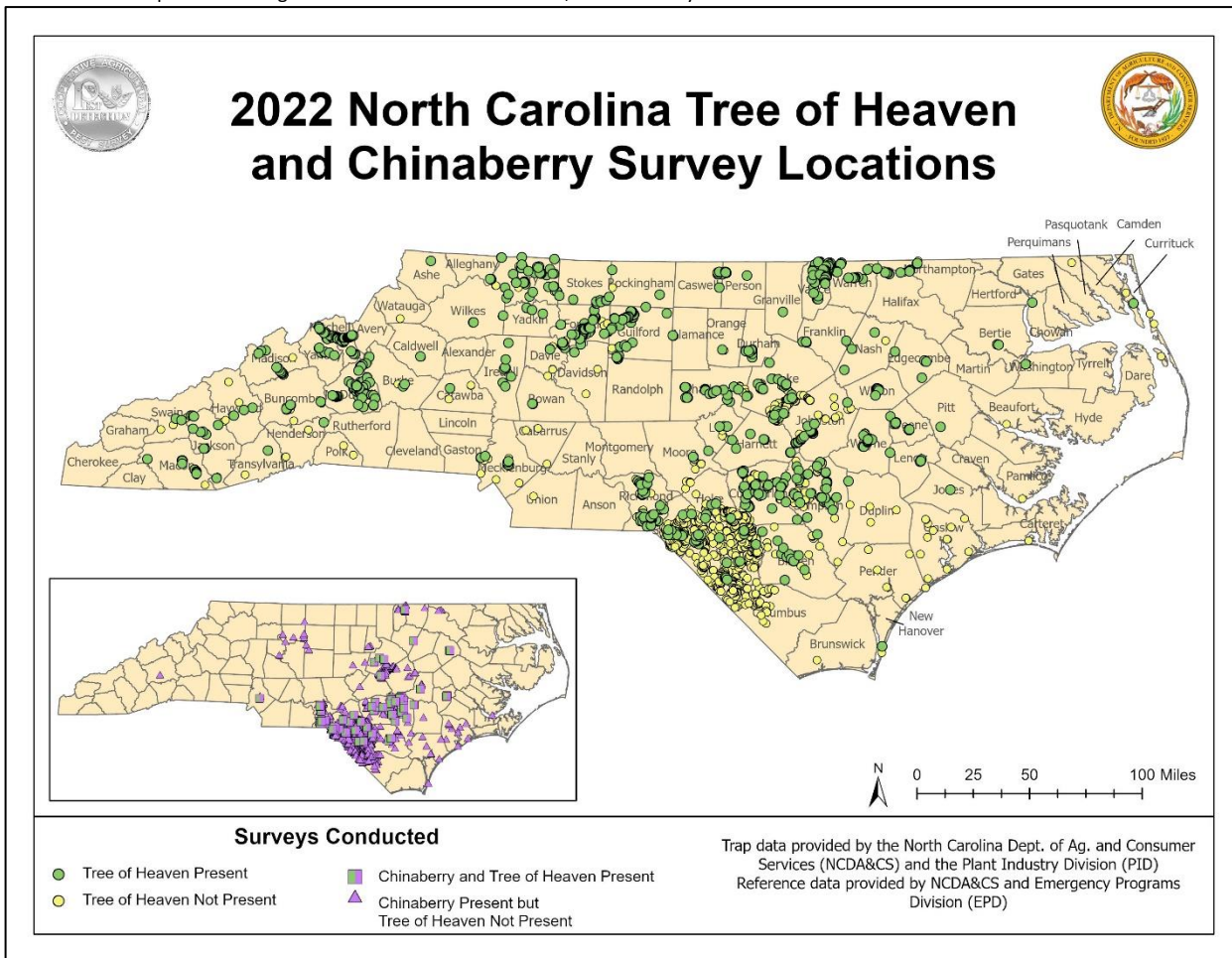


Figure 4.13. North Carolina Statewide SLF and Host Tree Survey 2022

Spotted Lanternfly Canine Program

In September 2021 Plant Industry Division began the process to add 2 USDA trained spotted lanternfly detector dogs to their staff. Canine handlers were selected from current staff and spent 4 weeks training with their dogs at the USDA National Detector Dog Training Center in Newnan, Georgia followed by an additional 22 days of in-field training in Winchester, Virginia. The handlers graduated from the program and returned to North Carolina with their canines on November 9, 2021.



Figure 4.14 - From Left: Canine Kita, Jacqueline Fredieu, David Jones, Canine Neeko (Goose) and Chad Taylor



Figure 4.15 - Chad Taylor training with Neeko (Goose) in Atlanta, Georgia at MARTA to expose the canine and the handler to real life situations



Figure 4.16 - Jacqueline Fredieu training with Kita at the Virginia Inland Port to expose the canine handler to real-life detection situations.

Since returning to North Carolina the teams have actively investigated all previous SLF reports in North Carolina to search for egg masses and completed inspections at high risk sites. To date, more than 166 North Carolina locations have been inspected by the detector dogs. Below are some of the more significant investigation and survey results:

- For several months after the initial deployment of the trained canine teams in North Carolina, both teams surveyed high risk parks and campgrounds across the state.
- A Chatham County nursery received a truckload of containerized plant material in September 2021 from a New Jersey nursery in the SLF quarantine area. The nursery owner reported live adults on the material and our initial investigation prior to the dog team's arrival found several dead adults. Jackie and Kita surveyed the entire nursery in December 2021. No egg masses were found.
- An image of a live nymph was submitted by a tourist at the Outer Banks this summer. Within days the SLF response team visited the exact location of the image, met with the photographer and completed a survey of the area and found no SLF life stages. Jackie and Kita returned to the area in February 2022 and Kita signaled on a single tree 2 days in a row, but no egg mass was found at that time. The tree was flagged and further inspected using ladders, but no egg mass was found. The Plant Pest Specialist who covers this region continues to survey that location.
- In January 2022, both canines and their handlers surveyed the vineyards, grounds and vulnerable parking areas at one of NC's largest tourist destinations. This survey was triggered

by an anecdotal report of SLF by a Pennsylvania resident. No SLF were found, however both canines signaled on a grape vine in the vineyard and despite a thorough survey no egg mass was found. The vineyard manager chose to remove and dispose of the vine.

- In September 2021 we received a report of live SLF that transited to Monroe, NC on the “Tinkerbelle”, a WWII plane that had just spent three months parked in Pennsylvania. In February 2022 both canines and their handlers inspected “Tinkerbelle” and the surrounding area. Kita found a dead adult in the rear landing gear. While in the area, both dogs also surveyed the business in Cabarrus County located beside railroad tracks that found a dead adult in their facility this past summer.
- NCDA&CS is working with the Virginia Department of Agriculture and Consumer Services (VDACS) to provide canine assistance with SLF surveying. March 8, 2022, both detector teams as well as the NC CAPS Coordinator and NC SPRO met in Hillsville, VA to assist with surveying.
- May 12, 2022 both Canine teams traveled to Lynchburg, Virginia to assist VDACS with SLF Surveys
- Most notably this year, an established population of spotted lanternfly (SLF) was detected in Kernersville, NC on June 23rd, 2022. NCDACS has done extensive work to mitigate this population in 2022 and will continue to do so in 2023 and beyond. Critical mitigation work included daily canine surveying to help determine the border of the infested area and find potential pathways for spread including dumpsters, logging and equipment. Daily utilization of the canines during the summer supported each dog’s ability to effectively find all life stages of SLF.
- The media support and outreach generated by the Kernersville SLF find cultivated additional SLF reports that required staff survey and canine follow-up. After survey staff completed a visual survey, the canine teams were utilized to confirm there were no life stages overlooked in an area. The canine support provided additional confidence that the report was not an undiscovered small population of SLF.
- As part of the Kernersville infested site survey, Chad and Goose investigated where the dumpsters located in the epicenter of the infested area transit. Chad and Goose followed up with a survey of the company in Jamestown NC where the dumpsters containing trash are emptied as well as a location in Greensboro, NC where the waste metal dumpster is unloaded.

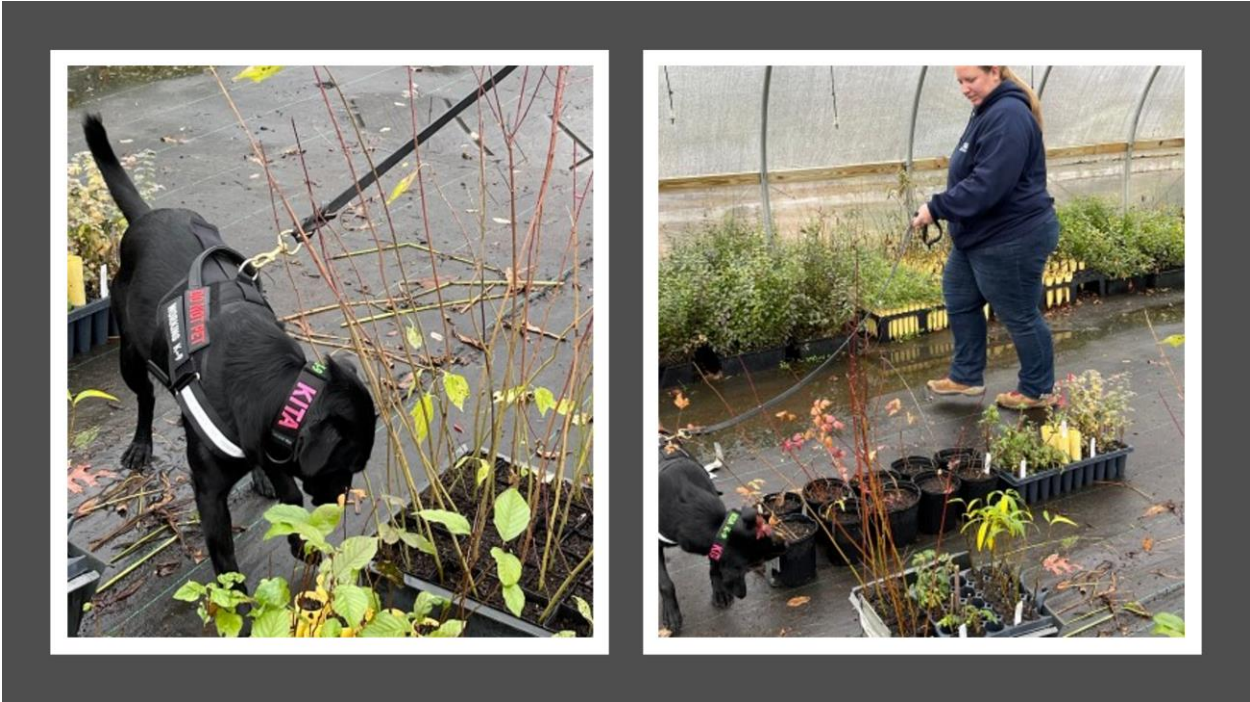


Figure 4.17 -Jackie and Kita – Inspection of Nursery material from New Jersey



Figure 4.18 – Kita found a dead adult on the ‘Tinkerbelle’ during her inspection February 2022

The canine teams have proven to be one of our best outreach tools for Spotted Lanternfly and have participated in planned outreach events as well as provided demonstrations intended for outreach purposes. Some of these are:

- SLF training to Biltmore and NC Arboretum Staff
- North Carolina Nursery and Landscape Association Green and Growin' Show
- North Carolina Christmas Tree Association Annual Meeting
- Poolside Pests – Southern Ideal Home Show – Wilmington, NC
- Poolside Pests – Southern Ideal Home and Raleigh NC.
- Got to Be NC festival at the NC State Fairgrounds Raleigh NC
- NC State FFA Conference, Raleigh NC
- Demonstration for NCDA&CS – Plant Industry Division Staff
- Media interviews and on-air demonstrations related to the Kernersville, NC first SLF find in North Carolina.



Figure 4.19 – NCDA&CS canine detector logo utilized for outreach

BROWN GARDEN SNAIL PROGRAM

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 (THOUSAND CANKERS)

The walnut twig beetle (*Pityophthorus 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 no longer operates this program, but we do still identify walnut twig beetle for NC Forest Service. The provided specimens for 2022 were negative for walnut twig beetle.

MOVEMENT OF LIVE ARTHROPODS FOR RESEARCH, COMMERCIAL, OR EDUCATION PURPOSES

The Entomological Programs Manager evaluated approx. 300 federal applications for PPQ 526 e-Permits in 2022. 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.

Nursery Certification Program

Prepared by Joy Goforth

NCDA&CS’ Plant Protection Specialists inspected 4,099 nursery dealers and nurseries during the 2022 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 1,303 nurseries and 2,796 nursery dealers during the 2022 calendar year (Table 5.1). Of the 1,303 nurseries, 643 were registered nurseries and 660 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 moderate increase in nurseries and a dramatic increase in nursery dealers. Registered and Certified nursery licensure increased by 53 locations and as of 12/30/22 there were still 173 nurseries who have not paid their renewal and thus are not expressed in the 2022 count. The increase in Nursery Dealers does not represent an uptick in retail locations selling plants across the state but reflects more timely renewals and increased online payments for licensure. The green industry remains incredibly strong in North Carolina and interstate shipping of plant material has been bolstered by increased online sales and homeowner direct shipments.

Table 5.1. *Number of NC nursery and nursery dealer licenses by year¹*

Calendar Year	Number of Licenses by Category			Total Number of Licenses	
	Registered Nursery ²	Certified Nursery ³	Nursery Dealer ⁴	Nurseries (Registered & Certified)	Nurseries & Dealers
2014	590	654	2,782	1,244	4,026
2015	594	612	3,188	1,206	4,394
2016	642	651	2,957	1,293	4,250
2017	620	646	2,858	1,266	4,124
2018	515	610	2,043	1,125	3,168
2019	504	602	1,697	1,106	2,803
2020	498	615	1,879	1,113	2,992

2021	601	649	1,629	1,250	2,879
2022	643	660	2,796	1,303	4,099

¹ Data based on receipt of license fees.

² Registered nursery – a location with less than one 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 the nursery industry to bring awareness of threats to the state.

Stop sale/movement notices are issued when high levels of pests and/or prohibited plants are noted. Plants can either be treated and/or destroyed when a stop sale/movement notice is issued. Plants can be released for sale/movement if testing of the material confirms they are free of the suspected pest(s). In 2022 seven (7) official Stop Sales were issued for regulatory violations. One (1) Stop Sale was issued for a collection of international and domestic soil brought into the state without proper permitting. Four (4) stop sale/movement notices were issued for *Acer* sp. in violation of USDA-APHIS-PPQ Post Entry Quarantine protocols that shipped to retail locations North Carolina prior to official release from the Federal Post Entry Quarantine program. In addition, two (2) individual stop sale/movement notices were issued related to potential movement of Federal Noxious weeds. One was for the sale of *Limnophila sessiflora* online and the other was for nursery stock contaminated with *Alternanthera sessilis*.

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 have 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 5.2. In 2022, NCDA&CS staff issued 9,677 federal phytosanitary certificates and 813 state phytosanitary certificates. China’s implementation of more strict import requirements for pine logs, increased transportation costs and other logistical issues continue to impact export certification numbers, however 2022 data indicates NCDA&CS issued the 2nd highest number of phytosanitary certificates on record. More than half of the 9,677 federal phytosanitary certificates issued in 2022 were for sweet potato exports with lumber being a close second. In addition, federal phytosanitary certificates issued were for lumber, logs, tobacco, cotton, cotton seed, corn, soybean, hemp, Christmas trees and cut greenery, science kits containing plant material, peanuts, nursery and greenhouse plants. Federal Certificates were issued for the movement of commodities to 95 countries, while state certificates were issued for 37 states, Puerto Rico, Guam and the US Virgin Islands. Nearly 31% of our federal phytosanitary certificates were for commodities going to the Netherlands, 14.5% transited to China, 20.6% were to Viet Nam and 21.4% went to the United Kingdom.

Table 5.2. *Number of phytosanitary certificates issued through the PCIT¹ system.*

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

2019					
(Calendar Year)	9,179	24	30	9,233	3,191
2020					
(Calendar Year)	10,529	16	1	10,546	1,903
2021					
(Calendar Year)	8,635	13	0	8,648	864
2022					
(Calendar Year)	9,677	16	0	9,693	813

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

Plant Conservation Program

Prepared by Lesley Starke

Governance

The Plant Conservation Program (PCP) meets quarterly with members of the NC Plant Conservation Board (the Board) whose seven members are appointed by either the Governor or the Commissioner of Agriculture for four-year terms. Board members in 2022 included: Julie Moore (Chairperson), David Hyatt, Jonathan Lanier, Esq., Dr. Bruce Williams, Jim Slye, Dr. Gary Walker, and Mike Kunz. PCP also meets regularly with members of the NC Plant Conservation Scientific Committee. This seven-member committee primarily consists of positions designated to the committee by law. Members include Dr. Alan Weakley (chair), Dr. Richard Braham, Dr. Johnny Randall, Hervey McIver, Brenda Wichmann, Dr. Shannon Currey, and Jerry Reynolds. There were no changes in the committee membership this year.

United States Fish and Wildlife Service (USFWS) Partnership

In 2022, PCP and USFWS continued a long-standing cooperative agreement related to the recovery of endangered and threatened plant species in North Carolina. In September the Cooperative Agreement was updated to include at-risk species, or species being reviewed for listing by the Service. This was the first update to this document since its origination in 1981. Grant funds obtained via this cooperative agreement provide critical recovery resources to North Carolina each year. This funding covers the program's research specialist position and a portion of the remaining funds support PCP temporary employees for part of the year. More specifically, the funding from this partnership supports imperiled plant monitoring; preserve management targeted towards federally listed, candidate, and at-risk plant species; and regulatory programs including protected plant permit evaluation and issuance.

PCP has multiple ongoing projects funded by various USFWS grants including (1) developing management plans for Plant Conservation Preserves, (2) land protection of mountain bog habitat, and (3) research and restoration for endangered plant species.

Regulatory Programs

The Plant Conservation Program is responsible for the protection and conservation of the NC Protected Plant List which currently includes 462 species, of which 28 are also federally listed. One of the protections for state listed plant species is that wild collection and the sale of wild individuals are both prohibited without a permit from PCP. Thus, the PCP staff convenes regular meetings with an interagency panel to review permit requests affecting these protected plant species. PCP reviews permit requests from individuals, research institutions, agencies, and others requesting to move or collect protected plants, including all state and federally listed plant species in North Carolina. This permit requirement applies to transplant and rescue projects, nurseries which propagate, sell, and export protected species, as well as many scientific research projects. The review process incorporates input from the US Fish and Wildlife Service, NC Natural Heritage Program, and advisory capacity from NC Botanical Garden.

Twelve protected plant permits were issued, and several additional requests were evaluated during 2022. 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 PID plant pest specialists. Sixty-three Certificates of Origin were issued for the sale of listed plants in 2022. Venus flytrap (*Dionaea muscipula*) was the most commonly certified protected plant, with 17 Certificates of Origin issued. Goldenseal (*Hydrastis canadensis*), recently relisted in North Carolina, was the second most common protected plant for which a Certificate of Origin was issued, with 10 issued.

PCP also administers the American ginseng (*Panax quinquefolius*) dealer licensing program for North Carolina. North Carolina American ginseng dealer licenses are issued annually prior to the opening of the harvest season which begins September 1st and ends December 31st. Licensed dealers may buy and sell ginseng during the buying season and must submit purchase records to PCP no less than once per month throughout the season. Copies of all purchase records must be retained by the dealers for inspection along with the roots at the time of certification for export. Copies of all export certificates are also submitted to PCP to help track not only the level of harvest per year in the state, but the volume exported as well.

For North Carolina's 2021-2022 ginseng buying season (which closed March 31st of 2022), plant pest specialists inspected and certified a calculated dry weight of 3,978 lbs of American ginseng for export. The vast majority (99.27%) of ginseng roots were wild harvested, totaling 3,949 lbs. (calculated dry weight), with the remainder being wild simulated (37.89lbs. calculated dry weight). To understand how many plants are represented by these reports of total dry weights of ginseng roots, we multiply the total weight by 300 as an approximate number of dry roots per pound. **For 2021-2022, PCP estimates that approximately 1,193,400 American ginseng plants were harvested from the wild.** Although this number fluctuates year to year, we estimate that over 1 million plants are harvested for export ever year.

Illegal harvest of American ginseng is a documented problem in North Carolina and throughout the species' range. In North Carolina, the Wildlife Resources Commission has partnered with NCDA to facilitate the enforcement of legal protections for this species. The Commission provides an annual report of processed ginseng crimes in their 8th and 9th Districts. In 2022, WRC reported a total of 24 cases/charges across 9 counties. Most of these cases were concentrated in McDowell (9) Haywood (4) Counties, with 1-2 cases in each of the following counties: Henderson, Graham, Jackson, Macon, Madison, Swain, and Yancey. This was a notable decrease in cases from 2020 (49 cases) and 2021 (35 cases). Interestingly, there has been overlap but not complete overlap in the counties where ginseng

violators have been caught. There are five counties which have had one or more violations in each of the three reporting years: Haywood, Henderson, Macon, Madison, and McDowell.

In some cases, ginseng material was seized and reported. A total of 740 confiscated roots were reported along with confiscations of ginseng berries too. This has also been a large drop from earlier reports. In 2020 >3,600 roots were confiscated and >1,100 roots were confiscated in 2021.

Friends of Plant Conservation

The Plant Conservation Program's closest partner is the Friends of Plant Conservation, Inc. (FOPC), a non-profit membership organization dedicated to supporting the mission of PCP. FOPC helps with fundraising and expands PCP's capacity for education and outreach as well as stewardship of the Plant Conservation Preserves. In partnership with NC Botanical Garden and Friends of Plant Conservation, PCP hosted three public education tours in 2022: Pondberry Bay in Sampson County, Tater Hill in Watauga County, and Long Mountain Preserve in Montgomery County. A fourth tour was planned for Melrose Mountain in Polk County but had to be postponed due to inclement weather. PCP also recruited guest speakers to provide public lectures covering various research and history highlights of each of these important plant conservation areas.

PCP also partnered with FOPC for workday events across the state: two for rare species monitoring and four for habitat management. PCP staff prepared content for FOPC social media posts and newsletter articles regarding the hands-on conservation and management strategies being employed to protect and recover imperiled species across the state. FOPC also supported the land management work conducted by PCP by purchasing \$5,000-worth of equipment and supplies such as personal protective gear, radios, and other supplies used during prescribed fires to restore and maintain rare plant habitats.

Other Outreach and Partnerships

The Plant Conservation Program is a member of several statewide or regional conservation partnerships. Examples include the Bog Learning Network, the Southern Blue Ridge Fire Learning Network, Southeastern Plant Conservation Alliance, and the Greater Uwharrie Conservation Partnership. In 2022, PCP collaborated with NC Botanical Garden and NC Natural Heritage Program staff to plan and host the Rare Plant Conservation Discussion Meeting on March 6, 2022, at the NC Botanical Garden. This annual one-day meeting had been suspended during the COVID-19 pandemic. The 2022 hybrid meeting brought together approximately 100 people including state and federal agency staff, university students and faculty, and representatives of conservation non-profit organizations to share presentations and hold discussions and pose questions regarding rare plant research. These meetings provide a good opportunity for PCP to keep current on ongoing research and communicate with current and future partners in rare plant conservation.

PCP Staff has also provided leadership in the development of the first North Carolina Plant Conservation Alliance (PCA). The goals of this partnership of plant conservation organizations and agencies is to maximize positive outcomes from our collective efforts in plant conservation and where possible, to leverage resources to be efficient and effective. Within the southeast region, most of the states have developed such alliances and coordinate at the regional level through the Southeastern Plant Conservation Alliance. By working together this way, the member groups anticipate more strategic recovery actions for the most imperiled plants in the southeast. In 2022, PCA working groups including PCP leadership were formed for the following tasks (1) Holistically evaluate plant species of greatest conservation need for the North Carolina Wildlife Action Plan which has previously not had plants included at all. This group will be asked to formulate an evaluation methodology and prepare the

necessary documents and review for the 2025 major revision to the NC WAP. (2) Evaluate data needs for species deemed data deficient in the last PCP listing review. (3) Assess the status of American Ginseng statewide.

In addition, PCP outreach to the public includes special presentations and by filling information requests. In 2022, PCP staff gave invited public lectures for the NC Sandhills Partnership Meeting and the NC Forest Service Isolated Wetlands Management Workshop as well as tour groups on the above-mentioned field trips.

North Carolina Plant Conservation Preserve System

The Plant Conservation Program, through the Plant Conservation Board, has the regulatory mandate to establish conservation programs for the long-term sustainability of the state's native flora. One of PCP's primary approaches to this is the establishment and management of Plant Conservation Preserves to protect imperiled plant species (Figure 6.1). These Preserves are the only state-managed lands selected and designed specifically for the conservation of plant species. Due to concerns about resource damage and plant poaching, access is generally limited to guided tours or to visits authorized by written permission issued by PCP. PCP Preserves serve as study sites for researchers of various disciplines including botany, geology, and herpetology. In 2022, 20 preserve access permits were issued for research and educational tours. To help educate and engage the public about rare plants and their conservation, PCP conducts guided preserve tours and gives presentations and lectures for the public throughout the year in collaboration with the Friends of Plant Conservation. The Preserve system consists of 26 Preserves distributed across North Carolina (see map below).



Figure 6.1. PCP Preserves of North Carolina

Preserve Management

Management and protection of Plant Conservation Preserves and other selected sites is a key component of the NC Plant Conservation Program's (PCP) efforts to recover listed plant species in North Carolina. In part, active management is needed to meet the intent of the Endangered Species Act, which has the stated goal of conserving the ecosystems upon which listed species depend. Many of the sites where these species occur have been degraded by lack of management and/or incompatible land-use

practices; active management as well as restoration efforts are urgently needed at these sites. In some cases, PCP works with other agencies and landowners to complement management of their lands for the benefit of rare plants and habitats.

In 2022, PCP staff focused on habitat restoration for the following projects and sites:

- Bunched Arrowhead (*Sagittaria fasciculata*)- Continued habitat restoration at Bat Fork Bog and Ochlawaha Bog Preserves in Henderson County
- Smooth Coneflower (*Echinacea laevigata*)- Continued habitat restoration in multiple protected sites in Durham and Granville Counties
- Schweinitz's Sunflower (*Helianthus schweinitzii*)- Continued habitat restoration at four PCP Preserves located in Gaston, Union, Randolph, and Montgomery Counties
- Rough-leaved Loosestrife (*Lysimachia asperulifolia*) and Venus Flytrap (*Dionaea muscipula*)- Continued habitat restoration at Boiling Spring Lakes and Hog Branch Ponds Preserves in Brunswick County
- Mountain Sweet Pitcherplant (*Sarracenia jonesii*), Mountain Purple Pitcherplant (*S. purpurea* var. *montana*), and Swamp Pink (*Helonias bullata*)- Continued habitat restoration at Cedar Mountain Bog and Dulany Bog Preserves in Transylvania and Jackson Counties respectively
- Pondberry (*Lindera melissifolia*) and Pondspice (*Litsea aestivalis*) – Continued habitat restoration at Pondberry Bay Preserve in Sampson County
- Northern Oconee Bells (*Shortia brevistyla*)—Continued habitat restoration at Caraway Preserve in McDowell County.
- Canby's Dropwort (*Tiedmannia canbyi*) and associated species—Continued habitat restoration at McIntosh Bays Preserve in Scotland County
- Sandhills Lily (*Lilium pyrophilum*)—Continued habitat restoration at Eastwood Preserve in Moore County
- Canada Lily (*Lilium canadense*)—Continued habitat restoration at Suther Prairie Preserve in Cabarrus County

Invasive species control

Invasive species control remains one of the most time and resource intensive habitat management strategies employed at the PCP Preserves. Invasive species control is also one of the most important habitat restoration strategies we use to maintain high quality rare species habitats. There are a multitude of important invasive species, some with regional importance including, but not limited to, Japanese Stiltgrass, Japanese Honeysuckle, Wisteria, Chinese and Japanese Privet, Japanese False Hawksbeard, Kudzu, Reed Canary-grass, American Bittersweet, Porcelainberry, Lesser Celandine, Tree of Heaven, Princess Tree, Chinaberry, Multiflora Rose, Marsh Dewflower, Purple Loosestrife, and several more. PCP uses a variety of control methods all custom fit to the sensitivity of the site. Where effective and safe we use herbicide in the most selective application method appropriate. Where herbicides are unsafe, we use mechanical methods to remove plants.

Prescribed burning

Prescribed burning is one the most pressing management needs across the Preserve system to enhance rare species populations and improve habitats for these species. With assistance and support from NC

Forest Service and other partners, PCP staff conducted four controlled burns across three counties this past year. Many planned burns could not be completed due to burning restrictions in place during periods of unsuitable weather. Additionally, many NC Forest Service personnel were dispatched to western states to help suppress wildfires this season leaving fewer available resources for prescribed burning in North Carolina. PCP continues to be responsible for all phases of burn planning and preparation as well as mop-up after the burns were conducted.

Table 6.1. Prescribed burns that occurred on PCP Preserves in 2022.

Preserve	County	Burn Unit	Date	Acres	Target species
Eastwood	Moore	2DEFHI	3/16/2022	61	Longleaf pine communities
Eastwood	Moore	1BCD	3/21/2022	35	Longleaf pine communities
Redlair	Gaston	2B	3/22/2022	2	Introductory fire
Redlair	Gaston	1	3/22/2022	1	Schweinitz’s sunflower
Long Mountain	Montgomery	N/A	4/13/2022	14	Oak-hickory community (USFS partnership)

Rare Species Monitoring

Understanding the current status and trends of the populations we protect is very important. To that end, PCP has been collecting flowering data on several species across the state. In 2022, census and/or population monitoring work was conducted for the following federally listed species:

- Bunched arrowhead (*Sagittaria fasciculata*) - Henderson Co. (2 sites)
- Canby’s dropwort (*Oxypolis canbyi*) - Scotland Co. (1 site)
- Heller’s blazing star (*Liatris helleri*) - Ashe Co. (1 site)
- Michaux’s sumac (*Rhus michauxii*) – Durham Co. (1 site)
- Mountain sweet pitcher plant (*Sarracenia jonesii*) - Transylvania Co. (1 site)
- Pondberry (*Lindera melissifolia*) – Sampson and Cumberland Cos. (2 sites)
- Rough-leaved loosestrife (*Lysimachia asperulifolia*) – Brunswick Co. (2 sites)
- Schweinitz’s sunflower (*Helianthus schweinitzii*) - Randolph, Montgomery, Union, Gaston Cos. (4 sites)
- Smooth coneflower (*Echinacea laevigata*) - Durham, Granville Cos. (5 sites)
- Swamp pink (*Helonias bullata*) - Henderson, Transylvania Cos. (2 sites)
- White irisette (*Sisyrinchium dichotomum*) – Polk Co. (1 site)

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

- Canada Lily (*Lilium canadense*) - Henderson Co. (1 site)
- Epling’s hedgenettle (*Stachys eplingii*) - Henderson Co. (1 site)
- French Broad heartleaf (*Hexastylis rhombiformis*) – Henderson and Transylvania Cos. (2 site)
- Georgia aster (*Symphotrichum georgianum*) – Union Co. (1 site)
- Heller’s bird-foot trefoil (*Acmispon helleri*) - Granville Co. (1 site)
- Leonard’s skullcap (*Scutellaria leonardii*) - Durham Co. (1 site)
- Sandhills Lily (*Lilium pyrophilum*) - Moore Co. (1 site)
- Schweinitz’s ragwort (*Packera schweinitziana*) - Watauga Co. (1 site)

- Seneca snakeroot (*Polygala senega*) - Durham Co. (1 site)
- Single flower sandwort (*Mononeuria uniflora*) - Anson Co. (1 site)
- Small butterwort (*Pinguicula pumila*) - Brunswick Co. (1 site)
- Small head marsh elder (*Iva microcephala*) - Scotland Co. (1 site)
- Veined skullcap (*Scutellaria nervosa*) – Granville Co. (1 site)

Plant Pathology Program

Prepared by Hsien Tzer Tseng, Regulatory plant pathologist.

Citrus Canker

Citrus canker is a devastating disease affecting the nation’s citrus producing industry and, to date, has not been found in North Carolina. Citrus canker causes fruit and leaves to drop prematurely, and results in lesions on citrus leaves, stems, and fruit. The disease affects all citrus varieties and is caused by the bacterial pathogen *Xanthomonas citri* subsp. *citri* (synonym *X. axonopodis* pv. *citri*).

On February 17, 2022, The U.S. Department of Agriculture’s (USDA) Animal and Plant Health Inspection Service (APHIS) confirmed the presence of citrus canker disease in some Meyer lemon (*Citrus meyeri*) and Key lime (*Citrus aurantifolia*) plants at a South Carolina nursery that sold and distributed these citrus plants to online consumers. Trace forward actions were taken according to USDA guidelines. E-mail notifications with detailed image of the symptoms of the disease were sent to 1,277 customers in NC based on the record provided by the nursery. All customers were small purchases of one or two plants. By the end of December 2022, thirteen people have replied with pictures of their plants with suspicious symptoms. Only one case was confirmed to be citrus canker. The plant was collected and destroyed by regional plant pest specialist.



Figure 7.1. Symptoms of citrus canker: lesions on citrus leaves, stems, and fruit. Characteristic lesions are raised and brown, have water-soaked margins, and usually have a yellow halo surrounding the lesion. (Picture credit: USDA APHIS)

First Reports in North Carolina

In 2022, four plant diseases were reported in North Carolina for the first time. These findings were reported by NCSU Plant Disease and Insect Clinic (PDIC), confirmed by USDA APHIS, National

identification services. Risk of these pathogens were evaluated by USDA-APHIS-Plant Protection and Quarantine and deemed as non-quarantine for the U.S. mainland.

- *Urocystis trillii*, the causal agent of smut disease on *Trillium spp.* was reported in May 2022. The fungus was previously only reported in Oregon, Idaho, and Washington State. The park facility in Forsyth County where the disease was found has not introduced new planting material in the past decade thus the origin of the pathogen is unknown. Smuts generally are soilborne and infect as plants emerge through the soil. It is believed that the fungus was already present in NC prior to this identification but was likely undetected.



Figure 7.2. *Trillium* smut. Necrotic lesions on the stem with splitting epidermal tissues containing spores. Picture credit: NCSU PDIC.

- *Alternaria celosiicola*, leaf spot on Cock's-comb (*Celosia cristata*) was reported by a nursery in July 2022. This species occurs naturally on *Celosia* but has experimentally been shown to be able to cause disease on *Amaranthus*, *Alternanthera*, and *Gomphrena* as well. Many leaf spot diseases on ornamental plants are overlooked or the plants would simply be discarded without closer examination. Symptoms of *Alternaria* leaf spot are shown in on the right (Figure 7.3, Picture credit: NCSU PDIC).



- *Pseudomonas asplenii*, the causal agent of bacterial leaf blight on bird's nest fern was reported in October 2022. This pathogen had been reported from California and Florida many decades ago. Symptoms of the disease include marginal necrosis and curling of young fronds. The bacterium may invade crown and kill the whole plant. Control depends on strict sanitation practices, including sterilizing flats, pots, media, and tools. Avoid excessive watering and too high humidity (Horst, R.K. (2013). Bacterial Diseases. In: Westcott's Plant Disease Handbook. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2141-8_15).



Figure 7.4. Bacterial leaf blight on bird's nest fern. Necrotic near the crown and symptoms of the foliage (Picture credit: NCSU PDIC).

- *Rosellinia necatrix*, white root rot, or Rosellinia root rot, or Dematophora root rot was reported in a home yard on American beautyberry (*Callicarpa americana*) in October 2022. Root rot initially causes foliage yellowing and wilting throughout the entire plant or in just a portion of the canopy. Leaves are undersized and sparse. Branches that are killed often retain dry foliage. Hosts generally die relatively quickly when infected with *R. necatrix*. Over 300 species of woody plants can be infected by *Rosellinia* species. Hosts include apple, avocado, ceanothus, cotoneaster, holly, pear, poplar, privet, and viburnum. More information can be found at: <https://ipm.ucanr.edu/PMG/GARDEN/PLANTS/DISEASES/dematrtrot.html>.

Boxwood Blight

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

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



Figure 7.5, Symptoms of boxwood blight (left to right): leaf spots on new growth, dark brown to black stem lesions, and underside of leaves with fungal sporulation.

Boxwood Blight Compliance Program

In February 2012, NCDA&CS developed an optional “Boxwood Blight Compliance Program” for nursery producers. The Boxwood Blight Compliance Agreement requires producers keep detailed records of shipments, isolate, hold and inspect buy-ins, report box blight symptoms and follow additional best management practices. To facilitate this program, the NCSU Plant Disease and Insect Clinic assays samples collected during this process at no charge.

The stipulations of the compliance agreement focus on buy-in inspection and record keeping, and renewed list of the program participants. As of December 2022, there are ninety participants in the program. Currently, States with established external quarantine against the boxwood blight pathogen includes Tennessee and Pennsylvania.

Boxwood Blight Confirmed Positive Buy-in Destruction

In February 2022, boxwood blight was found at a NC nursery that received 5-gallon sized Baby Gem boxwood from Oregon. This NC nursery is a participant of the Boxwood blight Statement Program. Following the buy-in quarantine protocol, the plants were quarantined for 30 days without any fungicide application and inspected by the nursery and regional specialist. Symptomatic plants were found on February 11. Samples were taken and confirmed to be boxwood blight by NCSU PDIC. On February 24, all 1,295 plants from the shipment were displaying some level of disease due to conducive weather conditions. All plants were destroyed by NCDA following protocol.

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

Sudden oak death (SOD), caused by the fungal-like oomycete, *Phytophthora ramorum*, is a major threat for North Carolina nursery industry and natural forests. The pathogen has been identified on well over 100 diverse species of plants, hosts include hardwood and conifer trees, shrubs, herbaceous plants and ferns. An official list of host plants as of 2022 is maintained by the USDA APHIS as part of federal quarantine. *P. ramorum* establishment in eastern US forests could be devastating, as there are several important tree species that are susceptible. Hosts that are commonly found in container nurseries includes rhododendron, camellia, viburnum, pieris, and kalmia.



Figure 7.6 Symptoms of *Phytophthora ramorum* infection on common nursery hosts.

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

For complete list of *P ramorum* hosts and associated plants:

https://www.aphis.usda.gov/plant_health/plant_pest_info/pram/downloads/pdf_files/usdaprlist.pdf

For more information:

<https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/phytophthora-ramorum/sod>

SOD Trace-forward/trace-back notifications

Three trace forward notifications issued by USDA were received in 2021:

1. January 2022: Two Nursery Dealer locations and one Certified Nursery in Mecklenburg County received a total of 5,577 Rhododendron plants from a nursery in Oregon. Shipping dates ranged between June and October 2021. Two regional plant pest specialists followed up with an official trace forward investigation. However, by the time NCDA received notification from USDA of the SOD shipments, all plants were sold at the two Nursery Dealer locations and the plants at the Mecklenburg County nursery were re-distributed to box stores upon receipt.
2. April 2022: Two Nursery Dealer locations and one Certified Nursery in Mecklenburg County received various numbers of Rhododendron plants from a nursery in Oregon. Shipping dates ranged between late January and mid-February 2022. The two Nursery Dealer locations were inspected by the regional specialist on 2/18 after receiving USDA required advanced

notification and no symptomatic plants were found. After receiving the official USDA notification, the plants were inspected again and three samples were collected and all tested negative for *Phytophthora*. The Mecklenburg County nursery no longer has the plants on site as they were re-distributed to box stores. NCDA&CS will continue to survey these locations.

3. July 2022: Between March 31 and April 21, 2022, The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) confirmed the presence of Sudden Oak Death in some rhododendron varieties at an Oregon nursery that sold and distributed these plants to online consumers nationwide. Thirty-seven North Carolina locations were involved with the trace forward. All locations were residential addresses with small purchases. Mail notifications with detailed images of the symptoms of the SOD on Rhododendron were sent to all known NC recipients, based on the record provided by USDA. Twenty homeowners responded to our mail with detailed pictures of their plants. No symptomatic plants were found.

No confirmed positive cases of SOD were found in North Carolina in 2022.

SOD Survey

The primary pathway for the pathogen is from trade of infected ornamental plants. A survey was developed to check plant materials that were likely to be imported from west-coast states. All suspect samples are screened for the presence of *Phytophthora* spp. using Enzyme Linked Immunosorbent Assay (ELISA) with positive samples forwarded to a USDA National Plant Diagnostic Network (NPDN) Lab for further diagnostics. 141 locations were surveyed during calendar year 2022. Of these locations, 129 locations were "big box" nursery stores that were surveyed by CAPS temporary personnel. The remainder were conducted by Specialists during routine nursery inspections. 11 samples were collected for ELISA screening by the Plant Pathologist. No target *Phytophthora sp.* was detected in 2022 as a result of this survey. Locations that were part of trace-forward investigations in 2022 (see Plant Pathology section) will be given top priority for survey in 2023.

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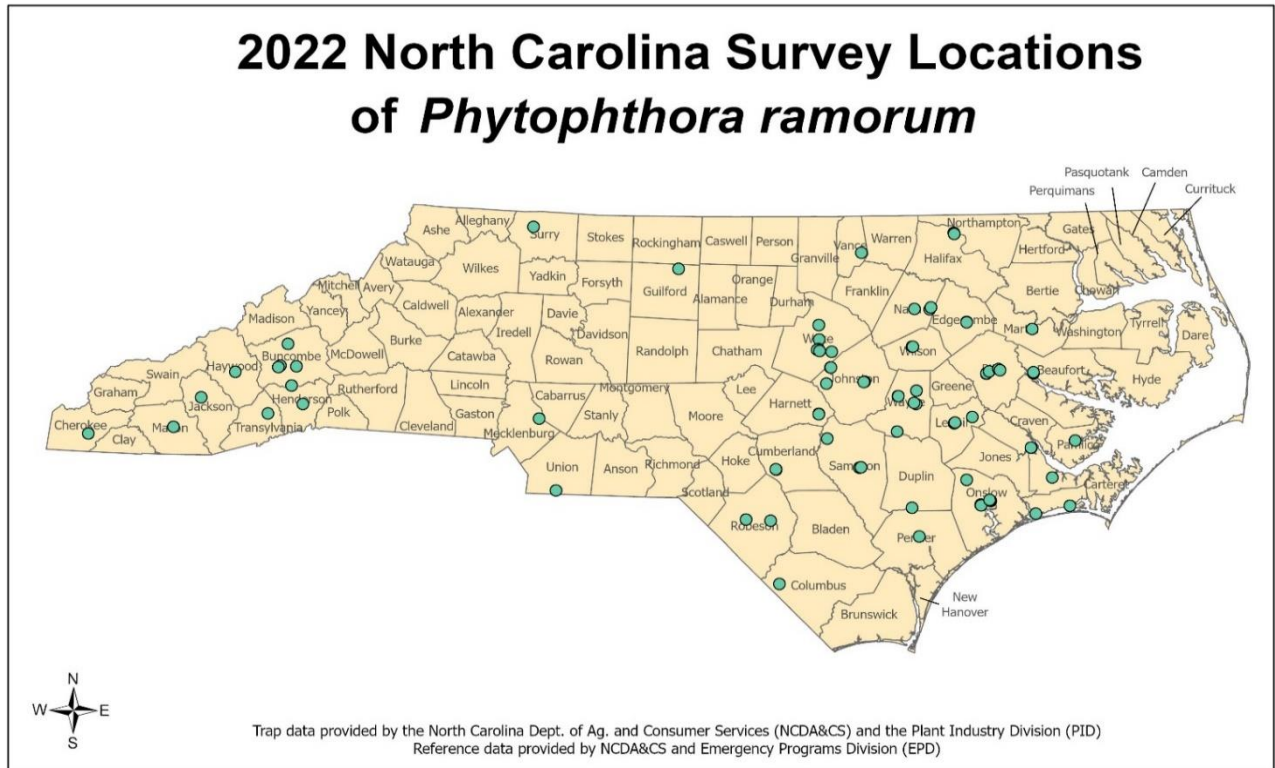


Figure 7.7 Map of *Phytophthora ramorum* survey sites, 2022

Guava Root Knot Nematode (*Meloidogyne enterolobii*)

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

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

Packing and shipping facilities are inspected by Regional Plant Pest Specialists for GRKN. When sweet potato with suspicious symptoms were found, the entire lot were held for further inspection. Samples were taken and molecularly diagnosed by NCDA Nematology Lab.

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

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 regarding 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: Nematode certification

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

Permits: Movement of plant pathogens for research and other purposes

USDA-APHIS-PPQ Form 526 (“Application and Permit to Move Live Plant Pests or Noxious Weeds”) permits the movement of plant pathogens and other pests into NC for research, diagnostic identifications, or commercial uses. The Plant Pathologist has the responsibility of reviewing and 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 2022, over 50 pathogenic species permit applications were evaluated which included fungi/oomycetes, bacteria, nematodes, and viruses.

The Regulatory Weeds Program

Program Objective

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

Executive Summary

The 2022 Regulatory Weeds Program was successful in administering treatment to sites where regulated noxious weeds were positively identified. The program handled numerous regulatory weeds in 2022 which included beach vitex (*Vitex rotundifolia*), yellow floating heart (*Nymphoides peltate*), purple loosestrife (*Lythrum salicaria*), tropical spiderwort (*Commelina benghalensis*), cogongrass (*Imperata cylindrica*), tropical soda apple (*Solanum viarum*), woolly frogsmouth (*Philydrum lanuginosum*), itchgrass (*Rottboellia cochinchinensis*), giant hogweed (*Heracleum mantegazzianum*), small broomrape (*Orobanche minor*) and witchweed (*Striga asiatica*). In most cases, the area Plant Pest Specialist and Regulatory Weeds Specialist along with Support Operations staff work together in providing treatment schedules for effective management or eradication of state and federal noxious weeds. The following provides further information about these treatments across the state.

Aquatic Dealer Inspections

Aquatic dealer inspections are an important activity as they help filter out unwanted invasive plants from entering the trade through aquariums and water gardens and are accomplished as a supplement to the aquatic nursery inspections. The aquatic dealers database is updated annually, and inspection sheets given to Plant Pest Specialists for completion each year. For the 2022 season, 108 aquatic dealers were inspected across the state, with one stop sale issued for ambulia (*Limnophila sessiliflora*).

Cogongrass (*Imperata cylindrica*)

NCDA&CS works in conjunction with NC Dept. of Transportation (NCDOT) in identifying and controlling regulated weeds along roadsides wherever they occur in the state. With help from NCDOT by spraying immediate roadside areas, and our team going onto private land, control was maintained for trouble spots occurring in Sampson and Pender Counties. We will continue this effort in the future as efficiency is gained with more staff available to survey and treat. Treatments over the past several years are beginning to yield favorable results. Figure one depicts examples of this situation.



Figure 8.1. Cogongrass in 2020 in Pender Co. (A). Cogongrass at the same location after treatments in 2022 (B).



Figure 8.2. Roadside/private land location of cogongrass. Two circular patches, one in foreground and one in background in 2020 (A). Same area after two seasons of treatment; looking in same direction as picture A (B) and one looking from within the infestation back towards the road (C).

After two seasons of rigorous treatments for each cogongrass location, declining cogongrass health can clearly be seen. This push will continue through 2023 with the intention that we will continue to see significant decline across all known locations where cogongrass infestations occur. Our aim is for complete eradication of all currently known locations.

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife is a Class B State Noxious Weed, and efforts to manage it have been ongoing since 1997. Both Guilford and Henderson Counties have infestations of this weed and are being treated with the hopes of someday reaching eradication. Treatments were accomplished using triclopyr. These treatments are found to be quite effective especially after several applications throughout the season to catch all plants that may have emerged later and to prevent further seed dispersal.

Three treatments were completed at the sites in Guilford County (Figure 8.3). These sites typically include right of ways beneath power lines where infestations are usually the heaviest. Treatments will continue for the 2023 season. Purple loosestrife is extremely difficult to eradicate because of its prolific seed production and longevity in the seedbank. Annual treatments of infested areas with herbicide remain the best way to combat this noxious weed.



Figure 8.3. A hand-pulled specimen of purple loosestrife from Guilford County.

Itchgrass (*Rottboellia cochinchinensis*)

This federal and state noxious weed produces hairs on leaf sheaths (Figure 8.4) which can penetrate the skin causing irritation, hence its name. It is problematic along roadsides, ditches, rights-of-way, pastures and row crops. As an annual grass, it spreads through seed. Seed production can exceed 3,000 per plant under optimal conditions. Seeds remain viable for 3-5 years and are dispersed mainly through wind, birds and roadside mowing equipment. It has also been noted that itchgrass has exhibited some level of allelopathy.

The battle for control with this weed has been ongoing in Robeson County since 1983. There are at least 6 separate areas located around the town of Rowland that are being monitored and treated. Applications of glyphosate were made to areas where plants were observed. In 2022, NCDOT helped treat several miles of roadside with the intention of treating areas again with preemergent herbicide in early spring 2023. 2022 was a banner year for seed production of this plant. It was observed in more locations than the previous year and was quick to grow back after glyphosate treatments (Figure 8.5). This year, we will employ additional help with spray treatments and utilize a preemergent herbicide to reduce the number of treatments to reduce seedbank production. After preemergent application, we will continue to survey and spot-treat areas where we observe regrowth.

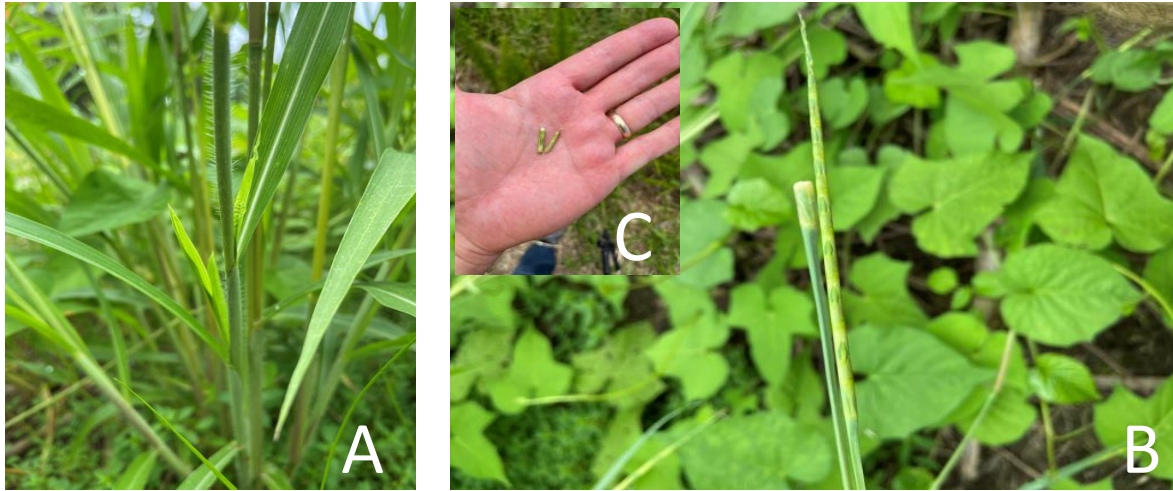


Figure 8.4. Short hairs present along leaf sheaths (A). The seed head of an itchgrass plant and independent seed (C).

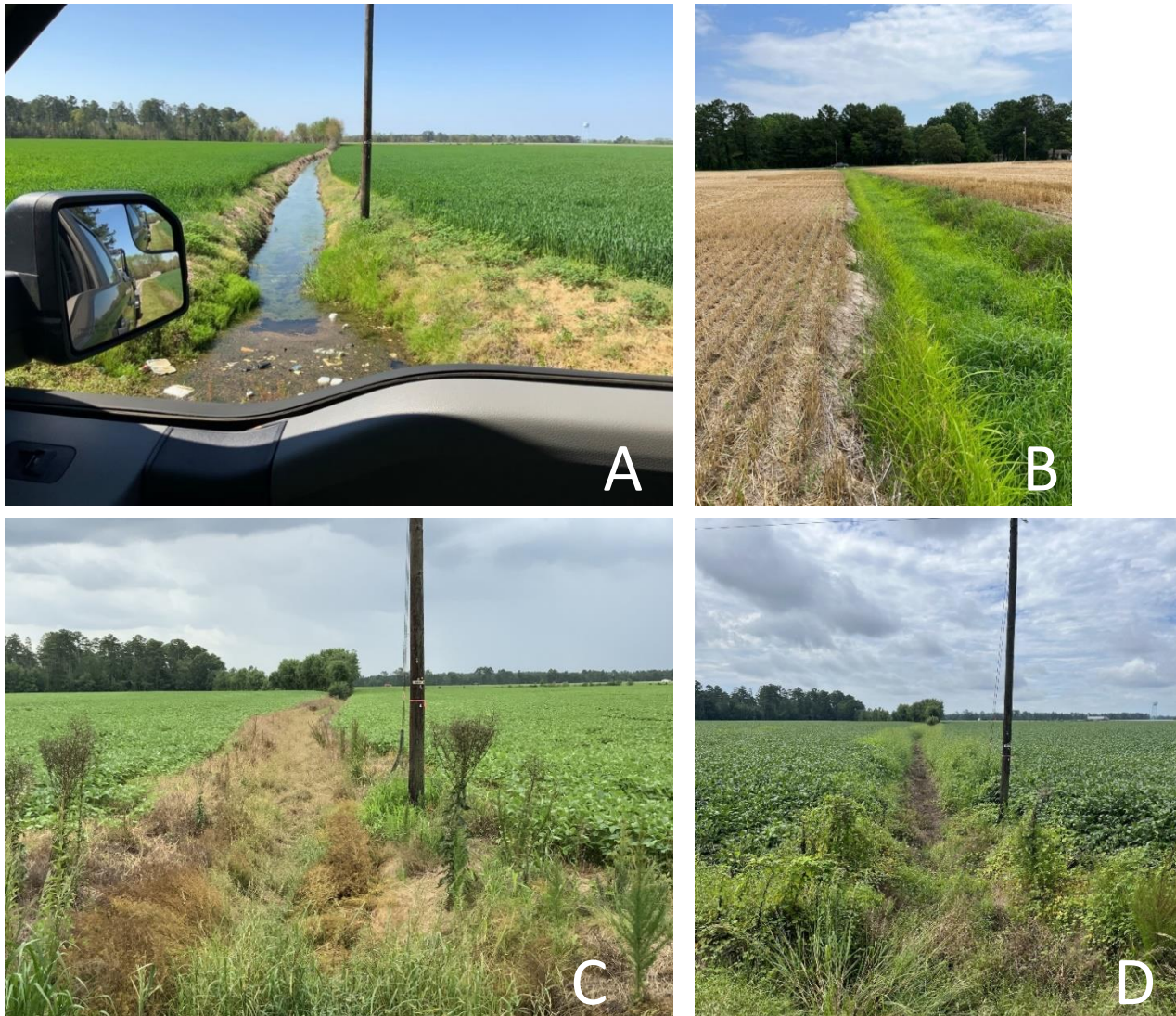


Figure 8.5. An example of one treatment site. Early April with no itchgrass present (A). Mid-June (B), early growth of itchgrass begins and is treated during this time. One month after treatment in mid July (C). Aggressive regrowth observed mid-September (D).

Tropical Soda Apple (*Solanum viarum*)

As a Federal noxious weed, tropical soda apple is a threat to NC agriculture since it outcompetes vegetable crops and serves as an alternate host for many important pathogens for solanaceous species. These include potato leafroll virus, potato virus Y, gemini virus, cucumber mosaic virus, tomato mosaic virus and tomato mottle virus. Prominent members of this genus include tomato, pepper, potato and eggplant. Three, separate survey dates (July, September and early November) were conducted at one location in Sampson County during 2022 to identify and pull tropical soda apple (Figure 8.6). This site remains the only known infestation of this weed in the state. Surveys were focused on previously identified hot spots covering approximately 7,000 acres. A total of 183 plants were identified and pulled during the 2022 growing season. This represents about 40 additional plants compared to last season. Plants are carefully pulled to ensure fruit does not escape. Rogued plants are placed in heavy duty paper bags for incineration.



Figure 8.6. A lone tropical soda apple plant showing off its large thorn-like prickles above leaf (left) and below leaf (right) surface.

Giant Hogweed (*Heracleum mantegazzianum*)

Watauga County remains the only county in NC where giant hogweed has been positively identified. The 2022 season brought with it several newly identified plants in new locations. All known locations are surveyed annually by the area Field Specialist. This is in addition to the many calls received by the public, which take this part of the survey all over the state. There are several lookalikes which can lead to a mistaken belief that someone has giant hogweed. In each of these calls during 2022, it was determined no further positively identified cases for this weed existed. In many instances a determination was able to be made from a digital photo. When a determination could not be reached a visual inspection was conducted.

Woolly Frogsmouth (*Philydrum lanuginosum*)

Initially found in August 2016 in NC, this Guam native served as a first find in the U.S. Initially treated in late 2016 and 2017, no treatment was done in 2018 because the plant could not be found. In 2019 woolly frogsmouth was found not only in the original pond, but also in a nearby pond. Treatments began again in 2019 and 2020. The 2020 survey revealed good control for plants found along the water's edge while below the waterline plants can escape treatment. The NCDA&CS working with NC Wildlife Resources Commission pursued additional treatment options in 2021 and pumped down the pond level approximately 18 inches to allow for us to treat plants that would have otherwise been submersed (Figure 8.7). The 2022 season found this borrow pit already low with very few plants present (Figure 8.8). Much less than previously noted from the prior season. The other infestation across the way from this pond found a modest increase in plant population. Overall, these sites continue to show progress.



Figure 7. Pond before (A) and after (B) our 2021 treatment. Photo B was taken two weeks after treatment.



Figure 8. Woolly frogmouth infested pond during our treatment in 2022. This figure depicts the same approximate location as previous season's data capture.

Tropical Spiderwort (*Commelina benghalensis*)

The exact point of introduction for this plant remains unclear, however information does exist going back to the 1930s where it could be found widespread throughout Florida. As an annual weed in temperate climates and herbaceous perennial weed in the tropics, tropical spiderwort (aka Benghal dayflower) is found in only a couple locations within NC. This weed can tolerate many herbicides, especially glyphosate. The presence of subterranean spathes on rhizomes differentiates *C. benghalensis* from other species (approximately 170) within the genus. Two look-a-likes for this species include *C. communis* (Asiatic dayflower), a non-native and non-noxious weed and *C. diffusa* (spreading dayflower), a native species. Both above and below ground flowers are self-fertile.

Benghal dayflower is a serious regulated weed that can become out of control if not managed early. A small, actively managed infestation originally found in June of 2015 near North Carolina State University (Figure 8.9) continues treatment. A much larger infestation on Cherry Research Station has also been closely managed and much progress has been made due to a large-scale fumigation treatment in 2020. Close monitoring of this site has yielded no positive identifications in 2021 and 2022.



Figure 8.9. Several tropical spiderwort plants growing at a location close to NCSU. Plants are still present after years of managing the area. A steady decline in the number of plants found at this location has been noted. These were the only plants observed at this site in 2022.

Beach Vitex (*Vitex rotundifolia*)

As a prostrate-sprawling woody shrub, it was once touted as an erosion controller and dune stabilizer in the 1980s, however, beach vitex (Figure 8.9) eventually became known to do the opposite. Native grasses such as sea oats, American beachgrass and panic grasses are more proficient at holding sand in place due to their root structure. Beach vitex can outcompete these native grasses and since it lacks a root system necessary to trap sand and reduce erosion, it was placed on the NC noxious weed list in 2009.

About a decade ago the Beach Vitex Task Force completed their survey and management of this noxious dune vine. A recent U.S. Fish and Wildlife grant was completed by a third party aimed at conducting survey and additional research on this plant. Our path forward for the management of this weed was to springboard from the work accomplished by this grant and the third-party grantees. Unfortunately, efforts to reach out to the involved parties were unsuccessful.

Reports of re-infestations received during the 2021 season increased over the previous season. When a call of an infestation came in from Duck, NC we began a different approach in combatting this weed. With the help of a local coordinator who was able to assemble a strong group of volunteers, three of our staff visited and educated this wonderful group on exactly how the Task Force once treated this plant in hopes of eradication. Since many of the coastal communities already have ordinances against this plant, it is our hope that working closely with each community, such as what was accomplished with Duck, that those towns will see the virtue of removing this plant through concerned citizens that are active in their community. Several new contacts have been made with coastal Public Works Departments that have employees capable of treating such infestations. In 2022, we worked closely with the towns of Carova, Corolla, Southern Shores, Kitty Hawk, North Topsail Beach, Surf City and Topsail Beach by visiting each location and working with local citizens and municipal employees very much like our 2021 Duck visit, which served as a proving ground for these “seaside seminars” and how this weed will be managed moving forward. During our visits to each of these locations, we disseminated information and physically demonstrated how to treat with the hopes of eradication at each location (Figure 8.10). We have plans to visit the coastal communities along Carteret County in 2023. It is our intent to continue in this way, disseminating information and providing an example for treatment by visiting those communities that request help when they observe an infestation of beach vitex, so we can more evenly manage this noxious weed.



Figure 8.10. Beach vitex infesting a property on Topsail Beach. Photo on left was taken in early July when we made an initial treatment. The photo on right from early September. Both photos are from 2022. Notice the decline in beach vitex health.

Small Broomrape (*Orobanche minor*)

Orobanche minor is a parasitic weed of many broadleaf plants, with origins in North Africa and the Middle East. This herbaceous annual weed gets all its nutrients from the hosts it attaches itself to (obligate parasite). A related species (*O. ramosa*) was first found in Texas, 1981 and by the early 1990s *O. minor* (Figure 8.11) was present in VA, two locations in SC and GA. It is not clear how NC became infested with *O. minor*, only that sometime in the mid to late 1990s the state began an eradication program for it. Seeds are described as being dust-like with estimates of 5,000 to 50,000 seeds per plant with a long-lived seed bank of 7-10 years or more, *O. minor* is parasitic to clover in Haywood and

Mitchell Counties. Movement of hay from currently infested fields and pasturelands is prohibited. The potential does exist for this to be a pest of many broadleaf row crops including tomato and tobacco.

More than 100 plants were observed and destroyed at a livestock market in Haywood County. Additional plants were hand pulled from all infested locations and chemical treatments done to omit clover from pastures infested with *Orobanche* were accomplished. Repeated annual surveys and follow-up treatments are necessary for this weed.



Figure 8.11. Orobanche minor plant in flowering phase, parasitizing clover.

Yellow Floating Heart (*Nymphoides peltata*)

We were able to visit each infested site of yellow floating heart three times for treatments in 2022 (Figure 8.12). Several locations were found to not have yellow floating heart during part of the season. A decision to consider an infested site eradicated for yellow floating heart will be given upon the third year when no infestation can be detected. No new infestations were observed or reported in 2022.



Figure 8.12. Two photos of the same location. Photo on left, from August 2020, our first look prior to treatments. Photo on right, from August 2022, showing yellow floating heart being managed.

Witchweed (*Striga asiatica*)

The USDA has been a long-term and faithful supporter of eradicating this federal and state noxious weed (Figure 8.13). Their continued support ensures forward progress is made as we continue to march down a path towards eradication of this plant. Our early temporary employees were hired in early June 2022 to begin survey work. Survey and treatment efforts were in full swing by the beginning of July when all temporary employees were brought on-board.



Figure 8.13. A witchweed plant parasitizes a nearby host, corn.

The Witchweed Program has long used a point system for monitoring field treatment schedules. Three phases govern this system; Infested, Release and Terminated. New fields positively identified with witchweed have a point status of 0-4.9 and are in the infested phase. At most, one point may be awarded per year. Once a field reaches 5 points, it begins the release phase where at minimum it will remain for 10 years. The last phase, termination, means a field has been considered eradicated and no longer requires survey or treatment.

The 2022 Witchweed field season saw a field staffing shortage. We continue to advertise for both a full-time field position and additional seasonal help. This added help, we believe, will allow us to continue to reach our goal of eventual eradication. Table 8.1 shows a small increase in infested acres for Bladen County in 2022. That increase brought 3 additional farms and 4 additional fields under quarantine. Table 8.2 shows that while we terminated almost 30 acres, we had a net increase of 3.6 acres to the quarantine.

Table 8.1. The number of farms, fields and infested acres per county for 2021 and 2022.

County		No. of Farms	No. of Fields	Infested Acres
Bladen	2021	30	49	459.00
	2022	33	53	490.20
Cumberland	2021	14	14	147.60
	2022	14	14	148.80
Pender	2021	3	3	30.50
	2022	3	3	30.50
Robeson	2021	10	13	323.10
	2022	10	13	323.10
Sampson	2021	2	2	80.20
	2022	2	2	80.20
Total	2021	59	81	1,040.40
	2022	62	85	1,072.80

Table 8.2. A summarization for total acres managed in 2022.

Total Acres in Infested Category	1,072.80
Acres Transferred from Infested to Release Category	0.80
Acres Transferred from Release to Infest (Re-infest)	33.20
Total Acres in Released Category	1,290.10
Total Acres Managed by Program	2,362.90
Total Acres Treated	1,886.15
Total Acres Surveyed	22,761.30
Acres Transferred from Release to Terminated	29.60
New Acres in Program	<u>-33.20</u>
Net Terminated Acres (Term. Acres – New Acres)	-3.60

SEED AND FERTILIZER SECTION

Prepared by Kathy Bowers & Bill Foote

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

The mission of this section is accomplished by:

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

The Seed and Fertilizer Section includes 24 staff members with responsibilities and accountability for administration, field services and North Carolina Seed Lab functions. The total budget for the Seed and Fertilizer Program for fiscal year 2021-22 was \$1,733,02 including a state appropriation of \$632,586 and receipts of \$1,100,415. Revenues included receipts from licenses, registration fees, and tonnage fees.

Seed and Fertilizer Field Programs

During the fiscal year 2021-22 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 6,326 licenses for business that sold wholesale and retail seed. During the 2021-22 fiscal year 729 fertilizer licenses were issued to companies manufacturing or distributing fertilizer products. These products were sold through chain and private retail outlets and through 250 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 administers a regulatory program to ensure full compliance with laws and regulations. An overview of program accomplishments is provided in Table 9.1.

Seed and Fertilizer Field Staff also provided support to the North Carolina Department of Transportation by collecting 138 samples 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, but fertilizer prices rose disproportionately to the commodity prices. Fertilizer prices resulted in a reduction of applied tonnage.

As a substitute for commercial fertilizers, producers took advantage of animal and poultry waste to provide nutrients to their crops.

Table 9.1 Seed and Fertilizer Program Inspection and Regulatory Activities, FY 2021-22

Number of Seed and Fertilizer Dealer Visits:	1,563
Seed and Fertilizer Samples collected	
Official Seed Samples	3,827
Official Fertilizer/Lime Samples	435
Regulatory Compliance Program	
Seed Stop Sales Issued	176
Seed Stop Sales Issued and Resolved on Site	130
Seed Stop Sales (N.C. Seed Lab)	46
Fertilizer Stop Sales Issued	21
Fertilizer Stop Sales Issued and Resolved on Site:	21

Table 9.2 and Table 9.3 provide additional information on fertilizer and lime samples taken by field staff and subsequently analyzed to ensure compliance with applicable statutes and regulations.

Table 9.2 Summary of fertilizer samples analyzed for the current and previous years

		FERTILIZER SAMPLING AND TONNAGE				
<u>Year</u>	<u>#Samples</u>	<u>#Compliant</u>	<u>%Compliant</u>	<u>Tonnage Reported</u>	<u>Tonnage Sampled</u>	<u>%Sampled</u>
2021-22	371	304	82	1,531,359	26,033	1.70
2020-21	244	199	81.55	1,609,398	487	0.03
2019-20	746	526	70.51	1,446,692	2375	0.16
2018-19	433	325	73.33	1,448,395	3176	0.21
2017-18						
2016-17	1,010	636	62.97	1,505,275	16,627	1.07
2015-16	899	605	67.30	1,556,575	13,809	0.92
2014-15	1,081	730	67.53	1,504,612	18,862	1.25
2013-14	1,374	1,058	77.00	1,497,209	22,309	1.48
2012-13	1,228	868	70.68	1,509,378	21,920	1.59

Table 9.3 Summary of lime and landplaster samples analyzed for the current and previous years.

LIME SAMPLING AND TONNAGE						
<u>Year</u>	<u>#Samples</u>	<u>#Compliant</u>	<u>%Compliant</u>	<u>Tonnage Reported</u>	<u>Tonnage Sampled</u>	<u>%Sampled</u>
2021-2022	64	60	94.00	1,012,744	3200	0.32
2020-21	289	267	93.08	815,746	5258	0.64
2019-20	66	52	78.78	856,282	925	0.11
2018-19	133	107	80.45	665,174	3,911	0.59
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

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 2021-22, the North Carolina Seed Laboratory conducted 2,901 regulatory seed tests and 12,258 service seed tests. These tests involve required testing for purity and germination. Multiple tests are generally conducted on each of the samples submitted with 13,725 individual tests carried out. Additional ancillary 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 1,467 ancillary tests conducted during the fiscal year.

The Seed and Fertilizer Section continued to implement the endophyte testing service. Several 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 8 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 and the division director 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 160 notifications and draft 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. As a prerequisite for participation in the project, all field staff are required to participate in training conducted by USDA-BRS focusing on workflow, 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. The Seed board conducted one investigation during the FY 2021-22 period. The complaint was resolved between concerned parties before advancing to an exhaustive investigation and Seed Board hearing.

North Carolina Tobacco Variety Evaluation Program

The annual Tobacco Variety Evaluation Program is conducted in cooperation with North Carolina State University North Carolina Crop Improvement Association. Flue-Cured Tobacco seed is sampled from every seed lot offered for sale in North Carolina annually. Seed samples are incorporated into the NC Variety Verification Trial Test where they are inspected during the flowering stage to determine if the seed lots exhibit true-to-type morphological characteristics.

Cotton Seed Cool Germination Testing

An enhanced cotton seed testing began as a pilot program during the 2020 growing season in response to poor performing seed claims reported by North Carolina cotton growers and North Carolina State University Extension personnel in 2019. As a result of these complaints, a modified cotton seed testing program was developed that incorporated the following elements.

- Advance notification of seed lots entering the state by seed companies
- Sampling of seed lots at the company warehouses
- Increased seed lot sampling rate at points of sale
- Cool Germination testing of all cotton seed lots (non-regulatory test) per AOSA protocols.
- Purchase of dedicated cool germination chamber and temperature recording instrumentation
- NCDA&CS Portal seed lot notification submission
- NCDA&CS Portal seed lot testing results notification

2022 marks the third year of the enhanced cotton testing pilot program. The testing results have been analyzed for the years 2020 through 2022, summary of that analysis is contained in Table 9.4. The program has been well received by North Carolina cotton growers and has been used as a decision aid when planting cotton seed in cool soils. The success of this program is due to the cooperation of the cotton seed companies, North Carolina State University Cotton Extension Team, NCDA&CS Seed & Fertilizer field staff and NCDA&CS Seed Lab Staff.

Table 9.4 Summary of 2020-2022 Cotton Seed Testing Program Results

Planting Year	Number of seed lots tested	Mean Warm Germination (%)	Mean Cool Germination (%)	Number Lots with Sub-Standard Warm Germ	Cool:Warm Germ Correlation (R ²)	Number of lots with (Warm Germ – Cool Germ) > 40%	Number of lots with Warm Germ >90%	Number of lots with Cool Germ < 50% and Warm Germ > 90%
2020	607	86.8	66.0	2	0.65	43	222	5
2021	615	86.7	67.8	4	0.68	32	300	4
2022	478	88.4	64.5	3	0.68	71	235	4

In addition to enhanced cotton seed testing described above, the seed lab divided samples and distributed the divided seed lots to multiple state seed labs. The results are summarized in Tables 9.5 and 9.6 and indicate that Cotton Cool Germination testing can vary significantly across seed labs. Data from 2020 is much more variable, some cool germination results varied +/- 50% across labs for the same seed lots (data not shown).

Table 9.5 Seed Lab comparison testing summary, 2021

Sample Number	Seed Company Warm Germ	Seed Company Cool Germ	Alabama Warm Germ	Alabama Cool Germ	South Carolina Warm Germ	South Carolina Cool Germ	North Carolina Warm Germ	North Carolina Cool Germ
659282	83	74	87	60	88	65	81	69
659281	86	62	89	60	90	69	85	72
659205	79	61	75	38	81	61	71	50
659769	77	48	81	34	84	46	69	39

Table 9.6 Seed Lab comparison testing summary, 2022

Sample Number	NCDA Warm Germ (%)	NCDA Cool Germ (%)	Miss State Warm Germ (%)	Miss State Cool Germ (%)	Alabama Warm Germ (%)	Alabama Cool Germ (%)
661409	92	90	80	79	94	28
661415	91	58	89	63	90	12
661498	68	51	87	45	88	4
661499	80	56	91	50	88	4

The variability between labs prompted the NCDA&CS Seed Lab to evaluate our own in-house testing repeatability. Three seed lots of different varieties and seed companies were divided and cycled through the germinator on three separate dates. The results from this sequential testing, Table 9.7, suggests that cool germination testing is not as repeatable as desired. Cool germination variability is of great concern since growers rely on these numbers to determine candidate seed lots to plant under adverse weather conditions. The seed lab will investigate potential causes of the non-repeatability by recording chamber, room, and wet towel temperatures hourly throughout the duration of the test. Results from these tests will be analyzed and included in the 2023 report.

Table 9.7 NCDA&CS Repeated Cool Germ Testing, 2022

Sample Number	Cool Germ 1/12/22 (%)	Cool Germ 4/1/22 (%)	Cool Germ 6/21/22 (%)
661494	56	15	50
661493	75	55	78
661490	51	24	54
J2004N	62 (1/29/2021)	25 (2/18/2021)	-

