

# *HOPKINS MEMORIAL FOREST*

## *The Year in Review*

*2021-2022*



Center for Environmental Studies

Williams College

December 2022

## SUMMARY

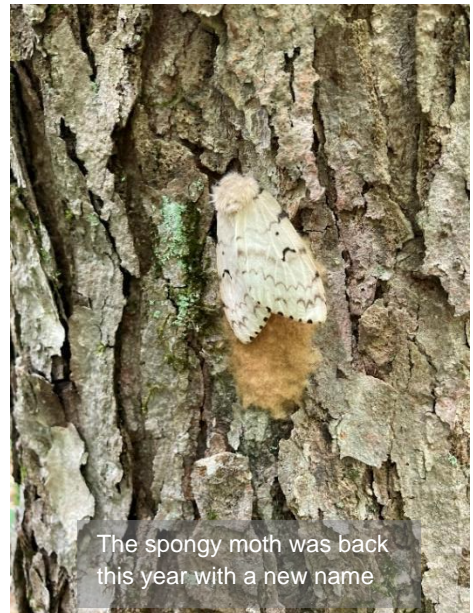
*September 2021 through August 2022*

This year, we were pleased to have academic programming return to pre-pandemic levels at Hopkins Memorial Forest (HMF), Williams College's environmental field station. With a steady improvement in the public health situation, we were able to bring back a full program of class visits, research activity and public programming. With the fall semester returned classes, largely unmasked, for lab sessions and field trips as well as public events, elementary field trips, and caretaking, with a minimum of masking or disruptions. Through the winter and spring we experienced occasional spikes in Covid-19 (Omicron) activity that necessitated a return to masking; by and large, these posed only minor impediments to our activities.

The forest saw the establishment of a new field study this year, when visiting researcher David Moreno Mateos of Harvard University incorporated it into his regional study of historical forest dynamics (chrono-sequencing) and made two sampling visits.

Allison Gill (Biology) continued her ecosystem-level study of nitrogen fertilization and substrate additions, and their effects on the rates of carbon sequestration and respiration. Several student assistants were involved with implementing treatments and taking measurements throughout the growing season, and two others developed honors theses from their previous work on the study. In Geosciences, Dartmouth College PhD candidate Jordan Fields continued his investigation of sediment fluxes in the Birch Brook system by monitoring the movement of tracer rocks and surveying the banks along its South Branch and Main Stem.

Many established projects continued as well, including Joan Edwards' (Biology) investigation of the effects of differential mowing regimes on late-season wildflowers and pollinators, and her long-term study of the population dynamics of garlic mustard (*Allaria petiolata*) at three sites in the forest. Under the direction of Jay Racela (Environmental Studies) the Environmental Analysis Lab entered its 40<sup>th</sup> year of continuous biogeochemistry and meteorological monitoring, while continuing the maintenance of weather and stream gauging stations and associated data. Kyle Bradford, of Antioch University, has been doing analyses of the data that he collected previously as part of his regional investigation of ant diversity.



With the relaxation of Covid-19 related protocols, classes were able to return full-bore, and an array of them -- from Environmental Studies to Biology to Geosciences -- made the most of the opportunity. Outreach activities ramped up once again as well, with the return of student-guided elementary field trips and popular events such as *Fall Festival*, *Maplefest* and *Alumni Weekend*. Student caretaking continued to be popular as ever as large numbers of students took advantage of this unique employment option throughout the year and during the summer.

Once again, the forest was open to deer hunters in the fall and other recreational users throughout the rest of the year. In the spring the students were busy in the sugarbush, helping to produce more than twenty gallons of syrup. One visitor, the spongy moth (*Lymantria dispar*), was especially notable in the summer -- causing moderate defoliation, primarily in oak stands, around the forest.

In 2022-23 we will continue to bolster our research program, and to promote the forest as a venue for teaching and outreach, both formal and informal. Moreover, we intend to start a process of envisioning the future of the forest; this will begin with a self-study of our policies and programs that may serve as a basis for an external review. Stay tuned.

## RESEARCH & MONITORING

The following scientific studies were underway during the past year.

### **Ecosystem-Level Nitrogen Fertilization Experiment** (*description by Allison Gill*).

The major focus of my research lab since arriving at Williams College has been the establishment of a new long-term nitrogen (N) fertilization and leaf litter substrate addition experiment at two sites within Hopkins Forest. This experiment is designed as a framework to broadly investigate the influence of N fertilization and carbon (C) (leaf litter) inputs on terrestrial ecosystem processes, but I am particularly interested in using it to explore the influence of N inputs on the process of soil organic matter (soil C) formation, and how those responses vary across sites with differing soil chemistry and mineralogy. The experiment is replicated in two locations in the forest: in a low-elevation site near the Rosenberg Center, and a high elevation site off the Taconic Crest Trail near Petersburg Pass. The sites differ in soil mineralogy, which may influence the plant and microbe-mediated processes by which added C substrates are stabilized in soils, as well the overall soil C response to N fertilization. Ultimately, I hope that these coupled N fertilization and C substrate addition experiments will help provide a mechanistic explanation for the varied soil C responses to N fertilization observed across globally-distributed experiments.

I established the plots in spring 2021, and my research group spent the year collecting intensive pre-treatment data to develop a stronger mechanistic understanding of the biogeochemical differences between the two experimental sites. We characterized soil C and N content, cation availability, cation exchange capacity, and nutrient availability in summer 2021. We mapped the size and identity of all trees within the plots in order to track tree growth and biomass production throughout the experiment, and measured continuous leaf litter production throughout the growing season. Aaron Stanton '22 completed an honors thesis evaluating relationships between soil chemistry and tree community composition across the experiment.

We made biweekly measurements of field-based soil carbon dioxide fluxes (soil respiration) throughout the 2021-2022 growing season, which thesis student Patrick Hodgson '22 used to model differences in the temperature sensitivity of soil respiration across sites. This is important baseline information about the differing susceptibility of soil C pools to warming temperatures. Patrick is supporting these field-based measurements with laboratory quantification of the microbially-available C pool size, as well as experimental determination of the capacity of the microbial communities to metabolize substrates of differing chemical complexity. He found large differences in the fraction of soil C that is available to microbial decomposers as metabolic substrate, which likely explains the strong variation in total C pool size across sites. We are currently re-structuring Patrick's thesis work as a manuscript for submission to *Ecosystems*.

This summer, incoming thesis student Maddie Annis '23, in collaboration with Katharine Cook '24 and Diya Pandey '25, explored the mechanisms by which soil C is protected from microbial decomposition across sites in order to better understand variation in microbially-accessible C across sites. We found a much larger pool of macroaggregates, or large physical conglomerations of soil particles, in the C-rich (and microbially-inaccessible) upper site soils, which associate with changes in the ratio of above- to below-ground plant biomass (relatively larger C allocation to roots at the upper elevation site). We are currently density-fractionating the soils to understand the relative fraction of particulate organic matter and mineral-associated organic matter across the plots, which we anticipate may show divergent responses to N fertilization. We also used the summer to characterize the soil N cycle, measuring rates of N mineralization and nitrification, as well as total inorganic N pool size throughout the growing season. These data will form the basis for Angela Hsuan Chen's '23 senior thesis, in which she



Katherine Cook '24



will evaluate N cycle differences across plots as a function of plant mycorrhizal association, as well as characterize the influence of plant-associated mycorrhizal fungi on N transformation using buried mycorrhizal ingrowth and exclusion bags currently incubating in the field.



*Maddie and Diya at work in the field*

Complementing our work evaluating microbial activity and soil C respiration, Molly Fraser '23 characterized invertebrate decomposer community composition in Summer 2021. Her work highlighted the dominance of invasive earthworms at the lower elevation site, and she is now working in the lab (in collaboration with Andrew Reinmann, CUNY Advanced Science Research Center) to quantify the effect of earthworms on the size of the microbially-available soil C pool, which will form the basis of her senior thesis work this year. Patrick Hodgson '22, Aaron Stanton '22, Molly Fraser '23, Angela Hsuan Chen '23, and Maddie Annis '23 all attended and presented their work related to the HMF study at the annual Ecological Society of America Meeting in Montreal in August 2022.

Following a year of intensive pre-treatment data collection, we initiated N fertilization experiments ( $10\text{g N m}^{-2}\text{ year}^{-1}$  as polymer-coated urea) in July 2022. We also built the fences required to sustain the litter substrate addition treatments (0.68 miles of chicken wire!), and will start litter substrate addition treatments in fall/winter 2022.

### **Impacts of Mowing Patterns on Flower Production and Pollinator Activity**

Joan Edwards' study of the effects of differential mowing regimes on fall wildflowers and their pollinators entered its tenth year. The goal of this study is to assess the impact of both timing and frequency of mowing on flower production and pollinator activity. The sixteen plots are divided into four blocks with treatments in a full-factorial randomized block design. This year, according to the schedule, we implemented both the annual and biennial treatments (eight plots were mown in late-July with four more set for early November). During autumn 2021 Professor Edwards and students (with help from some HMF caretakers) spent time gathering data on the flowering stems within the plots.

### **Garlic Mustard (*Alliaria petiolata*) Dynamics**

Three distinct sites – early successional (near the Rosenburg Center), mid-successional (Red Oak Stand) and late-successional (Beineke Stand) – have been the focus of Joan Edwards' garlic mustard study. This 23-year investigation involves a complete annual survey of the three sites in mid-July when researchers count all rosettes, reproductive stems and seeds in  $0.5\text{m} \times 0.5\text{m}$  permanent quadrats. Darren Wang '23 and Ben Su '24 provided field assistance this year.



*Mowing the plots in July*



### **Birch Brook Bedload Flux** – (description by Jordan Fields, PhD Candidate, Dartmouth College)

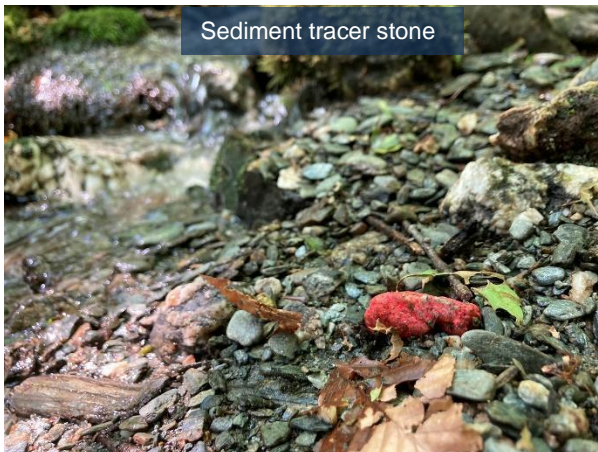
Our ongoing study of bedload sediment transport has now yielded two full years of data since we first deployed 85 Radio Frequency Identification (RFID) equipped tracer rocks in Birch Brook's South Branch. This year, we expanded the study to include the Middle Branch, deploying a similar number of tracers in that stream. The added benefit of the Middle Branch is that it has been experiencing high sediment fluxes since a moderately-sized landslide occurred along the channel in the mid-to-late 1990's (according to David Dethier), allowing us to compare bedload transport dynamics in supply-excess (Middle Branch) and supply-limited (South Branch) streams. Understanding how sediment moves in streams with significant sediment available vs. streams with little sediment available is an important outstanding question in the literature and relevant around the world as a rapidly changing climate forces changes to sediment delivery pathways to streams.

Over the past year, the work has included repeatedly locating rocks after storm events, counting grain sizes on the bed, surveying cross-sections of the stream channels, and measuring the amount of sediment stored behind wood jams (up to a decade of sediment may be stored at a single jam). We have also built a model that, so far, predicts bedload flux at the South Branch within ~25%, improving the existing general bedload models by two orders of magnitude. Completing these tasks is labor-intensive and would not be possible without the help of Drew Jones, Jay Racela, and David Dethier. In addition, in the past year two Dartmouth College undergraduates have worked on the project, as has a Hanover (New Hampshire) High School student, and four Williams undergraduates.



Elena Lowe '25

Our work remains ongoing, especially in the context of the drought experienced in Hopkins Forest for much of this summer, which resulted in very little sediment transport. High flows are an essential part of studying sediment transport and, as such, we are hoping for a good winter, and robust spring meltwater flows, which would be a boon for our study.



Sediment tracer stone

### **Birch Brook Stable Isotope Study**

With Mea Cook on leave, the Birch Brook Stable Isotope study, established in 2019, was suspended this year. The work -- aimed at identifying the sources of dissolved inorganic and organic carbon within the watershed -- can be used to track seasonal shifts in stream water carbon sources over the course of the year. The plan is to continue this study in the near future.

### **Ant/Tree Hopper Mutualism**

There was no work done on mutualism field sites this summer as Prof. Morales was on leave during the summer. The sites will likely be active in the future.

**Table I.** Student researchers in Hopkins Forest -- summer '22.

<b>Name</b>	<b>Lab</b>
Maddie Annis '23	Gill
Dan Lee '24	Gill
Katharine Cook '24	Gill
Diya Pandey '24	Gill
Darren Wang '23	Edwards
Ben Su '24	Edwards
Amaya Smith '25	Racela
Caroline Pratt '25	Racela
Sylvain Foisy '24	Constantine
Elena Lowe '25	Constantine
Isaac Freitas-Eagan '23	Campbell

**Ant Diversity and Habitat Use** *(description by Antioch University Masters candidate Kyle Bradford)*

This study seeks to ascertain how ant diversity and abundance vary in relation to vegetation characteristics, substrate type (rocky vs. sandplain), and forest management in pine barrens and heathlands in interior Massachusetts -- communities that are considered imperiled in the state. We are also evaluating the effects of predictor variables on parasitic ant abundance and diversity, as parasitic ants are of conservation concern and have the potential to be used as indicators of ecological integrity. This involves surveying vegetation and structural components of these ecosystems as well.

In July 2020, we sampled ants on two high-elevation sites in HMF (pictured below): the huckleberry bald (HMF1) near the southwest corner, and Jim Smith Hill (HMF2), two of many such sites in this region-wide study. In all, we collected 152 ants at Hopkins Forest, which yielded 16 species in 6 genera. In standardized sampling we found a total of 33 ant nests. HMF2 had more ant nests (19) than HMF1 (14). Diversity from standardized sampling was more similar between the two plots with HM1 having 8 species and HM2 having 9 species. The relatively high species richness for just two plots was somewhat surprising and exceed that of comparable sites in the Berkshires.

*Bradford's ant sampling sites: huckleberry glade and Jim Smith Hill*



This study, of regional conservation significance, has garnered collaboration from land managers and scientists from Harvard Forest, MassWildlife and the Massachusetts Department of Conservation and Recreation, as well as Antioch University.

### New Study: Forest Chronosequencing

This year visiting scientist Dr. David Moreno Mateos of Harvard University undertook sampling as part of a regional study on historical forest dynamics. The aim of this study is to build a chronosequence of New England forests recovering from former agricultural uses, using old growth stands that will serve as references and secondary stands (including Hopkins Forest) that will form the chronosequence itself. On each plot, the team will study the interactions between the tree community and the soil microbial community, starting with mycorrhizal fungi and later expanding to other fungal and bacterial communities.

To build the chronosequence, Mateos will determine an approximate abandonment date of each of the selected stands, using HMF historical maps and records (with assistance from Hank Art), and core the largest, or visually oldest, trees using a 5-mm tree borer. Their coring protocol follows the latest recommendations on dendrochronology to ensure a sanitary and short healing process.

Once the chronosequence is built, the team will sample 3 to 5 trees of each species found in the stand, including dominant, co-dominant and understory tree species; they expect to have between 4 and 7 tree species per stand. At least one tree will also be cored to assess the relationship between tree age and interaction structure. To sample the microbial community, they will collect four samples of tree roots from selected individuals at a depth of 0 to 15 cm, and retain the soil from these samples for chemical analysis. Mateos began his HMF sampling activities in summer '22.

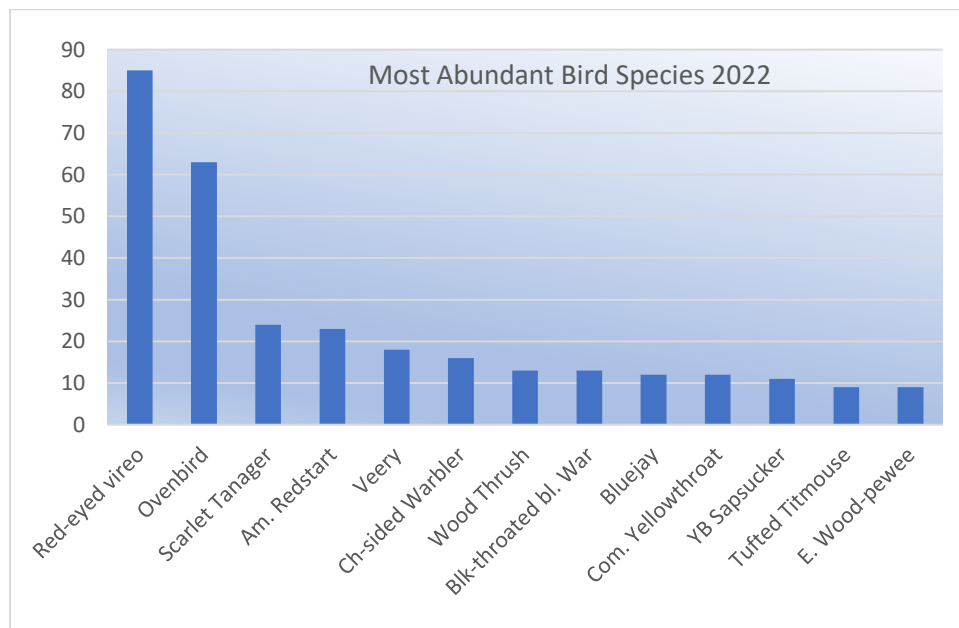
### Northern Saw-whet Owl (NSWO) Migration Banding

The Northern saw-whet owl (*Aegolius acadicus*) fall banding station was not open in 2021. We are in the process of incorporating the site into the continental Motus radio-tracking network, and any future banding efforts will be oriented toward equipping owls with Motus-issued radio transmitters.

### Breeding Bird Point Surveys

In June 2022, I sampled singing males at the 44 breeding bird monitoring points around the Forest for the 22<sup>nd</sup> consecutive year. The year's totals of 550 individuals and 50 species represented a small uptick from recent years. Again, the red-eyed vireo and ovenbird ranked as the two most abundant species, with the scarlet tanager, American redstart, and veery rounding out the top five (Figure I). Notable first-time encounters on the point counts this year were the blue-gray gnatcatcher and the brown thrasher.

**Figure I.** Most abundant bird species from 2022 point counts.



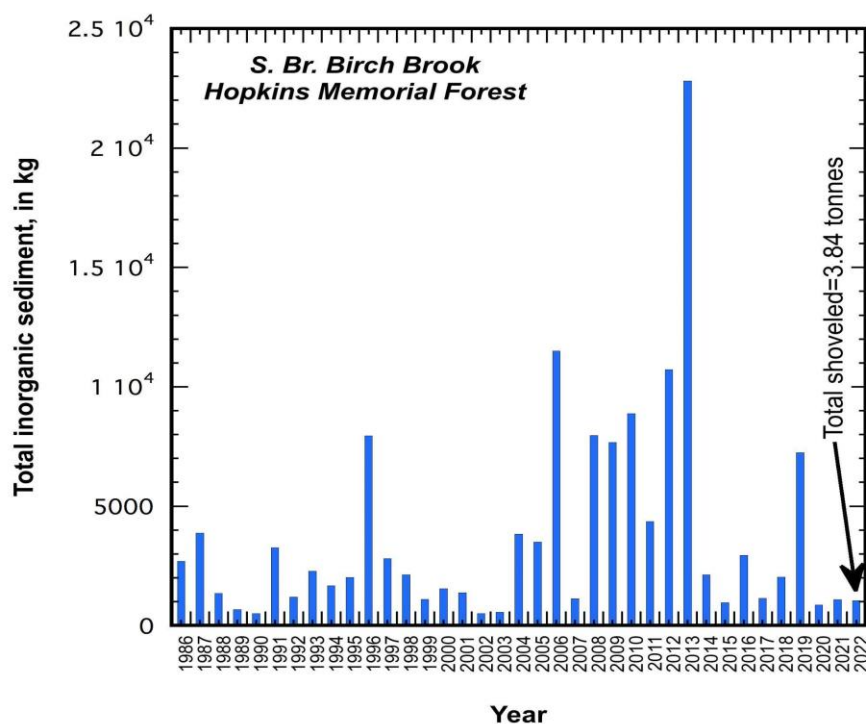


### Environmental Analysis Lab and Hydro-meteorological Research *(description by Jay Racela)*

Over the summer as part of the annual Summer Student Research (SSR) program at the college, we mentored two aspiring environmental researchers, Amaya Smith '25 and Caroline Pratt '25 here in the Envi Lab. During their tenure, Amaya and Caroline learned how to maintain and manage the daily responsibilities of the lab and its long-term monitoring program in Hopkins Forest. For their research, Amaya and Caroline analyzed the heavy metal constituents of HMF stream sediments and compared them to other local stream sediments. This work provided an initial peek into the possible metal contents in our local streams, and Amaya plans to continue this work over this coming Winter Study period to confirm the results.



*Caroline Pratt '25, Amaya Smith '25, Maddie Annis '23 and Katharine Cook '24 after shoveling sediment in Birch Brook*



Our long-term monitoring of the weather and water in and around Hopkins Forest has now been in continuous operation by the college for almost 40 years. To help keep the data as correct as possible, every summer we shovel and weigh the accumulated sediments upstream of the South Branch weir. This summer as a group of 17 participants from various disciplines, we shoveled approximately 3.84 tonnes of sediment, slightly below the long-term average (Figure II).

**Figure II.** The South Branch shoveled sediment record 1986-2022

In order to keep up with the maintenance of our monitoring infrastructure, early this fall we hired a crew of masons to repair the two stream weirs currently in use. This will help to ensure reliable data gathering of stream water volume, temperature and suspended sediment.





We also have been collaborating with Jordan Fields '17 in his PhD study of small stream flooding characteristics using Birch Brook as a study site. Additionally, geosciences major Elena Lowe '25 has been helping Jordan plus working towards a thesis on modeling suspended sediment in Birch Brook. Also Ariana Suarez '25 and Ellery McQuilkin '26 have been surveying and mapping the debris dams in the Middle Branch of Birch Brook as part of a geosciences research project.

*South Branch weir after masonry work completed, Sept. 2022*

## EDUCATION & OUTREACH

### Undergraduate Classes

Williams classes were able to resume their use of the forest for field investigations, teaching and independent studies. An initiative by students Aaron Stanton '22, Patrick Hodgson '22 and Molly Frasier '23 in Nick Howe's Environmental Senior Seminar featured a spring volunteer day in the forest. Two Winter Study courses, including Yacobellis' *Animal Tracking* were able to use the property and Rosenberg Center once again.

The classes that used the forest in 2021-22:

- BIOL/ENVI 203 – *Ecology* (Gill)
- BIOL 220 – *Field Botany and Plant Natural History* (Edwards)
- ENVI 102 – *Introduction to Environmental Science* (Apotsos)
- ENVI 450 – *Environmental Ethnography* (Meche)
- ENVI 460 – *Communicating Climate Change* (Howe)
- GEOS/ENVI 255 – *Environmental Observation* (Bradley)
- WS BIOL 013 -- *Animal Tracking* (Yacobellis)
- WS ENVI 015 – *New England: the wild side* (Jones)



*Aaron and Molly with Professor Howe*

## Elementary Education

With the relaxation of Covid-19 restrictions we were able to return to hosting in-person curricular-based field trips during 2021-22, though participation in the program only returned to about half of its pre-pandemic levels. In the fall we hosted four schools, with an additional eight returning for field trips in the spring. The Center for Learning in Action (CLIA) at Williams hired a team of student educators to plan and lead the field trips (Table II); we thank our partners at CLIA -- namely Renee Sheik and Jennifer Swoap -- for their roles in making this happen.



*Lea and Arielle with 4th graders*

**Table II.** Student Educators 2021-22.

Fall	Spring
Regina Fink '22	Regina Fink '22
Tali Natter '23	Ruby Gary '23
Rachel Morrow '22	Rachel Morrow '22
Jacques Lybarger-Martell '22	Malcolm Bellairs '23
Lea Elton '24	Lea Elton '24
Arielle Nathan '23	Arielle Nathan '23
Analua Moreira '25	Emily Axelrod '25
Yeldana Talgatkyzy '24	Grace Brose '23

## Community Events

We were able to host public events and workshops this year due with the relaxation of Covid-19 related restrictions. Among them were the *Fall Festival*, *Maplefest*, Animal Tracking, and Alumni Day events (see below).

- **Fall Festival** – Saturday, October 23<sup>rd</sup>, -- drew a crowd of 300 for traditional autumn- themed activities.
- **Wildlife Tracking** with Dan Yacobellis – Saturday February 12<sup>th</sup> – this, the second part of a twin bill with Williamstown Rural Lands, had 15 students attend.
- **Maple Festival** – Sunday March 13<sup>th</sup>. Held the day after a snowstorm, drawing 171 visitors.
- **Amphibian & Reptile Foray** – April 9<sup>th</sup>. Led by Darren Wang '23, attracting 30 participants.
- **Bird Walks** – January 30<sup>th</sup> and April 24<sup>th</sup>. Three to four students from the Williams Bird Club attended each.



- **Alumni Day** – June 11<sup>th</sup>. For the first time since 2019, we hosted various walks and activities, including bird watching and canopy walkway tours, for approximately 150 alumni and family members.

## RECREATION

Recreational activity of various kinds continued to be very popular in the forest, with hiking, dog-walking, jogging and cross-country skiing among the most popular pursuits. In order to facilitate this, Isaac Freitas-Eagan '23 spent the summer upgrading the web-based public map of the forest -- making it more interactive and informative. He was mentored by Cory Campbell (OIT) and funded by CES.

### Williams Outing and Bird Clubs

The Williams Outing Club sponsored occasional classes and activities in the forest, and used its trails and lean-to during *First Days*. Its cabin continued to be closed in 2021-22. Once the ageing wood stove is removed the building will be re-opened for student use as a three-season facility, possibly in the coming year.

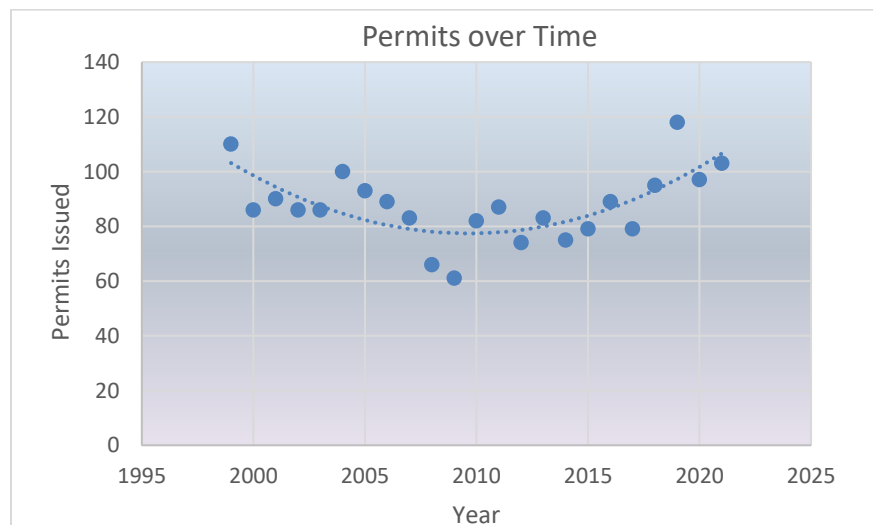
This was the initial year of the Williams Bird Club, a student organization for which I serve as faculty/staff sponsor. The group visited the forest on several occasions for bird watching outings and training sessions.

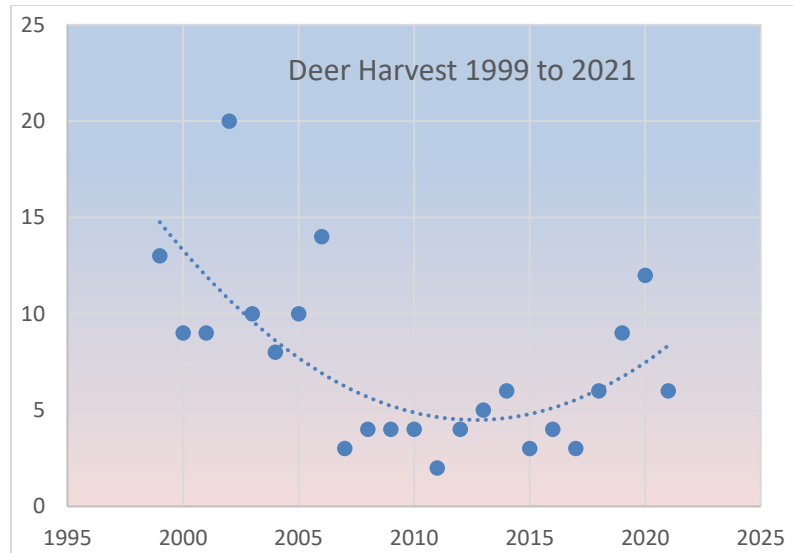


### Hunting

The special permit shotgun hunt for deer was held again in 2021; we issued permits to 103 hunters, who harvested 6 deer (unofficial tally board) from the property (Figures III and IV). The permit total was among the highest in my tenure as manager and might indicate a response to the relatively large harvest of the previous year. During the season one hunter was cited for a minor violation by the state environmental police officer and there was a complaint of hunters entering neighboring properties, which we've since taken measures to mitigate. Once again Williams College safety officers were on duty during the busiest days of the hunt.

**Figures III & IV.** HMF Deer hunting harvest and participation trends since 1999.



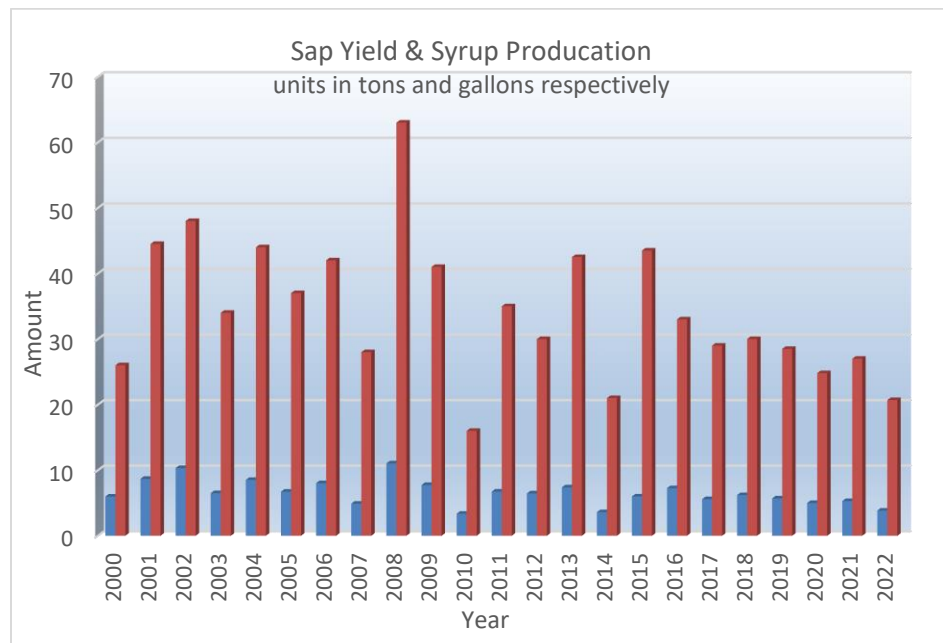


### MAPLE SYRUP PRODUCTION

The 2022 maple season limped along at a rather pedestrian pace this year as student caretakers managed to gather 960 gallons of sap (from 125 trees) and boil it into 20.7 gallons of finished syrup. These yields were among the lowest for Hopkins Forest since we've been keeping records, and continue the recent downward trend in maple productivity (Figure V). Boiling efficiency (20 gallons per hour) was also low and might have been a symptom of an ageing stove.

After a two-year hiatus, we were able to host a public *Maplefest* event in 2022. A nor'easter caused the event to be delayed until Sunday, March 13<sup>th</sup>, a day later than originally scheduled. Nonetheless 171 visitors from the campus and community came out to take part in the celebration.

**Figure V.** Hopkins Forest maple syrup production since 2000.





## LAND MANAGEMENT, CARETAKING & FACILITIES

### Forest Management—Vermont Parcel

We did not do any commercial or pre-commercial work on the remote Pownal tract this year. The 370-acre parcel remains in the Vermont Use Value Appraisal program. Its management plan -- approved by the Vermont Department of Forestry -- calls for timber harvesting in the next few years. We aim to reevaluate the policy toward the use of this tract as part of the forthcoming self-study process.

### Wire Bridge Farm

Jay Galusha of Williamstown continued to grow hay on the farm. His aim is to restore the meadow to its former quality, which would enable it to sustain two to three annual cuts. The parcel continued to be used sparingly for recreation and wildlife viewing.

### Infrastructure

Dry late-summer conditions enabled the oft-delayed restoration work on the weirs to begin in earnest, and by mid-September a local masonry company had reinforced and resurfaced the degraded sections of both the main stem and south branch gauging dams. This this spring, facilities was able to hire a contractor do to grade the driveway in earnest, a job that had been derailed during Covid-19.



Grading the driveway

### Caretaking

Caretaking proved to be immensely popular employment with students again this year as robust crews enlisted for both semesters. Indeed, the total of 1048.75 hours logged during the academic year (520 in the fall and 528.75 in the spring) was among the highest in my tenure as manager and continues the trend toward heightened interest in forest employment and activities since the Covid-19 pandemic. Retention between semesters and years, a sign of sustained interest, seems to be higher than in the past as well. Work focused on trails, boundary posting, gardening, maple sugaring, vegetation management and hosting public events.

During summer 2022 we hired a team of three caretaker interns – Ana-Sofia Roldan '23.5, Al Lake '24 and Brodie Leo '24 – to work for eight weeks. They were joined by long-serving, part-time gardener Debra Rogers-Gillig, whose work and mentorship in Buxton Garden has been exemplary.



Brodie and Al with their new waterbar

### Rosenburg Center/Moon Barn

This year the Rosenburg Center served as a focal point for classes and lab set-ups, caretaker and educator activities and was reopened for public visitation. The Moon Barn by contrast was used mainly for storage. We are awaiting the completion of a capital improvement project to restore power to the building.

### Canopy Walkway

This year the canopy walkway was used occasionally, including for *Fall Festival* and Alumni Weekend. In May 2022 it underwent safety inspection and evaluation.

### **FUTURE – What's in store for 2022-23?**

This coming year the Users Committee intends to launch a self-study that might lay the groundwork for an external review. As ever we will continue to support recently established initiatives such as Motus as well as long-term research and teaching the forest. We will also continue our collaboration with CLIA and regional public schools to run a robust elementary education program, and we will continue our community outreach efforts by offering themed events and activities.



*In addition to those featured in the preceding text special thanks go to Dee Dee Lewis, Janine Burt and Roger Bolton.*