INVASIVE SPECIES MANAGEMENT
ADIRONDACKS

Adirondack PRISM Forest Pest Research Assistant

Project Summary Report
2022

Follensby Pond Preserve

The Nature Conservancy
Adirondack Park Invasive Plant Program
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Executive Summary

Forest Pests and Pathogens (FPAPs) pose serious and urgent near-term ecological threats to North America's forests. FPAPs are often fast acting and are one of the only forest disturbance agents that can nearly eliminate entire tree species or genera within a matter of decades (Lovett, et al., 2016). The loss of tree species has cascading effects on ecosystems, both in the short and long-term.

The rate of new FPAP introductions continues to increase, with climate change accelerating the spread and establishment of FPAPs (Aukema et al., 2010). As the climate continues to warm, trees will continue to face increasing environmental stress from temperature change and severe weather events such as drought, fire, and flooding. These environmental stressors will make trees more vulnerable to invasions. New York is one of the most heavily invaded states, with the highest abundance of FPAP species in the United States (Liebhold et al., 2013). FPAPs are projected to cause high (25-100% loss of total basal area) or moderate (10-25% loss of total basal area) impact to approximately 4.2 million acres (32%) of New York State's resilient forest landscape by 2027 (Krist et al. 2012).

As climate change progresses, many species will need to migrate to keep pace with warming temperatures. The Adirondacks are one of the most resilient and connected landscapes in the Northeast, which will make it a crucial corridor and climate refuge for migrating species (Anderson et al., 2014). FPAPs threaten to reduce the resiliency of these forests in which so many species depend.

The Forest Pest Research Assistant (FPRA) position was created in 2022 to help mitigate the threat of forest pests on the resiliency of Adirondack forests. Primary responsibilities of the FPRA include early detection surveys for FPAPs and invasive plants, surveillance trapping/monitoring for FPAPs, and research on invasive species early detection, monitoring, and management.

Over 21 weeks of the 2022 field season, the FPRA surveyed for a total of 114 hours, covering over 83 miles of trail, and visiting 60 unique sites. In addition, the FPRA:

- Monitored eight emerald ash borer and nine spotted lanternfly surveillance traps over the course of 18 weeks
- Assisted with the management of hemlock woolly adelgid (HWA) on Dome Island
- Contributed to three Adirondack Park Invasive Plant Program (APIPP) research projects

Forest Pest Surveillance

Terrestrial invasive plants and forest pests can be unknowingly introduced and transported through human activities. Seeds and pests can be transported on gear, clothing, vehicles, etc. In addition, spread of invasive species can occur through natural vectors, such as movement of seeds and insects by birds and small mammals, windstorms, and precipitation or flooding. Because new introductions can occur frequently and randomly, it's important to perform routine early detection surveys to find new infestations quickly, which can increase opportunities for successful management interventions.

Throughout the 2022 season, the forest pest research assistant surveyed for numerous forest pests and their host trees including: hemlock woolly adelgid (*Adelges tsugae),* spotted lanternfly (*Lycorma delicatula),* tree-of-heaven (*Ailanthus altissima),* balsam woolly adelgid (*Adelges piceae)*, jumping worms (*Amynthas spp. & Metaphire spp.),* and beech leaf disease nematode (*Litylenchus crenatae mccannii)* (Table 1). In addition, numerous trailheads and one campground were surveyed for APIPP's full list of focal terrestrial invasive plants. Survey findings (detections and non-detections) were uploaded to the iMapInvasives database and/or The Nature Conservancy's Invasive Plant Mobile Monitoring System (IPMMS).

Table 1. Early detection survey metrics by species (2022).

Target Species or Site	**Total Survey Miles**	**Total Survey Hours**	**Total Survey Sites**
Hemlock Woolly Adelgid	56	74	18
Spotted Lantern Fly/Tree-of-Heaven	2.6	4	3
Jumping Worm	N/A	5.5	13
Balsam Woolly Adelgid	4	6.5	15
Beech Leaf Disease	11.2	14	11
Trailheads & Campgrounds	9.2	10	18
TOTALS	**83**	**114**	**60**

The following section provides a detailed overview of surveillance activities by target pest and location. Some sites were surveyed for multiple pests during the same visit.

Hemlock Woolly Adelgid

Introduction

Hemlock woolly adelgid (HWA) is a very small aphid-like insect that settles on hemlock twigs at the base of its needles and feeds on the tree's storages of starch (NYS DEC, January 2018). With no natural predators, HWA populations can expand quickly. Increased feeding pressure damages trees' conductive tissues, leading to needle loss, canopy decline, and eventually death. HWA can be identified by the white woolly masses that form at the base of the needles, which contain and protect HWA's eggs. Eastern hemlock is an ecologically important species in the Adirondacks, providing a unique microclimate that supports many other species of fungi, lichen, plants, and wildlife.

The first infestation of HWA in the Adirondacks was found in 2017 on Prospect Mountain in Lake George (NYSDEC, 2018). From 2020-2022, several new infestations were identified along the eastern shore on the Lake, on several islands, and recently on the western shore at Hearthstone Campground. HWA has yet to be found in the Adirondacks outside of the Lake George region. The goal of these surveys was to detect new infestations early and increase opportunities for management intervention.

Methods:

Survey locations were selected by referencing existing HWA survey reports from the iMapInvasives database with the known distribution of hemlock trees and publicly accessible (DEC) land. Previously unsurveyed sites near known infestations were assigned the highest priority. Several sites with non-detected points near known infestations were also visited, along with previously unsurveyed sites slightly farther from known infestations. Care was taken not to visit sites too close to or within known infestations, especially in late spring/early summer when HWA is in the nymph or "crawler" life stage. During this period, before the crawlers have settled at the base of the needles, they can be spread on items such as clothing, gear, and boots.

Once sites were selected, surveys were typically conducted along established trails in the forest preserve unit being surveyed. If there were multiple trails, the more heavily trafficked trail was selected. In locations where there were no official trails, there were sometimes old logging roads or herd paths to survey. There were also a few cases where surveying was done off trail, bushwhacking.

Hemlock trees with low branches were selected every 300-500 ft and visibly surveyed using a hand lens and light, if necessary. Trees were prioritized for inspection if they exhibited signs of decline such as a thinning canopy, lack of new spring growth, or pale foliage. All observations (detected and non-detected) were recorded and uploaded to iMapInvasives.

Survey Sites and Findings:

LAKE GEORGE WILD FOREST:

- **Shelving Rock Mountain (5/31/22)**: The survey was done along the trail up to the Shelving Rock Mountain Summit. This site is close to a known HWA infestation at Red Rock Bay. The survey covered 6.3 miles over the span of 4.5 hours. Hemlock trees on and within view of the trail and summit were surveyed. There were no signs of HWA; however, mild hemlock decline was observed. Many trees exhibited foliage loss and minor crown gaps. This was very likely due to heavy spongy moth (*Lymantria dispar*) infestation, as most hemlocks were covered in spongy moth caterpillars.
- **Pilot Knob Trailhead (5/31/22):** A survey was completed along the trail to Inman Pond. This trailhead is close to known HWA infestations near Shelving Rock. The survey covered approximately 2.7 miles over the span of two hours. Hemlocks along the trail and pond were inspected. There were no visible signs of HWA or hemlock decline.
- **Prospect Mountain Trailhead (06/06/22):** Survey followed the trail up to the Prospect Mountain summit. The survey covered 5.6 miles in around 4.5 hours. Prospect Mountain is heavily trafficked as the summit can be accessed via car. Hemlock on or adjacent to the trail and summit were surveyed. There were no visible signs of HWA; however, mild hemlock decline was noted, likely due to infestation of spongy moth caterpillars. Many trees were shedding needles, had gaps in the crown, and bare lower branches.

Hemlock along the shore of Inman Pond, 2022

- **Shelving Rock Falls Trailhead (06/06/22):** Survey followed the trail, slightly past end of Shelving Rock Falls trail, and down at the base of the falls. The survey covered 1.2 miles in about 1.5 hours. This location is very close to an HWA infestation further down the same trail past the falls. For this reason, all hemlock along and near the trails and falls were inspected very closely with many branches checked with a hand lens. There were no visible signs of HWA, but once again there was mild hemlock decline due to spongy moth infestation.
- **Clay Meadows Trailhead (06/27/22):** Survey followed the Northwest Bay trail about three quarters of the way to Montcalm Point. The survey covered a total of 7.9 miles in 7.5 hours. A new report of HWA had recently been made at Turtle Island and Mohican Island directly across from the Tongue Range and Northwest Bay trail, so hemlock along the shore and near the trail were closely observed with a hand lens. There were no visible signs of HWA or hemlock decline.

- **Warrensburg Hudson River Nature Trails (07/07/22):** The survey was conducted around the entire trail network and covered around 2 miles in 2.25 hours. This patch of forest is farther from known infestations; however, it was not previously surveyed, has a high density of hemlock, and is very accessible and popular. There were no visible signs of HWA or hemlock decline.
- **Cat and Thomas Trail (07/25/22)**: The survey was conducted partially up the trail to Cat and Thomas Mountains. This patch of forest preserve had not yet been surveyed and was relatively close to HWA infestations found on the western shore of Lake George. The survey took place along the section of trail that runs along the road, covering 1 mile in 1.5 hours. There were no visible signs of HWA and or hemlock decline.
- **Palmer Pond Trail (08/15/2022):** The survey followed the Palmer Pond trail to the Northwest shore of Palmer Pond, where an unconfirmed report of HWA was submitted to iMapInvasives. The goal of this survey was to locate and verify the original report. A total of 2.5 miles were surveyed in 1.5 hours. There were no visible signs of HWA at the point of the report or anywhere along the trail surveyed. Mild hemlock decline was observed, likely due to drought as well as the hemlock scale that was found on many trees. It is suspected that the original iMap report was hemlock scale.
- **Ralph Road State Forest (07/11/22):** This was a bushwhacking survey in the Ralph Road State Forest and the adjacent Lake George Wild Forest. Hemlock trees were surveyed along an old logging road and off trail within Ralph Road State Forest. Hemlock stands located to the north and south of Glens Falls Mountain Road and along Ralph Road were surveyed. This patch of forest was very close to known infestations, so hemlock branches were observed very closely with a hand lens. A total of 3 miles were surveyed in 4 hours. There were no visible signs of HWA or hemlock decline.

LAKE GEORGE ISLAND CAMPGROUND:

- **Long Island (06/28/22):** The survey was conducted around the entirety of the island after an incidental finding of HWA while collecting eDNA samples as part of a research project. A rough delineation survey was performed, which identified HWA on the northern third of the island. A total of 4 miles were surveyed over three hours. An extensive infestation of Japanese stiltgrass (*Microstegium vimineum)* and wineberry (*Rubus phoenicolasius*) were also discovered and mapped on the island.
- **Speaker Heck Island (06/28/22):** A survey was completed around the entire island for signs of HWA or other infestations of Japanese stiltgrass and wineberry. The survey covered about 0.5 miles over 1 hour. There were no visible signs of HWA. A small infestation of Japanese stiltgrass was discovered and mapped.
- **Diamond Island (06/28/22):** A survey was completed around the entire island, covering about 0.3 miles in 0.5 hours. There were no visible signs of HWA or any other invasive plants

HWA infestation on Long Island, 2022

- **Various Lake George Islands (07/20/22):** Surveys were completed on several islands after finishing eDNA sampling, including Agnes, the Odell islands, St. Sacrament, and Mother Bunch Island. The survey was for HWA as well as any other terrestrial invasive plants. There were no visible signs of HWA. Several common terrestrial invasive plants were recorded in IPMMS. The surveys totaled approximately 7.7 miles in 8 hours.

PHARAOH LAKE WILDERNESS AREA:

- **West Hague Rd Trailhead (05/26/22):** The survey was completed along the trail to Spring Hill Pond. This wilderness area is a popular destination for backpacking and camping in the Lake George region and had not yet been surveyed for HWA. A total of 8.4 miles were surveyed over 6.5 hours. Hemlock along the trail and shoreline of Spring Hill Pond were surveyed. There were no visible signs of HWA or hemlock decline

HUDSON RIVER SPECIAL MANAGEMENT AREA:

- **Buttermilk Brook Trail (07/07/22):** The survey was conducted within the Bear Slides trail network. These trails are a popular destination for swimming and had not previously been surveyed. Hemlock along the trail were surveyed until the trail intersected back with the road. A total of 2 miles were surveyed over 2 hours. There were no visible signs of HWA or hemlock decline.

PRIVATE PROPERTY:

- **Chestertown (08/16/2022):** A survey was conducted on private property near Loon Lake in response to a report of HWA that was made by the landowner to iMapInvasives. Hemlock around the property were thoroughly inspected and there were no visible signs of HWA. There were several hemlock trees with missing portions of their crown and with dead lower branches, but this was likely due to the drought in the region this summer.

HEARTHSTONE STATE CAMPGROUND:

- **Hearthstone (08/24/22, 08/25/22, 09/07/22, 09/08/22):** A delineation survey was completed to help inform future HWA management activities. Approximately 24 miles were surveyed over four days, with approximately 20 active survey hours. GPS coordinates were recorded for 579 trees, 110 of which were infested. For each infested tree the DBH, canopy health, and severity of infestation were recorded.

A hiking trail passes through a mixed hemlock stand in the Pharaoh Lakes Wilderness Area, 2022

Spotted Lanternfly and Tree-of-Heaven

Introduction

Spotted lanternfly (SLF) is a pervasive invasive species that poses major threats to forest health and agriculture. Established infestations of SLF have yet to be found within the Adirondack PRISM, so early detection surveys are critical. The primary host species of SLF, tree-of-heaven (TOH) *(Ailanthus altissima)*, is known to occur within the PRISM. Surveys for SLF are often targeted around tree-of-heaven; however, SLF can feed on over 70 native plants and trees. SLF can have devasting effects on important agricultural plants such as grapes, apple trees, and hops (USDA, 2020).

Methods

The two main methods used for monitoring SLF this season were surveillance trapping and active surveying. Placing surveillance traps on preferential host trees is an efficient way to monitor areas for SLF. A total of 10 circle traps were deployed in different locations across the Adirondack Park, nine of which were monitored by the FPRA (Table 2). These circle traps are made up of wire and mesh and create a funnel when attached to a tree (see image to the right). The funnel leads to a plastic bag secured to the trap with a rubber band. If spotted lanternfly nymphs were present on the host tree, they would get caught in the trap while crawling up the tree. All traps were placed on maple trees (*Acer spp.)*, which are a known host for SLF. These traps were deployed in June and monitored bi-weekly for a max of 12 weeks. Sample bags were checked for SLF, bycatch was discarded, and the bag returned to the trap.

SLF Trap deployed at the ADK Loj, 2022

Active boots-on-the-ground surveys are another effective method to monitor for SLF, but they are time consuming, making it difficult to cover a large geographic area. Each year iMapInvasives administers a program where community scientists can claim grid squares to survey for SLF and TOH on public land. Several of these grid squares were claimed and surveyed over the course of the season. During these surveys all hard surfaces were thoroughly checked for egg masses, the forest composition was checked for preferred host species including TOH, and visual surveys were done for nymph and adult SLF.

Trap Sites and Findings:

Table 2. SLF trap locations monitored by the FPRA in 2022.

Site	Deployed	Retrieved	SLF Found
ADK Loj	6/1/2022	9/26/2022	No
Ausable Point Campground	6/1/2022	9/26/2022	No
Up Yonda Farm	6/1/2022	9/26/2022	No
Hearthstone Point Campground	6/1/2022	9/27/2022	No
Lake George Battleground Campground	6/1/2022	9/27/2022	No
Rogers Rock Campground	6/1/2022	9/26/2022	No
Highlands Vineyard	6/21/2022	9/26/2022	No
Northampton Beach Campground	6/21/2022	9/27/2022	No
Caroga Lake Campground	6/21/2022	9/27/2022	No

Survey Sites and Findings:

The following locations were surveyed as part of iMapInvasives SLF grid square survey program.

LAKE LUZERNE STATE CAMPGROUND

- **Luzerne Campground (07/25/22):** A survey was completed for grid square 18T WP 9501, within the campground and on state land close to the road. The survey covered 1 mile over 1.5 hours. There were no visible signs of SLF or TOH.

LAKE GEORGE WILD FOREST:

- **Hudson River Nature Trails (07/25/22**): A survey was completed for grid square 18T WP 9618. The survey covered the half of the square that fell within state land. A total of 0.6 miles were surveyed over 0.75 hours. There were no visible signs of SLF or TOH.
- **Cat and Thomas Trail (07/25/22)**: A survey was completed for grid square 18T XP 0528. A total of 1 mile was surveyed over 1.5 hours. There were no visible signs of SLF or TOH.

Jumping Worms

Introduction

Jumping worms (*Amynthas spp. & Metaphire spp.*) are non-native earthworms known to occur in several counties within the Adirondack PRISM. Jumping worms can be identified by their flailing motions, which gives them their name and distinguishes them from other worms. In addition, jumping worms are dark in color with a smooth, milky white clitellum that is close to the head and flush with the body (Cornell Cooperative Extension, 2022).

Jumping Worm found during survey in Hague NY, 2021

Jumping worms can significantly alter the structure and chemistry of the soil. They leave behind castings that give the soil a grainy, coffee-ground-like appearance. Soil impacted by jumping worms is often devoid of nutrients. Jumping worms are a threat to gardens, lawns, and understory vegetation in forested areas (Cornell Cooperative Extension, 2022). They can easily be spread by transporting soil and plants that contain their cocoons.

The goal of this survey effort was to increase understanding of the regional distribution of these species. Counties without known jumping worm infestations, such as Clinton, Lewis, and Herkimer, were prioritized. Survey sites included campgrounds and trailheads where there is high recreational use and foot traffic.

Methods:

At each previously selected survey location, a suitable sample site was identified. Sample sites included areas such as gardens, waste piles, and areas of high traffic such as near trail entrances and trail registers. At each site, a small area was cleared of leaf litter and covered with a 0.25 m^2 PVC quadrat. A solution of water and mustard power was slowly poured over the soil surface within the quadrat to draw worms to the surface. All earthworms were removed with forceps and placed on a metal tray for inspection and identification. All reports (detected and not-detected) were recorded and submitted to iMapInvasives.

Survey Sites and Findings:

AUSABLE POINT CAMPGROUND

- **Ausable Point Campground (07/26/22)**: Surveys were completed at the wood pile adjacent to the beach/day use area and near the bathrooms adjacent to the boat launch. No jumping worms were found.

POINT AU ROCHE STATE PARK

- **Point Au Roche DEC Boat Launch (07/26/22**): The survey was completed between the parking lot and mowed field adjacent to boat launch. No jumping worms were found.

LAKE ALICE WILDLIFE MANAGEMENT AREA

- **Lake Alice Wildlife Management Area (07/26/22):** The survey was completed adjacent to the trail near the parking area. No jumping worms were found.

FLAT ROCK STATE FOREST

- **Flat Rock State Forest (07/26/22):** The survey was completed off the trail near the entrance to the state forest, off river road. No jumping worms were found.

DUNKINS RESERVE STATE FOREST

- **Dunkin's Reserve State Forest (07/26/22):** The survey was completed near the trail, adjacent to entrance to state forest. No jumping worms were found.

CHAZY HIGHLANDS STATE & WILD FOREST

- **Chazy Highlands State Forest (08/23/22):** The survey was completed at the Route 374 parking lot spring, beside a small trail. No jumping worms were found.
- **Chazy Lake DEC boat launch (08/23/22):** The survey was completed adjacent to privy, and no jumping worms were found.

SARANAC LAKES WILD FOREST

- **Panther Mountain Trailhead (08/23/22):** The survey was completed next to the trail register for Panther Mountain. No jumping worms were found.
- **Turtle Pond Access Trailhead (08/23/22):** The survey was completed next to the trail to Turtle Pond. No jumping worms were found.
- **Lake Clear Beach (08/23/22):** The survey was completed adjacent to trail entrance leading to the pond. No jumping worms were found.

TAYLOR POND WILD FOREST

- **Franklin Falls Fishing Access Site (08/23/22):** The survey was completed adjacent to the small trail leading to the water. No jumping worms were found.

DEBAR MOUNTAIN WILD FOREST

- **Debar Mountain Trailhead (08/23/22):** Survey was done adjacent to trail register and no jumping worms were found.

Balsam Woolly Adelgid

Introduction:

Balsam woolly adelgid (BWA) (*Abies piceae*) is an invasive forest pest originally introduced to the United States from Europe (Ragenovich & Mitchell, 2006). Balsam woolly adelgid can attack all species of fir and over time can lead to mortality of infected host trees. BWA feeds on host trees and injects a substance that can disrupt hormonal production in the tree, leading to abnormal cell division (Ragenovich & Mitchell, 2006). The goal of this survey effort was to increase understanding of the regional distribution of this species, especially in counties where BWA is not yet reported. Most surveys were conducted at trailheads where the host tree, balsam fir (*Abies balsamea)* was present.

BWA infestation on the main stem of a balsam fir in Speculator, NY (2022).

Methods:

Once the trailhead or site was chosen, a visual survey was conducted around the parking lot and sometimes along the trail within a mile of the parking area. The stem and branches of balsam fir were visually inspected for signs or symptoms of BWA, aided by a hand lens and light, when needed. A common symptom of BWA is "gouting" which is a swelling of the buds and branch nodes accompanied by stunting of terminal growth (Ragenovich & Mitchell, 2006). Several branches from each tree were checked for this symptom, as well as overall observations of crown health. Survey points (detected or not-detected) were recorded every 300-500ft along the trail or parking area and later submitted to iMapInvasives.

Survey Sites and Findings:

TAYLOR POND WILD FOREST

- **Taylor Pond Trailhead (08/09/22):** No signs of BWA or other invasive plants
- **Taylor Pond Wild Forest (08/09/22):** Survey was completed north of Union Falls Pond and Alder Brook Road. There were no signs of BWA. A few patches of Japanese knotweed were found and recorded.
- **Franklin Falls Fishing Access Site (08/23/22):** Survey was completed along a small trail to the water. There were no signs of BWA. Purple loosestrife was found growing on the shoreline and was reported and removed.

DEBAR MOUNTAIN WILD FOREST

- **Hays Brook Trailhead (08/09/22):** No signs of BWA or other invasive plants.
- **Debar Mtn Trailhead (08/23/22):** Survey was completed around trail parking area and register. No BWA was found.

ST. REGIS CANOE AREA

- **St. Regis Mountain Trailhead (08/09/22):** No signs of BWA or other invasive plants.

SARANAC LAKES WILD FOREST

- **Panther Mountain Trailhead (08/09/22):** No signs of BWA or other invasive plants.

HORSESHOE LAKE WILD FOREST

- **Mount Arab Trailhead (08/09/22):** There were very few fir trees but no signs of BWA on fir down the road from the trailhead.

CRANBERRY LAKE WILD FOREST

- **Gilbert Tract Trailhead (08/09/22):** No host trees present

CHAZY HIGHLANDS STATE FOREST

- **Lyon Mtn Trailhead (08/10/22):** No signs of BWA.
- **Chazy Highland State Forest (08/10/22):** Survey was completed at the Route 374 parking lot spring. There were no signs of BWA. Several invasive purple loosestrife (*Lythrum salicaria)* plants were located, recorded, and removed.

DUNKINS RESERVE STATE FOREST

- **Dunkins Reserve State Forest (08/10/22):** Survey was completed place at Diamond Way entrance. No BWA was found.

TERRY MOUNTAIN STATE FOREST

- **Terry Mtn State Forest (08/10/22):** Survey was completed south of Peasleeville Road. There were no signs of BWA.
- **Mud Pond Trailhead (08/10/22):** No signs of BWA, HWA, or other invasive plants.

Checking (healthy) balsam fir for BWA (2022).

BURNT HILL STATE FOREST

- **Burnt Hill Parking area (08/10/22):** No signs of BWA or HWA.

WILCOX LAKE WILD FOREST

- **Crane Mountain Parking Area (08/31/22):** No signs of BWA.

ALGER ISLAND CAMPGROUND

- **Alger Island (09/01/22):** No signs of BWA.

Beech Leaf Disease

Introduction:

Beech leaf disease (BLD) is a disease thought to be caused by the nematode *Litylenchus crenatae mccannii.* This forest pest has only recently been discovered and there is still very little known about it. It is still unknown how BLD attacks the trees, how it spreads, and whether it can be managed. BLD attacks both native and ornamental species of beech. BLD can kill beech in as little as 2 years, and sometimes sooner for saplings. Beech is an important understory species in the Adirondacks that provide food and habitat for many birds and mammals (NYSDEC, 2022).

Complications from beech bark disease (BBD) have already altered the state of Adirondack forests as distressed beech trees send out root suckers that produce thickets in the understory (NYSDEC, 2022). This reaction has detrimental effects on other understory species and shade tolerant saplings, reducing productivity and biodiversity as the thickets shade out other plants. The combination of BBD and BLD would likely increase this stress reaction and have a cascading effect on ecosystems. Because there are so many unknowns surrounding BLD, early detection is key for research and monitoring. This summer, the first report of BLD in the Adirondack PRISM was confirmed in Herkimer County within the Ferris Lake Wild Forest. The goal of these surveys was to check surrounding areas to assess the severity and scope of the infestation.

Beech Leaf Disease at Caleb Smith State Park in Suffolk County, NY 2020

Methods:

Survey locations were selected within the Ferris Lake Wild Forest, where the first infestation of BLD in the Adirondacks was discovered, based off their proximity to the known infestation. Most survey sites had trails where the survey was done, but several sites closer to the report did not have trails so a bushwhacking survey was completed. Once a survey site was chosen, a representative sample of beech trees on and near the trail(s) were visually inspected for signs of BLD. The most common sign of BLD is banding between the veins of the leaves, sometimes called zebra striping. This banding is obvious when looking up through the leaves, as the bands are thick and appear as dark stripes from below. BLD is also characterized by a leathery texture the leaves take on as they start to curl and die. In addition, a thinning canopy can be a sign of BLD. Canopy thinning can also indicate other disease, so all these signs were checked for at each site. A report (detected or not-detected) was recorded in iMapInvasives every 300-500 feet.

Survey Site and Findings:

FERRIS LAKE WILD FOREST

- **Jerrysfield Road (09/20/22):** The survey started at the end of Jerrysfield Road southwest of Klondike Reserve and of the iMapInvasives BLD report. A bushwhacking survey was completed to the northwest of Jerrysfield Road for a total of 1.5 miles over 2 hours. Many trees were infested with BBD, however there were no signs of BLD related decline.
- **Upper Bungtown Road (09/20/22):** The survey was conducted in the patch of forest east of the Klondike Reserve and southeast of the known BLD infestation. This survey was closest to the existing infestation. A bushwhacking survey was completed along Trammel Creek for a total of 1.5 miles over 2 hours. There were many trees infected by BBD, but no signs of BLD related decline.
- **East Road Trailhead (09/20/22):** The trailhead was inaccessible due to road conditions, however there were no signs of BLD on the beech along East Road on the approach to the trailhead.
- **Burnt Vly Trailhead (09/20/22):** A survey was completed along the hiking trail to Burnt Vly for a total of 1 mile over 35 minutes. There were no signs of BLD and very few trees were visibly infected with BBD.
- **Broomstick Lake Trailhead (09/21/22):** A survey was completed along the 1.5 mile hiking trail to Broomstick Lake over 2 hours. Approximately 25% of trees surveyed had signs of BBD, but no signs of BLD-related decline were observed.
- **Good Luck Lake Trailhead (09/21/22):** Surveyed partially down the trail and around the lake shore for about 1.3 miles over 1.5 hours. There were no signs of BLD and few trees were infected with BBD.
- **Jockeybush Lake Trailhead (09/21/22):** A partial trail survey was completed along approximately 1.3 miles over 1.25 hours. The survey ended at the large waterfall on the river adjacent to the trail. There were no signs of BLD and few trees were visibly infected by BBD.
- **Powley Rd (10/05/22):** Surveyed a report of BLD submitted to iMapInvasives at 43.31563, -74.6495. No BLD was present. A sample was collected for follow-up and confirmation. The survey continued along several points along the road, as well as the trail to Sand Lake. Total survey encompassed approximately 2 miles over 3 hours.

Beech Leaf Disease at Caleb Smith State Park, Suffolk County NY 2020

BLACK RIVER WILD FOREST

- **Vista Trail Parking (09/21/22):** A partial trail survey was completed along 1.4 miles over 1.75 hours. There were many trees infected by BBD, but no signs of BLD related decline.

Emerald Ash Borer

Introduction:

Emerald ash borer (EAB) (*Agrilus planipennis)* is an invasive beetle that was introduced to North America from Asia. EAB attacks all native species of ash (*Franxinas spp.)* found in the Adirondacks, including black, green, and white ash. EAB aggressively attacks ash trees and typically kills them within 2-4 years (NYSDEC, n.d.). EAB is a small beetle, less than the size of a penny, and is named for its distinct metallic green color. EAB infestations can also be identified by the "D" shaped exit holes the insects leave as well as the serpentine tunneling patterns from larvae that can be found under the bark. Many ash trees infested with EAB will also display blonding, thinning of the canopy, and may have significant woodpecker damage.

Ash plays an important role in northern hardwood forest ecosystems, providing food for many species of mammals and birds. It's also commercially valuable as it is often used as lumber and in production of pallets, furniture, and flooring (NYS DEC, n.d.). Black ash is also a culturally significant species to indigenous tribes that harvest them for basket making (NYS DEC, n.d.). The decline of ash due to EAB threatens to change the forest composition of the Adirondacks. EAB is typically spread through the movement of firewood, and it is already known to occur in several counties in the Adirondack PRISM.

EAB Surveillance trap at Putnam Farm Rd., Wilcox Lake Wild Forest

Methods:

One of the most efficient ways to monitor for EAB is through surveillance trapping. Trapping allows for the monitoring of many locations, while only having to service traps once every two weeks. Multilayered green funnel traps were placed at eight locations within approximately 10 miles of known EAB infestations in Warren County (Table 3).

At each site, an ash tree with a low branch was selected so the rope could easily be thrown over the branch to hoist the trap. Traps were deployed and affixed with a Hexanol or leaf alcohol kairomone lure. Traps were checked every two weeks and all specimens from the collection cup were collected by pouring the liquid through a labeled paint filter that was then folded and placed in a zip lock bag. The samples were visually assessed for signs of EAB and then stored in a freezer before being sent to the lab for evaluation. The traps sample cup was refilled with antifreeze and secured back on the trap. Lures were changed every four weeks. Most of the traps were deployed in May, with one trap being deployed in June (Boquet) and one deployed in July (River Road). Most of the traps were monitored for a total of 16 weeks, except for the traps that were deployed later. All traps were

taken down in September. Laboratory analysis of the samples is still pending, but there were no suspicious sightings during the monitoring of the traps.

Trap Sites and Findings:

Table 3. EAB trap locations monitored by the FPRA in 2022.

Site	Deployed	Retrieved	EAB Found
Cayuga Camp -Scaroon Manor Campground	05/24/2022	09/27/22	No
Riparius Bridge	05/24/2022	09/27/22	No
Eagle Pond Trail - Wilcox Lake Wild Forest	05/24/2022	09/27/22	No
Putnam Farm Road Trail - Wilcox Lake Wild Forest	05/24/2022	09/27/22	No
Warrensburg Fish Hatchery	05/24/2022	09/27/22	No
Deer Leap Trail - Lake George Wild Forest	05/24/2022	09/26/22	No
TNC's Boquet River Nature Preserve	06/21/22	09/26/22	No
River Rd. - Vanderwhacker Mountain Wild Forest	07/06/22	09/27/22	No

Campground and Trailhead Surveys:

The main goal of the forest pest research assistant position was to monitor, research, and survey for forest pests throughout the Adirondacks. While out monitoring for such pests, many locations were also surveyed for terrestrial invasive plants. Trailhead and campground surveys are a major part of the work that APPIP does. The trailheads and campgrounds surveyed for terrestrial invasive plants through this position can be found in Appendix C. For a complete list of trailhead and campground surveys by APIPP, please see the Invasive Species Campground Steward Annual Report.

Table 4. *List of trailheads and campgrounds surveyed by Forest Pest Research Assistant in 2022. Where terrestrial invasive plants were present the box is red, where no terrestrial invasive plants were present the box is green.*

Hague Road Trailhead		Mount Arab Trailhead	
Clay Meadows Trailhead		Gilbert Tract Trailhead	
Mud Pond Trailhead		Burnt Vly Trailhead	
Taylor Pond Trailhead		Broomstick Lake Trailhead	
Dannemora Parking lot Spring		Good Luck Lake Trailhead	
Hays Brook Trailhead		Jockeybush Lake Trailhead	
Debar Mountain Trailhead		Vista Trail Trailhead	

Forest Pest Management

Once forest pests become established, management intervention may be necessary to limit the spread of the pest and prevent mortality of the host tree. There are a variety of management tools that can be used to combat infestations of invasive forest pests including biological, chemical, and mechanical control. Generally speaking, the earlier an infestation is detected, the greater the likelihood of successful management.

Hemlock Woolly Adelgid

Introduction

Hemlock growing on the shore of Dome Island, 2022

Infestations of HWA are often not detected until they are well established, and eradication is no longer feasible. Left unaddressed, HWA infestations will spread and eventually lead to host tree mortality. The two major control methods for HWA are biological and chemical control. Pesticide application is the only short-term tool to quickly control HWA and help preserve already infested trees and protect healthy trees in at risk areas (NYSDEC, 2018). Biological control is the only long-term, landscape level management solution for HWA. Biological control involves the release of natural predators to control HWA populations. The two biological control agents currently being researched for HWA are *Laricobius* beetles (*Laricobius nigrinus*) and silver flies (*Leucotaraxis argenticollis and L. piniperda*). Development and release of biological controls is a long process. The NYS Hemlock Initiative at Cornell University is leading efforts to develop and deploy HWA biocontrol in New York. Limited biological control agents have been released in the Adirondacks, and until they are well established, chemical control is an important tool to help preserve valuable hemlock resources.

Currently, the main management strategy for HWA in the Adirondacks is chemical control. The two main pesticides used for HWA management are imidacloprid and dinotefuran. Dinotefuran is a fast-acting pesticide with a translocation speed of about two weeks. Dinotefuran persists in the tree for up to one season. Imidacloprid takes longer to act, with a translocation speed that can take up to one season but can persist longer in trees and provides HWA resistance for up to seven years. When used in conjunction these pesticides work together to provide immediate HWA control and longer-term protection. The two main application methods employed are trunk injection and basal bark spraying. Both methods allow for selective application, reducing the likelihood for off-target impacts (NYSDEC, 2018).

This season, the FPRA assisted with HWA management efforts on Dome Island. Dome Island is an approximately 15-acre island located centrally on Lake George. It was donated to The Nature Conservancy by John Apperson in 1956. A 2019-2020 tree census completed by Skidmore

College revealed that 61% of the trees on the island are eastern hemlock. HWA was first discovered on Dome Island in 2020.

The 2022 field season was the third consecutive year of HWA management efforts on the island. There is an annual limit to the total basal area of hemlock that can be treated, so the goal is to return each year until most of the hemlock on the island is managed for HWA. Treatment is most effective during the spring and fall because during this time the soil is moist and water uptake by the trees is at its greatest, allowing for greater translocation of the pesticides (NYS DEC, 2018).

Methods

Prior to treatment, all target hemlock trees are tagged and measured to ensure the proper number of diameter inches are treated each year. A GPS coordinate was recorded for each target tree, its diameter at breast height (DBH) was recorded, and it was affixed with temporary flagging and a metal, numbered tree tag. All treatment planning work was completed on 9/14/22 and 9/28/22.

The main treatment method used this year was a basal bark application of imidacloprid-based insecticide. Backpack sprayers were used to spray the lower portion of trunk, approximately four feet up the tree. Trees received a specific dose of insecticide based on their diameter. All applications were performed by licensed applicators. The flagging was removed, and trees were marked on GPS as they were treated. Spray work was completed on 10/03/22 and 10/04/22.

Another method used to treat hemlock this season was trunk injection. This is a more time-consuming method, so it was only used for the hemlock on steep banks or near the shoreline where basal bark application is not feasible. For this method, small holes are drilled around the base of the tree and a specialized tool is used to inject a prescribed dose of imidacloprid. The number of holes drilled is determined by the DBH. This year, injection treatment was done in the spring on 05/22/22.

APIPP Conservation and GIS Analyst, Zack Simek, prepares a hemlock tree for imidacloprid injection on Dome Island.

Management Totals

In 2022, a total of 505 trees were treated with a basal bark spray of imidacloprid. A total of 22 trees were treated via injection with imidacloprid. Since management efforts began in 2020, over 1,440 trees have been treated across the island (Figure 1).

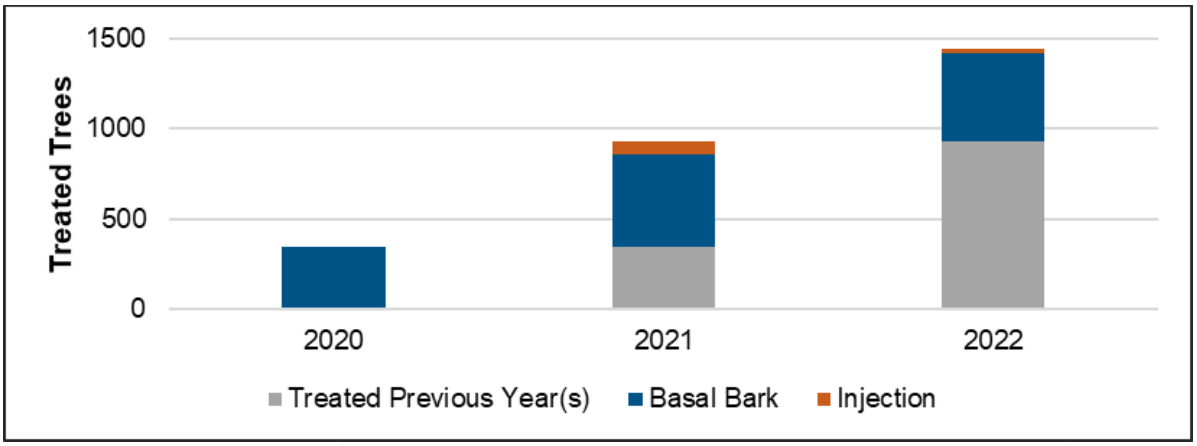

Figure 1. Cumulative number of treated trees on Dome Island, by management method and year of application

View of Dome Island from Lake George, 2022

Research and Special Projects

In addition to routine forest pest surveillance and management activities, the FPRA had the opportunity to assist APIPP staff with new and ongoing regional research projects. The goal of these research projects is to improve understanding of invasive species detection techniques, management strategies and associated stressors. The three major research projects for this season included the use of environmental DNA for detection of hemlock woolly adelgid, alternative chemical and mechanical treatments for knotweed species, and an ongoing Assessing Vegetation Impact from Deer (AVID) monitoring project. A summary of each project is provided below.

Hemlock Woolly Adelgid Environmental DNA

Purpose:

Hemlock woolly adelgid is very small insect which makes detection, particularly early detection, very difficult. The goal of this study is to determine whether environmental DNA (eDNA) is a viable HWA early detection tool.

eDNA is the DNA of organisms that is released into the environment. Samples of water, soil, foliage, etc. can be collected and analyzed in a lab to detect the presence of and quantify a target species DNA. Current research has indicated that eDNA from HWA can be easily spread through wind, rain, and canopy throughfall (NYS Hemlock Initiative, June 2022). This means that, in theory, foliage samples collected from lower branches of infested trees should contain HWA eDNA.

Branches along the shoreline were sampled from a boat.

In this study we collected branch samples from trees located in various buffer distances from known infestations of HWA. Samples were submitted to the NYS Hemlock Initiative lab at Cornell University for testing.

Methods:

Detection of eDNA in the lab is highly sensitive to contamination from an individual's clothing, hands, and tools (NYS Hemlock Initiative, June 2022). For this reason, we followed a specific decontamination protocol at the start of each sampling day, before each individual sampling, and after the end of each sampling day.

In total, 25 sample sites were selected in the Lake George region, along with three positive controls and five negative controls. The main sample sites were selected based on their proximity to known HWA infestations and were in one for following buffers:

- 0–1-miles from known HWA
- 1–2-mile from known HWA
- 2-3 mile from known HWA
- 3-4 mile from known HWA

Each sample was collected in a stand of at least 50% hemlock. A central hemlock tree was flagged, measured, and its GPS coordinates were recorded. We collected six 10-15 cm terminal branch samples from six different hemlock trees within 15 m of the central tree. Branch clippings were placed in the labeled zip lock bag as they were collected, and the bag immediately sealed after collection.

Positive control samples were either collected at the end of a sample day or on a separate day to avoid the accidental spread of eDNA to other previous samples. In the event an infestation of HWA was discovered at a non-positive control site, sampling for the day ceased to avoid cross contamination. This occurred when a sample at Long Island on Lake George was found to have an infestation of HWA.

Results:

All samples were submitted to the NYS Hemlock Initiative lab at Cornell University for processing. At the time of this writing, analysis was still underway.

Chemical and Mechanical Treatment Alternatives for Knotweed

Purpose:

Invasive knotweed spp. (*Reynoutria spp.)* are prolific invasive plants that are widespread throughout New York State. Knotweed typically establishes on roadsides, disturbed areas, and riparian buffers (NYIS, 2019). Many of these buffers are prone to flooding and disturbance, which make them more vulnerable to knotweed invasion. These habitats provide crucial ecosystem services, such as flood mitigation, and provide habitat for many other species (NYIS, 2019). Knotweed grows exceedingly fast and can reproduce via vegetative propagation, meaning new knotweed stems can grow from small fragments of the plant. This makes knotweed one of the more difficult invasive plants to manage. One of the most common management techniques for knotweed is the application of the glyphosate-based herbicide, either through stem injection or foliar spray. Unfortunately, recent legislation has established increased restrictive conditions for glyphosate use on state lands in NY. The purpose of this study was to evaluate the effectiveness of chemical and mechanical treatment alternatives to glyphosate.

Methods:

Plots were established at three study sites in Willsboro, Cranberry Lake, and Elizabethtown. Each site was selected because it contained a large continuous knotweed patch at least 0.1 acres in extent. At each study site, we established one-to-three sets of seven 1 m^2 plots to evaluate three herbicides using two application techniques:

- Foliar Application: Glyphosate
- Foliar Application: Imazapyr
- Foliar Application: Aminopyralid
- Injection Application: Glyphosate
- Injection Application: Imazapyr
- Injection Application: Aminopyralid

At each site, plots were positioned at least 5 meters apart and at least 3 meters from the edge of the infestation. However, foliar plots were established closer to the edge to facilitate treatment. Care was taken to avoid trampling stems within the plots themselves and within the surrounding area. A PVC stake was labeled and placed at the center of each plot and GPS coordinates were recorded.

We recorded the diameter of each stem at the second node (about 6in above the ground) within each plot and flagged them with marking tape. Stems 20mm in diameter and above were numbered (the rest were un-numbered but still flagged and recorded). At each plot, native and non-native plant cover was observed, characterized, and recorded as a percent of total plot cover. Once the plots were established, treatments were randomly assigned. Control and injection treatments were assigned to interior plots and foliar spray treatments to edge plots.

Herbicide injectors were calibrated and used to inject all labeled stems over 20mm with 3ml of glyphosate, 3ml of imazapyr, or 1ml of aminopyralid. A separate injector was used for each product to avoid cross contamination. For the foliar plots, a sprayer was used to coat the leaves of the knotweed within each plot. We used a 3% solution of glyphosate, a 1% solution of imazapyr, or 0.75% solution of aminopyralid. Separate sprayers were used for each product to avoid cross contamination. A ladder was used to treat the foliar plots so the leaves could be sprayed from above to limit overspray. A pole was also used to help hold back non-target stems surrounding the plots being sprayed. Each foliar plot was sprayed until all leaves were coated with the product. This process will be repeated once each year of the study.

Plots were monitored at two, four, and six weeks after treatment. Monitoring ceased after the first hard killing frost. The stems in each plot were visually evaluated for foliar senescence and abscission on a scale of 0-100%, with 0 meaning all stems remained alive and 100% being mortality of all stems. At injection plots, a visual assessment was conducted to identify any damaged stems within a 2 meter radius plots to assess herbicide translocation. Monitoring and treatment will continue for 3 years from the time of plot establishment.

In addition to the chemical control plots, a wire mesh treatment plot was established at a separate patch of knotweed at the Cranberry Site. The patch was covered in fine wire mesh that was secured to the ground over the patch of knotweed. As the knotweed grows, the wire mesh girdles the stems. The wire mesh plot was also monitored for six weeks, with visual assessments conducted at each visit.

Knotweed shoots emerge through wire mesh treatment. As stems increase in diameter, they are girdled and killed by the wire mesh.

Results:

At six weeks after treatment, stem injury/ mortality was greater in injection plots vs. foliar treatment plots. On average, injection plots exhibited 92% injury while foliar plots displayed 52% injury. Of the three herbicides used for foliar spray, aminopyralid resulted in the greatest percent injury (82%), followed by glyphosate (74%), and imazapyr (61%).

After six weeks, the greatest injury was observed in plots injected with aminopyralid and glyphosate, both with an average injury of 96%. Injection of imazapyr was also effective, with average injury of 84% (Figure 2). Monitoring will continue in spring 2023 to assess re-growth in treated plots. Treatment with the same products will continue in plots in the summer 2023.

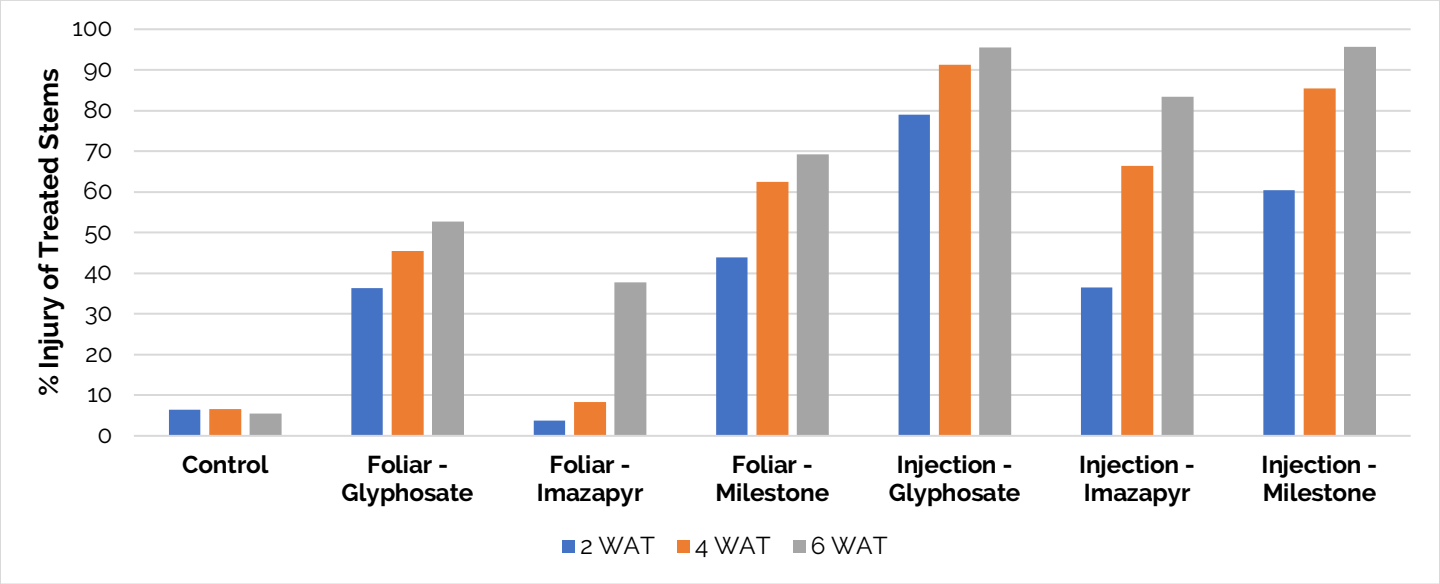

Figure 2. *Percent injury of treated stems at two, four, and six weeks after treatment (WAT).*

Assessing Vegetation Impacts from Deer

Purpose

Whitetail deer are one of several stressors impacting forest ecosystems in the Adirondacks. Few natural predators of whitetail deer remain, which can create an unbalanced dynamic where browse pressure can negatively impact forest dynamics. Deer preferentially browse on native shrubs, herbs, and woody seedlings. Over time, this browse pressure can disrupt regeneration of native plants and trees and create a disturbed environment where invasive species are more likely to take hold. Generally, deer avoid browsing on invasive plants which are less palatable to them. The pressure that deer put on these ecosystems can negatively impact efforts to restore habitat after removing invasive plants.

In this ongoing study, we assess the impact of deer browse pressure on woody seedlings and wildflowers at four TNC properties. The goal of this research is to determine whether deer browse impacts are reaching a level that could inhibit invasive species management and native species recovery. Browse impacts were evaluated using the Assessing Vegetation Impacts from Deer (AVID) protocol. This protocol was designed to help landowners and managers better asses impacts of deer browse on the forests. More information on this protocol can be found are www.AVIDdeer.com.

Spring Pond Bog Preserve, 2022

Methods:

AVID plots were established at four TNC preserves in 2020 and have been monitored each year since. These preserves include Spring Pond Bog Preserve, Boquet River Nature Preserve, Sliver Lake Bog Preserve, and Follensby Pond Preserve. Wildflower monitoring plots were established at Spring Pond Bog, Sliver Lake Bog, and Boquet River Nature Preserve. Paired fenced-open woody seedling monitoring plots were established at Spring Pond Bog and Follensby Pond.

Wildflower plots include purple trillium (*Trillium erectum*) and white trillium (*Trillium grandiflorum*). Individual plots were chosen within these preserves based on the presence of *Trillium spp*. All wildflower plots were unfenced and marked with a PVC center stake. Approximately 7-10 *Trillium* were tagged and numbered in each plot. The height of tagged flowers (inches) and flowering status is recorded annually to assess growth patterns and browse impacts.

A group of white trillium present at Boquet River Nature Preserve.

Woody seedling plots include species that are preferentially browsed by deer such as ash *(Fraxinus spp.)* and maple (*Acer spp.)*. Paired plots were chosen based on the abundance of these species' saplings. We established pairs of fenced and open plots at each study site. Plots were marked with a PVC center stake and stems were marked with numbered tags. The height of tagged seedlings (inches) is recorded annually to assess growth rates and survival. We monitored ash and sugar maple at Follensby Pond and ash and red maple at Spring Pond Bog.

Results: Wildflower Monitoring

Boquet River Nature Preserve: Upland Forest Plots

Total plant count has fluctuated from 2020-2022 as some stems are damaged or cannot be relocated for measurement (Figure 4). Of the 31 original tagged individuals, 23 were located and resampled in 2022. Average annual plant height increased slightly from 2020, but was lower than 2021 (Figure 3).

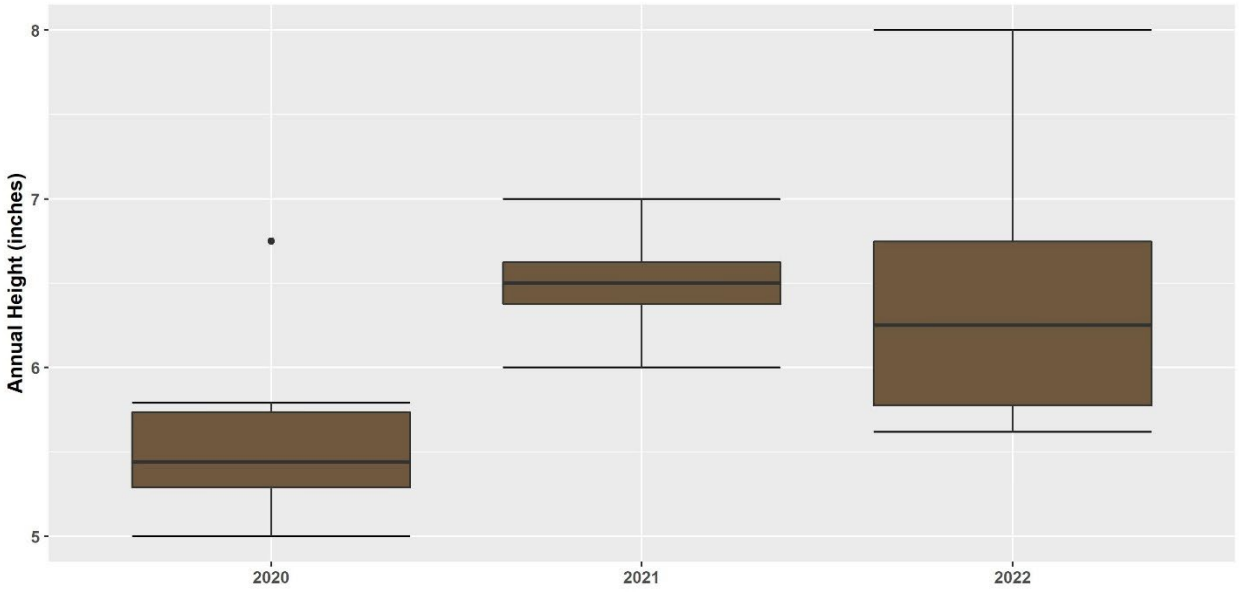

Figure 3. *Change in Trillium annual height at Bouquet River Nature Preserve – Upland Forest (2020-2022).*

The number of flowering plants present remained relatively constant. Four flowering individuals were present in 2022 (Figure 4).

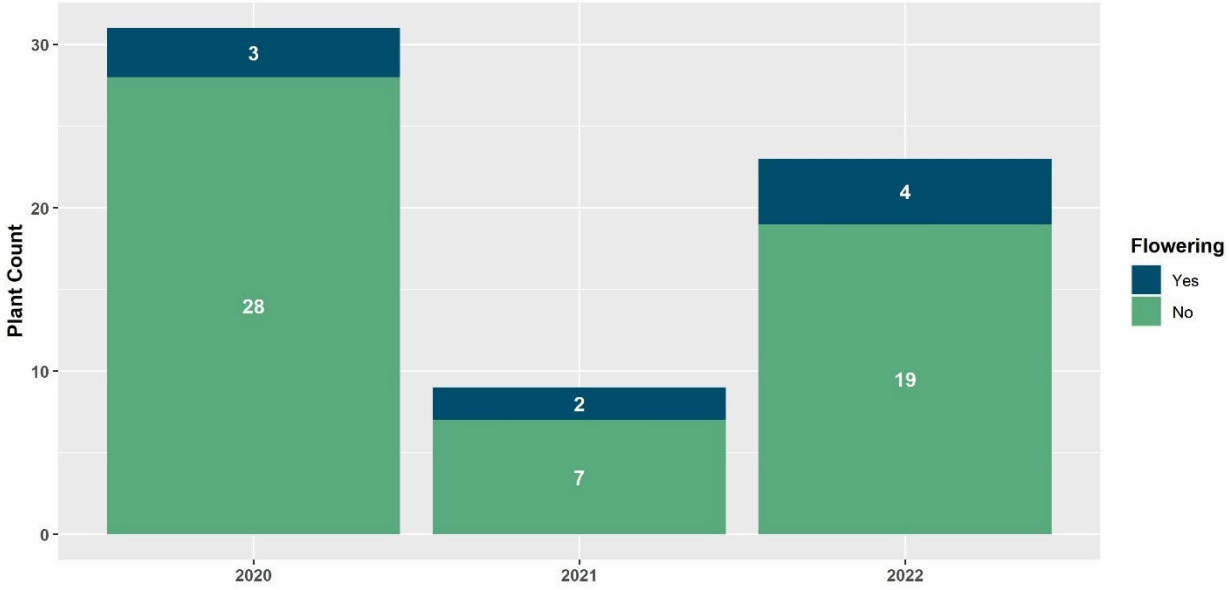

Figure 4. *Plant count by flowering status at Bouquet River Nature Preserve – Upland Forest (2020-2022).*

Boquet River Nature Preserve: Tim's Trail Plots

Total plant count has decreased since monitoring began in 2020. Many individuals could not be relocated for sampling in 2022 (Figure 6). However, average annual height of plants in the plot has remained stable, increasing slightly from 6.13 to 6.70 inches (Figure 5).

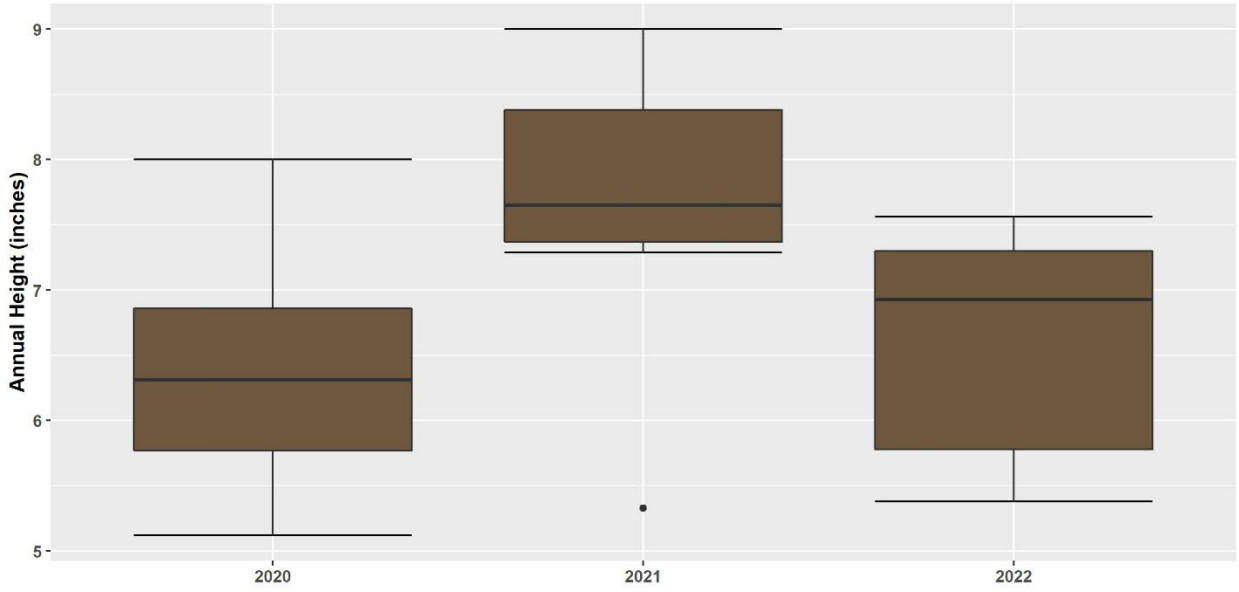

Figure 5. *Change in Trillium annual height at Bouquet River Nature Preserve – Tim's Trail (2020-2022).*

The number of flowering plants present during monitoring remains relatively unchanged, with six flowering plants observed in 2022 (Figure 6).

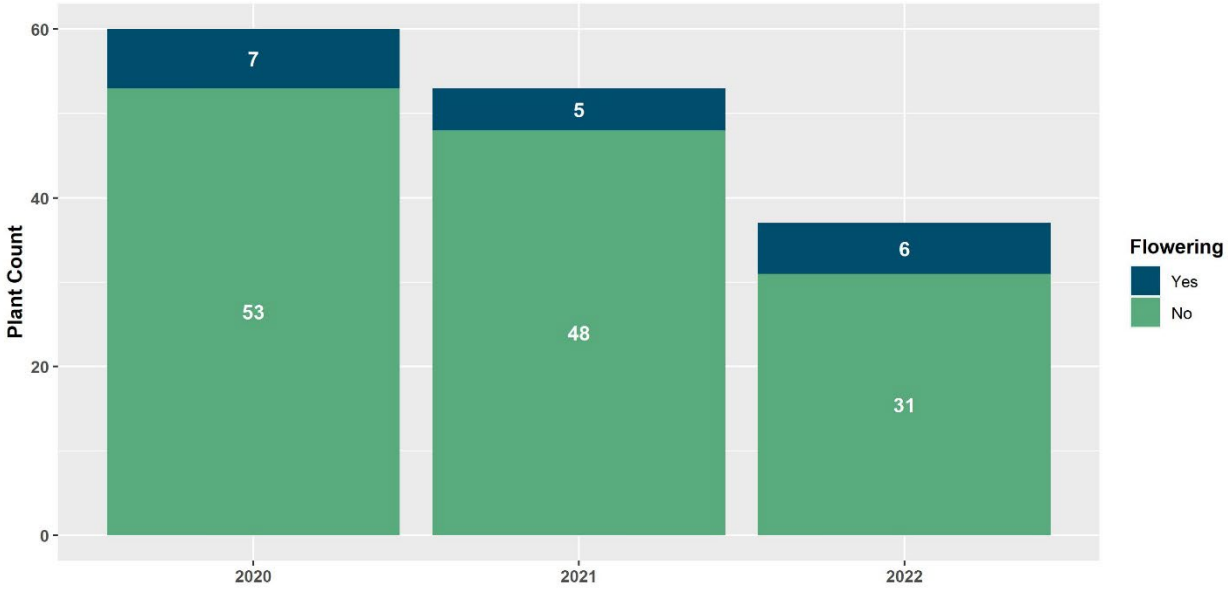

Figure 6. *Plant count by flowering status at Bouquet River Nature Preserve – Tim's Trail (2020-2022).*

Silver Lake Bog

Only 1/3 of the originally tagged stems were relocated for sampling in 2022 (Figure 8). Of those, height remained consistent, averaging 5.94 inches across plots (Figure 7).

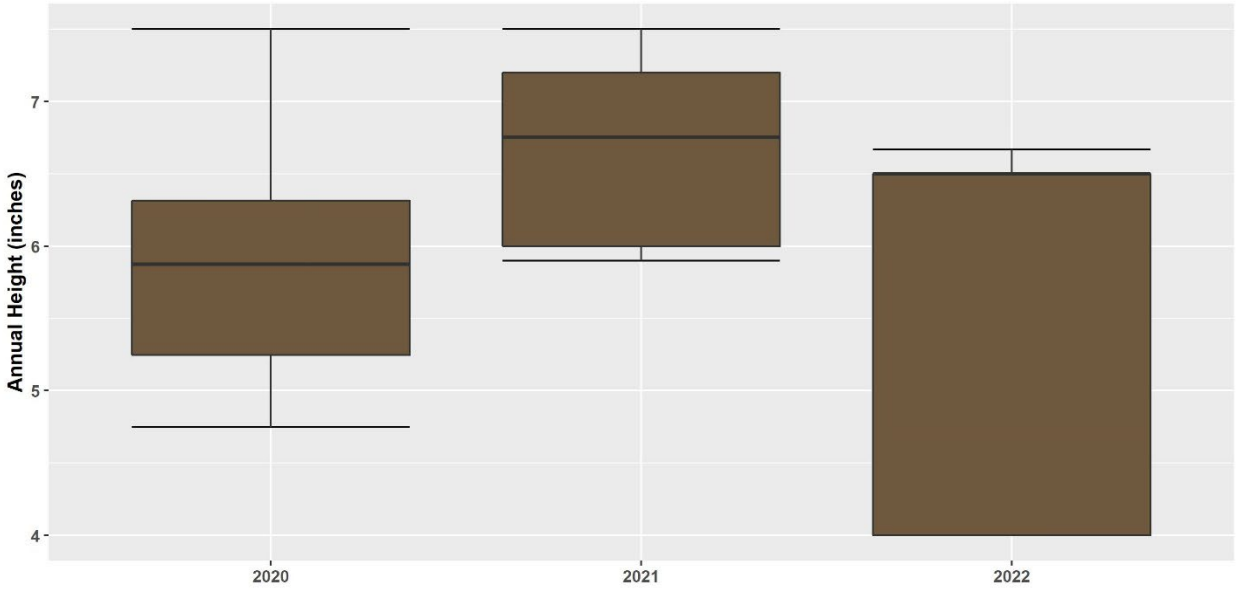

***Figure 7**. Change in Trillium annual height at Silver Lake Bog Preserve (2020-2022).*

The number of flowering plants observed has gradually decreased over time, with no flowering plants present in 2022 (Figure 8).

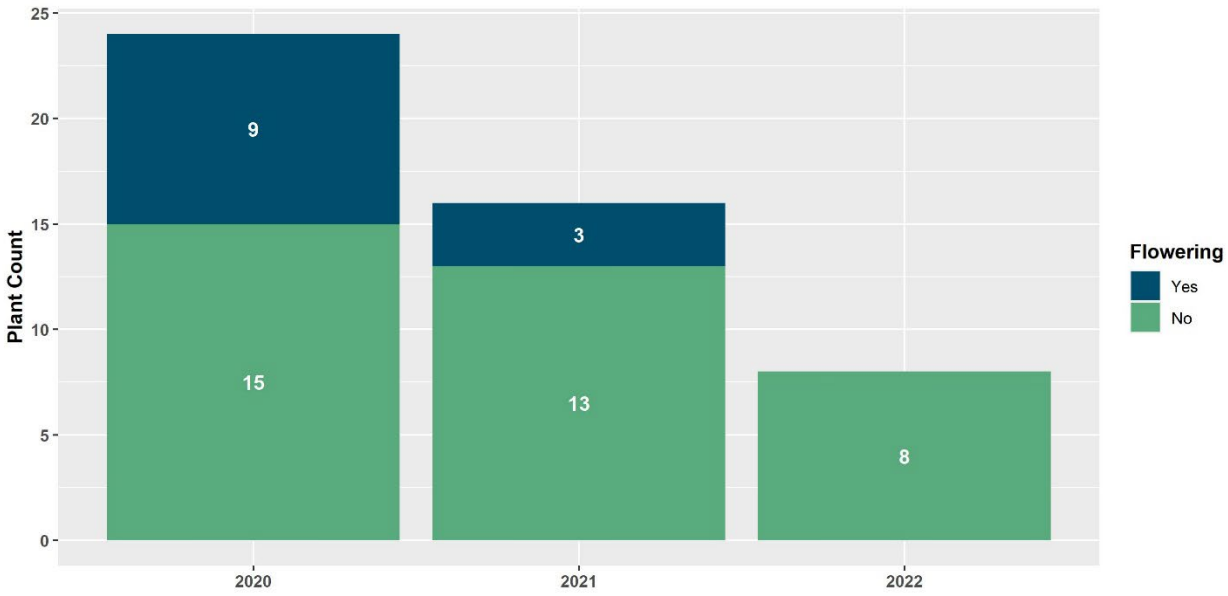

***Figure 8** Plant count by flowering status at Silver Lake Bog Preserve (2020-2022).*

Spring Pond Bog

Total plant count has decreased since monitoring began, but a greater number of individuals were located and resampled in 2022 vs. 2021 (Figure 10). Average annual plant height of remaining stems increased 56% from 2020 to 2022, the greatest increase observed at all wildflower monitoring sites (Figure 9).

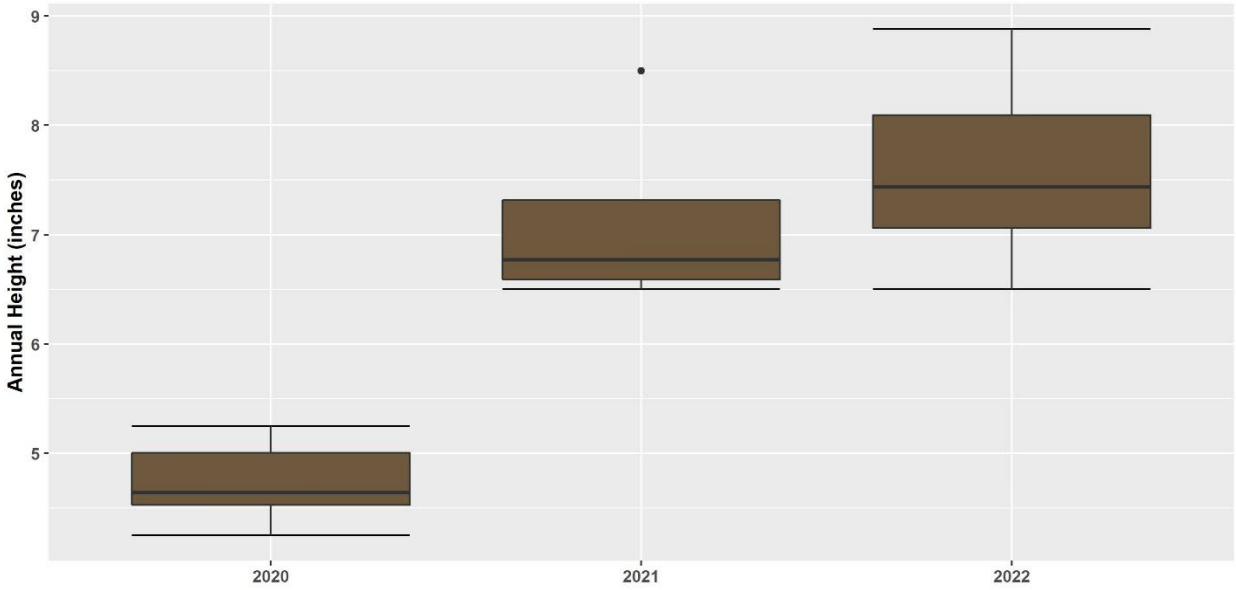

Figure 9. *Change in Trillium annual height at Spring Pong Bog Preserve (2020-2022).*

The total number of flowering plants has decrease since monitoring began with only four flowering individuals observed in 2022 (Figure 10).

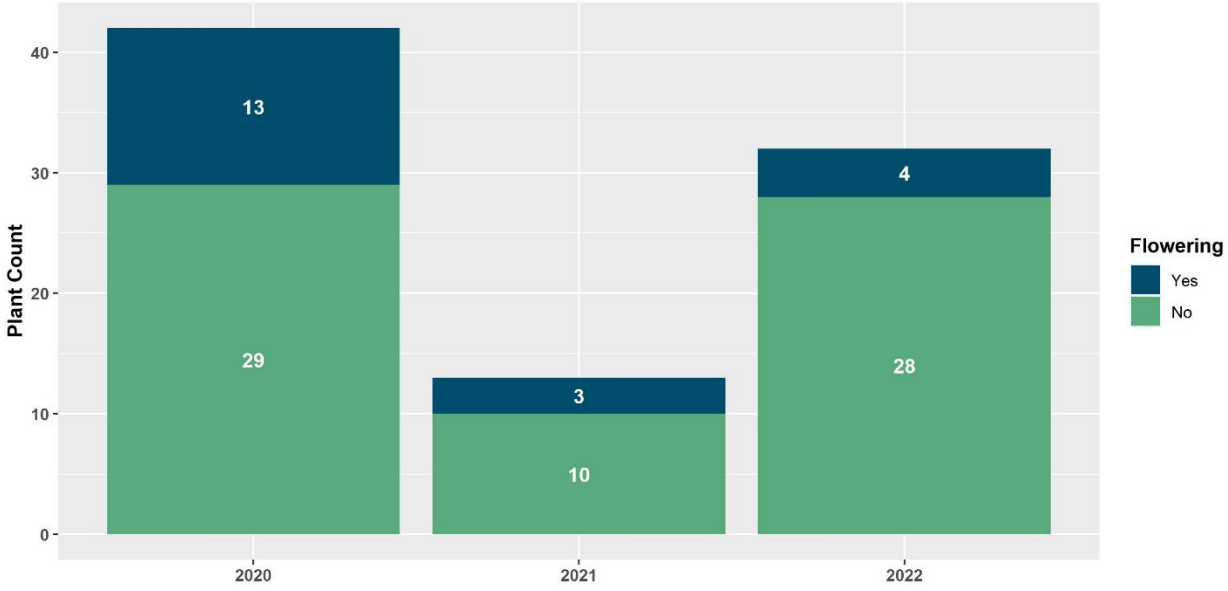

Figure 10. *Plant count by flowering status at Spring Pond Bog Preserve (2020-2022).*

Results: Woody Seedling Monitoring

Spring Pond Bog

Since monitoring began in 2020, average annual plant height has increased by 4.61 and 2.66 inches in closed and open plots, respectively (Figure 11). There was not a statistically significant difference in annual plant height between open and closed plots in 2022. The average height for both species increased from 2021 to 2022. Red maple averaged 15.63 and 11.85 inches in closed and open plots, respectively. Ash averaged 16.0 and 14.5 inches in closed and open plots, respectively. Minor stem mortality was observed in both closed and open plots with no explicitly discernable cause.

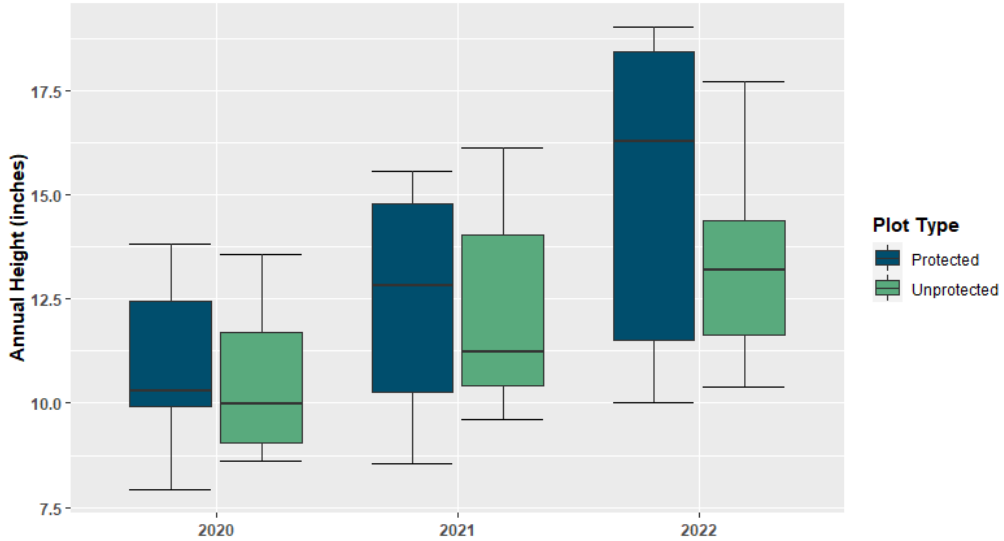

Figure 111. *Change in woody seedling annual height in closed and open plots at Spring Pond Bog Preserve (2020-2022).*

Follensby Pond

Since monitoring began in 2020, average annual plant height has increased by 2.32 and 1.41 inches in closed and open plots, respectively (Figure 12). There was no statistically significant difference in annual plant height between open and closed plots in 2022. The average height for both species increased from 2021 to 2022. Red maple averaged 13.61 and 12.95 inches in closed and open plots, respectively. Ash averaged 14.87 and 12.60 inches in closed and open plots, respectively.

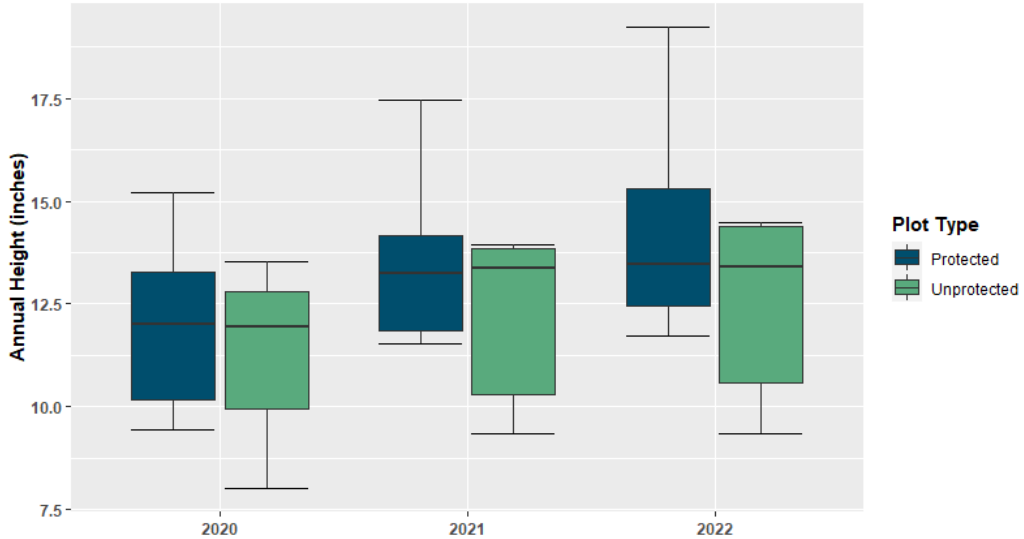

Figure 12 *Change in woody seedling annual height in closed and open plots at Follensby Pond Preserve (2020-2022).*

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