Great Hollow

Nature Preserve & Ecological Research Center

2022 | ANNUAL REVIEW

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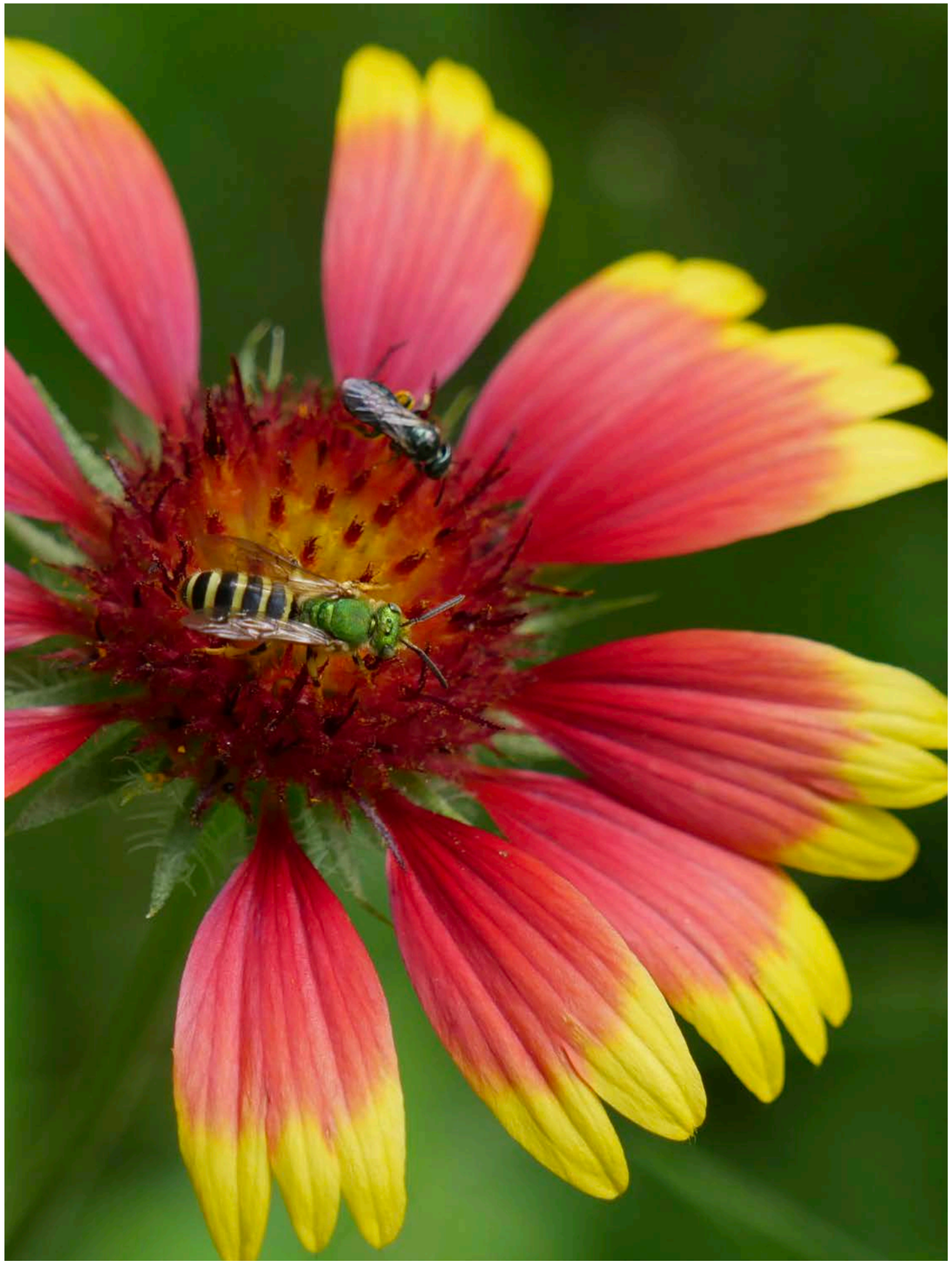
FROM THE EXECUTIVE DIRECTOR

It is hard to believe another year has already come and gone. As I look back on 2022, I cannot help thinking about Great Hollow's humble beginnings in 2016 as a small, nascent organization attempting to breathe new life and purpose into an old farmstead and neglected historic buildings. It truly feels like yesterday. From day one, it has been the enthusiastic support of people like you that has helped us continually reach higher in our efforts to make scientific advances towards biodiversity conservation, educate and inspire the children who will be tomorrow's voices for the planet, and provide the public with enriching experiences that connect them to the outdoors. As I write this in mid-winter, I am often asked if things are now "quiet" at Great Hollow and my response is always the same – there is no quiet time at Great Hollow! Sure, summer is undoubtedly busy, with camp, events, field research, and peak visitation by the public, but so too are the other seasons. Fall and winter are times to analyze data and publish papers to disseminate the findings of our summer research projects to the scientific community (a laborious process that takes a minimum of several months). It is also a time to design, plan, and fundraise for studies that will be conducted the following spring and summer, and to develop curricula and lesson plans for the next season of Eco-Discovery Camp. Meanwhile, our education programs and community events remain in full swing all year long, and our facilities, grounds, and trail network never stop requiring maintenance. No matter the time of year, Great Hollow is always busy both in the office and out on the preserve. As highlighted in the pages ahead, 2022 was no exception. We published novel research on the mutualistic relationship between ants and spring ephemeral wildflowers, and the harmful impacts of mercury pollution to migratory birds while also making significant headway on studies of the effects of invasive plants on forest food webs and the effects of light pollution on bats. Eco-Discovery Camp grew yet again to record numbers of attendance thanks to a Connecticut Department of Education grant and a partnership with Yale University that both allowed us to increase our capacity. Demand and turnout for community events reached new heights in 2022, and many new faces from the beginning of the year have now become regulars. We are incredibly fortunate to have so many people take interest and participate in all that we do, with more people discovering Great Hollow every day. There is no Great Hollow without you. Thank you for your inspiration and support through another great year, and we look forward to seeing you and your family around the Hollow in the days ahead.

Chad Seewagen



CONSERVATION SCIENCE

Central to Great Hollow's mission is the advancement of conservation science that brings attention to and helps solve significant issues facing our region's wildlife. Our scientists lead and partner on interdisciplinary studies of plants and animals to better understand and mitigate their responses to anthropogenic stressors, such as introduced species and pollution. We design our research to yield information that can directly support science-based decision-making about the protection of declining and imperiled species, and the management of their habitat. This can be seen across our work in 2022, which involved the spatial impact of light pollution to bats, food requirements of migrating songbirds, effects of invasive plants on insects and birds, and drone-assisted monitoring of turtle nests.

Shining a Light on the Impact of Light Pollution to Bats

Light pollution is a rapidly growing threat to nocturnal wildlife around the world. More than 50% of the land area of the U.S. is now subjected to light pollution and yet the effects this is having on bats, which provide ecologically and economically valuable ecosystem services, are largely unknown. Elsewhere in the world, some bat species are known to be attracted to light by high concentrations of insect prey while other species strongly avoid it. Great Hollow began studying this issue in 2016 to better understand the responses of our region's bat species to light pollution. The first phase of that research, published in 2021 in *Ecology and Evolution*, discovered significant light avoidance by the big brown bat and imperiled little brown bat, leading to a dramatic change in the overall species composition of the bat community. This year, with a grant from the Connecticut Department of Energy and Environmental Protection, we and our collaborator Dr. Amanda Adams of Bat Conservation International conducted a follow-up experiment to measure the spatial extent of this impact to bats. We wanted to know the distance up to which light-averse bat species are displaced from their habitat by light. Is it just a few meters or could the reach of the impact be much greater? The answer to this question has profound implications for the cumulative footprint of disturbance caused by lighting on the present-day landscape as well as the ability of regulators to effectively safeguard important bat habitat from light pollution generated by future development.

In the new study, we erected three LED floodlights along the large wetland at Great Hollow (a popular foraging spot for bats) and then recorded bat echolocation calls with acoustic detectors placed 0, 25, 50, and 75 meters away from the lights. Each night during the summer, we randomly chose whether the lights would be on or off that night. With the lights on, the light level near the lights measured 24 lux and then quickly faded to only 2 lux 25 meters away, 1 lux 50 meters away, and 0 lux 75 meters away. We then analyzed the bat recordings to identify them to species and compare the number of individuals of each species foraging around each recorder's location between nights when the lights were off and when they were on. We are still analyzing the data, but preliminary results indicate the lighting had a significant displacement effect on big brown bats for a distance of at least 25 meters (82 feet) and little brown bats for a distance of at least 75 meters (246 feet) (Figure 1). Light avoidance by these two species but not others resulted in a significant change in the overall species composition of the bat community up to 50 meters away. Unfortunately, what this shows is the cumulative reach of light pollution across the landscape is likely to be tremendous and much larger than expected. Imagine mapping a 75-meter circle around every porch light, street light, and other outdoor light source in the region, and measuring the total amount of habitat encompassed by that. This raises major concerns about the impact that outdoor lighting is having on bats in our region and highlights the importance of protecting dark refugia, like Great Hollow, from encroaching development. You too can help bats by simply avoiding the use of any unnecessary outdoor lighting at your home at night—even a single light matters!

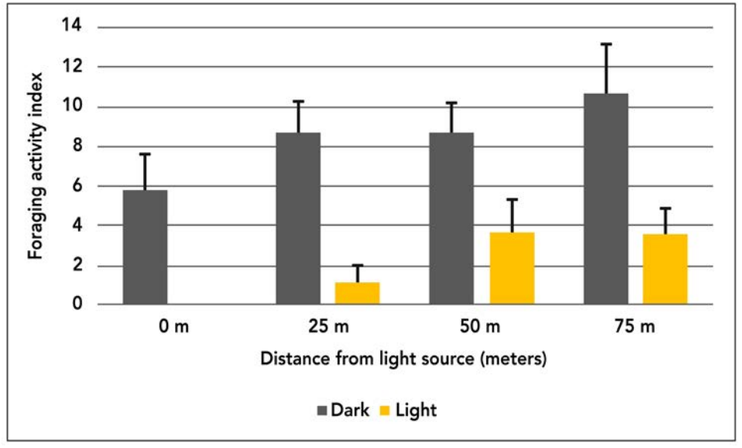
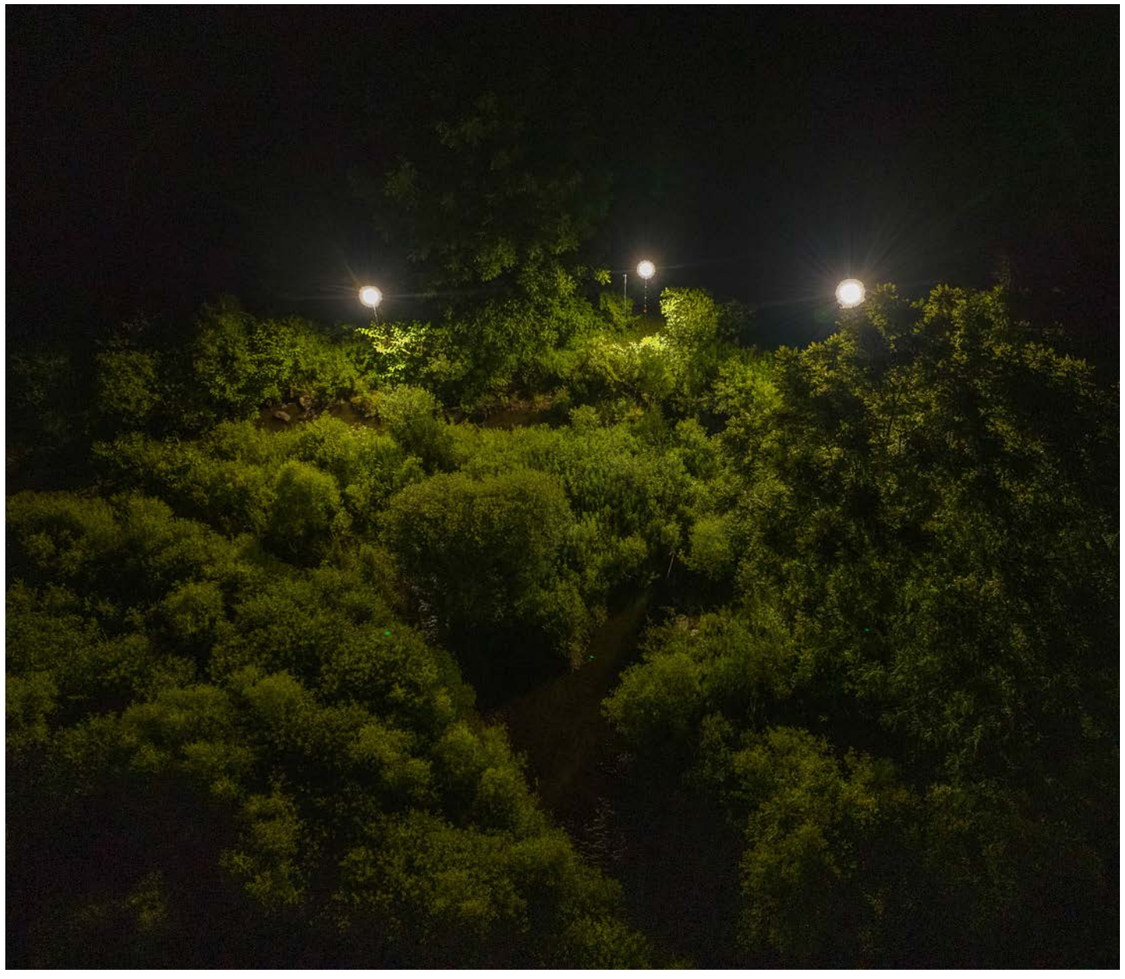


Figure 1. Foraging activity of little brown bats under naturally dark and artificially lit conditions, 0 to 75 meters from the light source.

Experimental lighting array to study the footprint of disturbance to bats caused by light pollution.



Top: Drone photograph of a wood turtle nesting area. Middle: Eastern box turtle hatching from egg. Bottom: Newly hatched wood turtles ready for release from the enclosure protecting their nest from predators.

Turtle Nest-Monitoring Made Easy with A Drone

Last year, Great Hollow's naturalist and steward John Foley obtained his Unmanned Aircraft System Remote Pilot license from the Federal Aviation Administration to legally fly a drone high above Great Hollow and the surrounding area. Besides providing beautiful bird's-eye photos of Great Hollow, the drone is also turning out to be a very valuable tool for research and habitat management. So far, it has come in handy for monitoring the distribution of invasive Japanese knotweed at Great Hollow, selecting recording locations for our lighting experiment on bats, and finding and monitoring turtle nests at our study sites in the Great Swamp Watershed.

The 63,000-acre Great Swamp Watershed, spanning the New York-Connecticut border, is home to one of the most significant wood turtle populations remaining in either state and supports a large population of eastern box turtles as well. Both species were once fairly common, but are now in steep decline and of high conservation concern. John has been involved with nest monitoring and radiotelemetry studies of these elusive turtles within the watershed for over a decade. This past summer, he decided to try something new and use the drone to conduct aerial surveys for nesting turtles rather than surveying on foot. With the drone, he found he was able to survey much larger areas and in less time than ever before, while also generating less disturbance to the turtles. Whenever he observed a nesting female from the air, John would photograph the nest site, record its GPS coordinates, and return to it on foot once the turtle had finished laying and moved on. He would then install a predator exclusion device made of hardware cloth around the nest to protect the eggs from predators, such as raccoons and skunks. Upwards of 95 percent of turtle nests are dug up and predated within only the first few days of eggs being laid, so protecting nests from predators can have immense benefits. John continued to keep tabs on each nest by air for the next few months to know when the eggs had hatched, and record data on hatching success and incubation times. In the end, six wood turtle nests were found and protected from predation, yielding 16 baby turtles from 36 eggs that were laid. Two box turtle nests were also found and protected, totaling 12 eggs, all of which hatched successfully. After a quick hydration soak and a rare photo opportunity, the 18 hatchlings were released from the predator excluders to fend for themselves and begin life's perilous journey.

Conservation Science

Some Invasive Plants Serve up High-Quality Food for Birds

Invasive plants present a serious challenge for habitat management and wildlife conservation around the world. They can form dense stands that displace native plants and thereby potentially limit food and other resources needed by wildlife. However, our work at Great Hollow on many of the region's most infamous invasive plants has suggested that they may not all be as bad as previously thought. For example, in one of our ongoing studies, highlighted in last year's Annual Review (pp. 10-13), we have found many invasive plants to support a similar biomass of insects as native plants and to be foraged on by birds just as often. Not all insects are an equally good meal for birds, however, so some of our follow-up work this year sought to evaluate the nutritional quality of insects supported by non-native versus native host plants.

To do this, we teamed up with Dr. Tim Ku at Wesleyan University to measure the protein content of thousands of insects and spiders that we collected from non-native autumn olive, burning bush, Japanese barberry, and Morrow's honeysuckle, and six native plant species in the same forest. Protein is a critical macronutrient for breeding birds and a useful proxy for overall food quality. What we have found so far is that spiders on Japanese barberry are significantly lower in protein than spiders on the native plants, but otherwise, spider protein content is comparable across all of the other non-native and native species we examined. Among herbivorous insects, such as caterpillars, those supported by invasive autumn olive, burning bush, and Japanese barberry are similar in protein content to those supported by the six native plant species in our study. Meanwhile, herbivorous insects on invasive honeysuckle actually have significantly more protein than those on the native plants (Figure 2). We previously found honeysuckle to also support a relatively high abundance of insects, so what's going on with this species that is so maligned and often targeted for eradication? We keep finding evidence that it produces quite a bit of food for songbirds, so should invasive plant removal efforts be focused on "worse" species instead? Invasive plant removal on large scales is extremely labor-intensive and costly, so funding available for habitat restoration needs to be directed where it will have the greatest benefits. Our findings suggest that the four invasive species we examined support similar insect quantity *and* quality as native plants, and are foraged on by birds just as often, so conservation resources being used to combat these species may be better spent elsewhere. Efforts to combat these species (on behalf of birds, anyway) may not be worthwhile. However, it is important to recognize that insects and birds are only a piece of the forest ecosystem, and these invasive plants can certainly have detrimental impacts in myriad other ways that our research has not covered. Much remains to be learned about the relationships between non-native plants and the biological communities they invade before we can make fully science-based management decisions.

CURRENT PROJECTS

- Effects of invasive plants on insect-bird trophic interactions and the nutritional quality of insects as food for birds
- Forest songbird diet composition in an arthropod food web altered by invasive Japanese barberry
- The scale and timing of antioxidant-rich fruit consumption by migrating songbirds and its implications for body condition
- Effect-distances of LED light pollution on bats
- New England cottontail population estimation and monitoring at Great Hollow
- Effects of weather and nocturnal migration intensity on bird collisions with buildings in New York City

Figure 2. The quality of insects as food for birds on native (green circles) and invasive (red triangles) plants at Great Hollow.

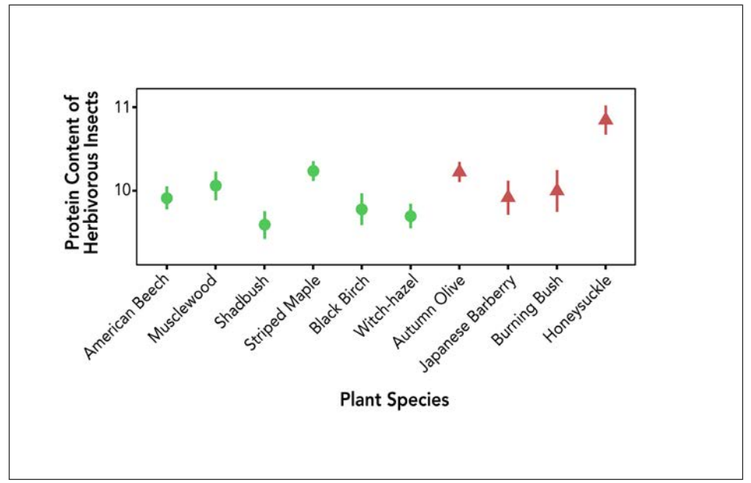


Photo © Carl Bergstrom

Above: Swainson's thrush eating antioxidant-rich berries. Right: Example of reference seeds used to identify the diet composition of birds from their droppings.

How the Diet of Songbirds May Affect their Fall Migration

Most songbirds eat insects, fruits (berries), or a mix of both, depending on the time of year. Insects contain far more protein than fruits, which is perfect if you're feeding growing nestlings during the summer, but not as clearly advantageous in other seasons. Fruits, meanwhile, have gained attention for their potential value during migration because of their high antioxidant content. Antioxidants may be beneficial to birds during migration because they can alleviate some of the negative physiological impacts of long-distance flight (known as oxidative stress). To better understand the effect of diet choices on migrating birds, we wanted to know how the timing and magnitude of shifting away from insect-based summer diets towards more fruit-based diets during the fall influences their body condition and fat stores.

How do you study the diet of a wild bird? One classic option is to collect its droppings and look for clues among the remnants. A more modern technique is to link the isotope signatures of a bird's tissues (e.g., blood, feathers) to those of its food. For example, insects have more nitrogen than fruits because they are higher in protein, so a relatively high nitrogen isotope signal in a bird's tissues indicates a more insect-based diet. This method has the advantage of providing a snapshot of diet composition at different time periods thanks to differences among tissues in their turnover rate (the time it takes for growth and regeneration). You are what you eat, so tissues with slower turnover rates provide information about diet further back in time while tissues with faster turnover rates reflect more recent diet composition. We used these methods to characterize the diets of fall-migrant Swainson's thrushes and hermit thrushes, to see whether they had consumed any high-antioxidant fruits lately and estimate how much they had shifted their diet from insects towards fruits over the course of their migration. To do this, we collected blood, feather, and fecal samples from 44 thrushes captured and released during migration at Great Hollow, while also getting samples from an additional 120 thrushes collected for us by colleagues at the Braddock Bay Bird Observatory in western New York and Powdermill Avian Research Center in western Pennsylvania. Blood plasma, which has a fast turnover rate, reflects a bird's diet within the week prior to collection while red blood cells reflect the diet approximately 2 to 3 weeks prior to collection, and feathers reflect the diet at the time of their growth, more than a month or two prior to our collection.

What did we find? Most interestingly, there was a difference between the species, where increasing fruit consumption in the past couple of weeks improved body condition and fat stores for Swainson's thrushes, but not hermit thrushes. We suspect this is due to differences in these species' migration strategies: Swainson's thrushes are long-distance travelers that winter in Central and South America whereas hermit thrushes typically migrate only as far as the southeastern U.S. For a species undertaking a longer, more strenuous journey, it makes sense that shifting to a readily available, high-fat, high-carbohydrate food source like berries would have a more visible impact on fattening and body condition than a species that has a less challenging migration. The influence of migration distance and temporal pressure could be further seen in the differing importance of time of season on our two study species, with condition and even diet shifts themselves being closely related to sampling date in Swainson's thrushes, but not hermit thrushes. Meanwhile, although shifting towards a more fruit-based diet did improve physical condition for Swainson's thrushes, their condition was unrelated to the presence of especially high-antioxidant types of fruit in their diets, which suggests that the convenience and perhaps high carbohydrate and fat content of fruits, rather than their antioxidant content, are most important for supporting migration.

Overall, our findings highlight the value of fruits to fall-migrant songbirds and underscore the importance of managing stopover habitat to provide an abundance of fruiting plants. While some of our other research has shown that non-native plants can support abundant insect prey for birds during summer, those plants tend to produce much lower quality fruits than native species during fall. For example, the berries of non-native plants often have lower energy, fat, and antioxidant content than native plants. However, birds are known to commonly consume both native and non-native fruits during migration, and what non-native fruits lack in quality might be compensated for by their superabundance. It is not well-understood how invasive plants affect stopover habitat quality for birds and this is an area that is ripe for future research (pun intended!). Ultimately, what might be most important to birds is a wide diversity of plant species with different fruiting periods to ensure fruits are abundantly available throughout the entire migration season, which extends from late August all the way through October.

SCIENTIFIC PUBLICATIONS

Great Hollow is proud to have published two journal articles in 2022, our 12th and 13th peer-reviewed publications since our founding in 2016. One focuses on a fascinating and globally unique mutualistic relationship between ants and spring ephemeral wildflowers, and its robustness to forest disturbance. The other concerns the effects of mercury pollution on migrating birds – a focal area of our conservation science program and our 6th paper on the subject.

Ants and Wildflowers Make a Good Team

Spring ephemeral wildflowers, like red trillium, trout lily, and Dutchman's breeches have only a short window of time each year to grow, flower, and produce seeds. To make the most of their limited time, many of these species have come up with a creative strategy for seed dispersal — ants! These unique ants, belonging to the genus *Aphaenogaster*, carry the seeds away to new locations where they can germinate, and in exchange, receive a small food reward (a fleshy structure on the top of the seeds, called an elaiosome, whose sole function appears to be to attract ants). Seed dispersal by ants is a very rare phenomenon since nearly all plants have their seeds dispersed by wind, birds, or mammals. Interestingly, some of the highest diversity of ant-dispersed plants in the world occurs in New England and New York forests.

In a study published this year in the journal *Food Webs*, Great Hollow research scientist Dr. Rob Clark conducted an experiment to see how important these wildflowers are as a food source for their mutualistic ants. While many studies have demonstrated that the wildflowers greatly benefit from the ants, it has remained unclear how much the ants benefit from the wildflowers in return. To test this, Dr. Clark and volunteers removed wildflower seeds from three experimental plots in a Connecticut forest while adding seeds to three other plots. After three years of this seed removal and supplementation, wildflower and ant abundance were measured and compared to control plots where no manipulation occurred. As expected, seed removal slightly reduced the relative abundance of wildflowers in those plots, but surprisingly, it did not reduce the abundance of the ants at all. Seed supplementation also did not increase the abundance of ants. This does not necessarily mean that wildflowers are not important to *Aphaenogaster* ants, but demonstrates the ants are robust to long-term wildflower loss and disturbance, and able to get enough food from other sources when necessary. Over the course of the study, Dr. Clark catalogued 30 different species of spring ephemeral wildflowers growing in Connecticut forests, including seven native violet species, eastern and Carolina spring beauty, bloodroot, three trillium species, and American cowwheat. This represents the first complete checklist of ant-dispersed wildflowers for the state of Connecticut.

***Aphaenogaster* ants dispersing a bloodroot seed.**

Mercury Pollution is a Real Drag for Migrating Birds

Migratory birds have been called the super-athletes of the animal kingdom because of the remarkable endurance they display during non-stop flights that can span thousands of miles. Their endurance is made possible by a unique ability to power high-intensity activity with fat rather than the less energy-dense and less storable carbohydrates on which mammals like us rely. Research led by Great Hollow and published this year in *Scientific Reports* found evidence to suggest that the globally widespread pollutant, methylmercury, may be hindering the ability of birds to burn fat rapidly enough to sustain migratory flights and then promptly replenish those fat stores during stopovers. Today, global mercury emissions are approximately 450% greater than pre-industrial levels and represent a well-documented threat to human and wildlife health, but mercury's effects on the metabolic processes underlying migration had never been studied before.

The study's authors, including Great Hollow's executive director Dr. Chad Seewagen and collaborators from UMass-Amherst, Western University (Canada), and Guangxi University (China), analyzed muscle and liver samples from yellow-rumped warblers that were previously found to have weaker flight endurance in a wind tunnel as a result of only short-term exposure to a concentration of methylmercury even lower than that which occurs in a can of tuna fish. To investigate mechanisms by which the methylmercury may have caused this reduction in endurance in the prior study, the team measured multiple markers of fat metabolism in the birds' breast muscles, including catabolic enzymes, fatty acid transport proteins, and lipid metabolism regulators known as PPARs. They measured the same markers in the birds' livers to also assess the livers' capacity to synthesize fat for storage during stopover refueling.

The researchers found mercury-exposed warblers to have significantly lower muscle aerobic and fatty acid oxidation capacity, elevated liver energy costs, lower fatty acid uptake capacity in the liver, and lower liver expression of PPAR-γ (a regulator of enzymes that birds increase during migration to facilitate rapid fat storage). The diminished muscle oxidative enzyme capacity of the mercury-exposed birds likely contributed to their weaker flight endurance in the prior study, while the effects on the liver have potential to inhibit stopover refueling.

"We found that fat catabolism, synthesis, and storage processes in birds can be disrupted by only brief and low exposure to this ubiquitous contaminant, which is likely to have significant consequences for migratory performance," said Dr. Seewagen. "This concerns me that mercury pollution is making the deadliest event in the life-cycle of migratory birds even more difficult for them to complete alive and on time. Considering the influence that migratory performance has on bird population sizes, we think it should be a priority to better understand and mitigate the impacts of contaminants like mercury on the survivorship of migration." Fortunately, the rapidly growing body of evidence of how mercury pollution is impacting birds and other wildlife is helping lead to reduced mercury emissions in some parts of the world and ratification of the Minamata Convention — the first global treaty specifically intended to curb pollution from a heavy metal.

Yellow-rumped warbler flying in a wind tunnel at the Advanced Facility for Avian Research at Western University, Ontario, Canada.

Photo © Brock Fenton

ECO-DISCOVERY CAMP

Eco-Discovery Camp draws on multiple methods and fields of education to create a unique and immersive opportunity for children ages 5-12 to learn about the biological and physical processes that sustain life on Earth. This year's camp season was another triumphant success, consisting of nine sold-out sessions with more than 100 different children in attendance. It was also a summer of marked growth and capacity building for our camp thanks to a partnership with Yale University and a generous grant from the Connecticut Department of Education.

In the partnership with Yale, Great Hollow was selected to host a "conservation scholar" from the university's Conservation Scholar Early Leadership Initiative program. The main goal of the program is to promote diversity in the conservation workforce by placing undergraduate students from traditionally underrepresented groups in summer internships with environmental organizations and agencies. We were delighted to be paired with Jazlyn Marcos (pictured bottom right), who first completed the program in 2018 and returned this year as an alumni assistant. While Jazlyn already has a permanent position as an elementary school teacher in Oklahoma City, she thought returning to the Yale program would be a great source of professional development during the summer recess, and boy, were we glad to have her! She worked with us on curriculum development and lesson planning prior to the start of camp, contributing many great ideas, and then served as a valuable and effective instructor through most of the summer. Jazlyn returned to Oklahoma at the end of July, but not before leaving a lasting impression on our staff and campers.

The Summer Enrichment Expansion grant from the Connecticut Department of Education allowed us to hire two additional counselors, bring in visiting presenters to expand the curriculum, and purchase equipment and supplies for many new learning and recreational activities. One of the most exciting additions made possible by the grant was yoga. The twice-weekly sessions were led by licensed yoga instructor, Sarah Maasik, of New Fairfield Yoga and Wellness. Campers and counselors got to set up their mats outdoors on our deck and enjoy the yoga lessons under the shade of a large oak tree. Campers used this time to not only improve their balance and flexibility, but to reflect on their emotions and what they had learned that week at camp. The grant also allowed for the return of one of our favorite guests, Darlene Kascak of the Institute for American Indian Studies in Washington, CT. Ms. Kascak is a member of the Schaghticoke Tribal Nation and a traditional Native American storyteller. During her visits to Great Hollow, she delighted our campers with traditional stories, such as 'How the chipmunk got its stripes' as well as the history of the indigenous people who called Quinnehtukqut their home. Ms. Kascak also brought with her several

Eco-Discovery Camp

traditional Native American tools and fur pelts to pass around to all of the campers.

New this year was our Women in Science session in which campers learned about some of the most important and influential female scientists in history and why they are or are not household names today. Did you know the tongue twister, "she sells seashells down by the seashore," was inspired by the paleontologist, Mary Anning? Or before Beatrix Potter became famous for writing and illustrating Peter Rabbit, she was a mycologist (a scientist who studies fungi)? A kid favorite that week was learning about the British chemist and often-overlooked contributor to the discovery of DNA's chemical structure, Rosalind Franklin. As part of the lesson, campers constructed three-dimensional DNA models out of Twizzlers and Dots and then wasted no time eating them immediately afterwards.

Of course we also had to bring back some perennial favorites, such as Water Exploration week. Campers were delighted to take daily visits down to Quaker Brook where they were able to catch and observe fish, crayfish, and macroinvertebrates. This year we challenged our campers to identify the macroinvertebrates they caught using a field guide and discovered that the predominant species of crayfish in Quaker Brook is the non-native ringed crayfish. STEAM Week also remained a popular theme for both our Knee-High Naturalists (ages 6-8) and Eco-Explorers (ages 9-12), with fun activities like stone stacking and making solar s'mores ovens, slime, and "elephant toothpaste."

We thank all of the families who participated in Eco-Discovery Camp this year and made it another memorable and rewarding experience for all. We also thank counselors Tallulah Comaskey and Jennifer Kast, and CITs Arlette Avaros, Marissa Avaros, Ford Brennan, Maevon Cohen, Kyrillos Courgi, Tristan Cunningham, Tommy Day, Claire Enerson, Anne Johnston, Sarah Lippman, Katie McMorrow, and Ava Kuehn for their outstanding efforts to provide campers with an enriching summer they will never forget.

NEW AROUND GREAT HOLLOW

You may have noticed many new additions around Great Hollow's campus this year. Thanks to ambitious Scouts and other volunteers, we now have new and improved bee hives, a "bug hotel," a compost bin for the vegetable garden, a welcome kiosk at the visitors' parking area, and new interpretive signage along our trails. The honeybee hives were set up by local beekeeper and former apiary owner, Mike Bruen, next to our pollinator garden, where the bees and flowering plants can directly benefit from one another. Beekeeping has been a long tradition in Mike's family, passed down to him by his father and grandfather. He has won several awards for his honey and we are greatly looking forward to seeing (and tasting) what our bees produce! Next to our vegetable garden, Lianna Furnari and Amanda Carlacci of Girl Scout Troop 50511 installed a "bug hotel" to give beneficial insects a helping hand. A bug hotel consists of several chambers filled with various natural materials to provide shelter for predatory insects, such as solitary bees and earwigs, which act like an insect army against unwanted garden pests. With the bee hives, pollinator garden, vegetable garden, and bug hotel all tied together, benefiting one another, the ecological mutualism is off the charts! Another new feature for our vegetable garden is a beautiful compost bin built by Francine Marlow, Olivia Malanga, and Hannah Greco of Girl Scout Troop 50511 to turn food and yard waste into healthy soil.

Above: New bee hives set up and maintained by volunteer, Mike Bruen, next to Great Hollow's pollinator garden. Left: Interpretive signage designed by New Fairfield High School student, Jen Arena.

To welcome visitors to Great Hollow, we were thrilled to have Daniel Seiler of Boy Scout Troop 137 build a large kiosk with plenty of room for a map of our campus and trails, background information about Great Hollow, and notices of upcoming events and programs. No longer will first-time visitors be unsure of what Great Hollow is and does, or where to find our different buildings and trailheads. Lastly, we were thrilled to have New Fairfield High School Student, Jen Arena, select Great Hollow for her Senior Enrichment Experience project. Jen researched interesting facts about the natural history of several plant species at Great Hollow and then created beautiful interpretive signage to place along our trails (pictured left). We could not be more impressed by or appreciative of these outstanding volunteers for their amazing contributions and improvements to Great Hollow. Thanks to all for your hard work!

SEASONAL RESEARCH STAFF

A central part of the research we do at Great Hollow is our summer internship program, which provides hands-on research experience to college students or recent graduates who are pursuing careers in conservation biology. Our interns play a key role in collecting data in both the field and the lab, and most of our projects would not be possible without their hard work. In 2022, we were pleased to have Julia Nadeau-Gneckow join us for the summer to assist with our ongoing studies of the quality of non-native plants as food sources for birds and the effects of light pollution on bats. Julia had just graduated with a B.S. in Biology from the University of Central Florida, where she also assisted with disease ecology and parasitology research on tree swallows, purple martins, and Florida scrub jays. Although she is a lifelong birder and came to us looking to gain additional experience in ornithology, she quickly took great interest in the bat project and became proficient in the use of the bat recording equipment and acoustic analysis software. We could not have been more pleased with the professionalism and dedication Julia displayed towards her work, and her willingness to take on responsibilities outside of her comfort zone. We are certain she has a bright future in the field of environmental research and conservation ahead of her. Julia is now back in Florida, where she is applying to graduate programs for next year, but remains highly involved in the bat project as a coauthor of the manuscript we are currently preparing for publication in a scientific journal. We greatly look forward to continuing to work with Julia and wish her the best in her future graduate studies!

Left: Great Hollow research intern, Julia Nadeau-Gneckow.

BUILDING BRIDGES

The land long-known as Great Hollow had never been open to the public before the establishment of our organization in 2016. One of our first orders of business was to improve and expand the property's trails for the public to enjoy, and today, they are trekked by countless people all year long. Keeping the trails passable, clean, and well-marked requires constant upkeep. During the winter of 2021-2022, not one, but two of our bridges that cross Quaker Brook were damaged beyond repair by storm surges and erosion, forcing us to close major portions of our trail network indefinitely. The cost to replace the bridges and make them more resistant to future storm surges was going to be substantial, but in almost no time at all, our community of supporters rallied to contribute the funds needed to complete the project. Thanks to several generous donations and a grant from the New Fairfield Community Thrift Shop (see Acknowledgments, p. 24), we were able to have the bridges professionally rebuilt and fully re-open the red and yellow trails just in time for spring. The outpouring of support towards this project was tremendously moving and we could not have been more appreciative and pleased to see everyone enjoying our trails again. Thank you to everyone who helped make it happen.

WITH THANKS AND ACKNOWLEDGMENT

Great Hollow is grateful to the donors, members, local businesses, volunteers, and program participants whose support in 2022 furthered our efforts to advance environmental science, education, and conservation in Connecticut and beyond.

Donations in support of the replacement bridges over Quaker Brook were generously made by Kerri Ahearn, Megan Blank, Julie Burnett-Toscano, Brina Corini, Doreen Costabile, Melody Curra, Angela Dimmitt, Fleur Fairman, Sarah Gilchrist, Amanda Gleason, Susan Goldsmith, Justin Goodhart, Russell Harkavy, Kathleen Harpster, Jane Maloney, Justin Mondshine, MaryAnn Naughton, New Fairfield Community Thrift Shop, Carol Paterno, Dorothy and Helder Prata, Brendan and Donna Quinn, Mark Savoia, Rebecca Sawyer, Erica Schlaug, Steven Schneider, Michelle Schulze, Tamara Strauss, Victoria Vance, Tee Vozella, Stephanie Warren, Mark Werner, and Michaella Winter.

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2022 Art Show prizes were donated by Visual Impact, New Milford Swim & Tennis Club, Claire's Garden Center, American Pie Company, Barn Gallery & Frame Shop, The Cue, Sherman IGA, White Silo, Painted Lemon Restaurant, Bank Street Theater, Haviland Hollow Wine Shop, Sacred Grounds Coffee, New Fairfield Yoga and Wellness, Johnny's Food Center, New Fairfield Liquor Shop, Bruno's Pizza, Fairwood Wine and Liquor, Sherman Wine and Spirits, Goodie Shop, and LAND Gallery. The Music on the Lawn series was generously sponsored by Edward Jones Investments.

Friends of Great Hollow who volunteered their valuable time to help with events, stewardship, research, and raptor care included Jennifer Andrews, Mike Bruen, George Buck, Rich Connell, Billy Flash, Claudia Henry, James Kloos, and Claire Williams. We also extend our sincerest thanks to Dr. David Gropper for volunteering as our camp physician for the 6th straight year.

We were honored to receive grants this year from the Connecticut Department of Energy and Environmental Protection for our research on the effects of light pollution on bats, and from the Connecticut Department of Education to expand our summer camp curriculum and enrollment capacity. We also received a generous grant from the New Fairfield Community Thrift Shop towards the replacement of the foot bridges over Quaker Brook.

We thank Boy Scout Troop 137 for the great service projects they completed this year. For his Life Project, Greg Mable helped with much-needed maintenance of the purple trail to clear overgrown vegetation. For their Star Projects, Mathew Crisci built a boardwalk across a muddy section of the green trail, Connor Welsh cleaned out the 40+ nest boxes at Great Hollow at the end of the nesting season, and Liam Hearty ran an informational table at HollowFest. Also hard at work was Girl Scout Troop 50511 of New Fairfield. For their Silver Award projects, Lianna Furnari and Amanda Carlacci built a bug hotel and Francine Marlow, Olivia Malanga, and Hannah Greco built a compost bin for the garden. Boy Scout Troop 42 banded together to help with the fall cutting and cleanup of the pollinator garden. Thank you all for your amazing work!

Finally, we thank our members for their ongoing support and commitment to keeping Great Hollow going strong.

2022 MEMBERS

Merritt Club	Gary Goldring | Henry and Sabine Renard | Amy McIntosh and Jeffrey Toobin
Quaker Brook Club	Jaime Garamella | Donald and Cindy Tanenbaum | Paul Wolansky
Sponsor	Justin Mondshine
Family	Andrea Barry | Barbara Berliner | Fleur Fairman | Katie Firth | Luciana Fota | Jaime Garamella | Juliana Geoghan | Jennifer Gray | Christina Guffee | Linda Hubbard | Winsome Jeffries | Cathy Kadets | Victoria Landry | Kristina Leonetti | Amy Lokhin | Erin Lynch | Dawn Maguire | Tara O'Brien | Steven Pitt | Brett Pransky | Anita Raja | Michelle Ravich | Kristen Schneider | Stephen Schneider | Kenneth Smalley | Andrew Wallach | Alisha Welsh | Jessica Williams | Joanna Wozniak Brown | Karen Zeilnhofer
Individual	Ann Arbeit | Reed Asher | Laura Brundage | Sue Carbone | Margaret Cook | Melissa Cook | Melody Curra | Lindsey Daddio | Michael Damici | Joann Dickinson| Margaret Ditullio | Robert Doscher | Carol Frey | Jeff Ginsburg | Karen Golden | Susan Goldsmith | Justin Goodhart | Jennifer Hannigan | Michael Hansen | Kathleen Harpster | Michael Horowitz | Becky Hrdy | Cliff Jensen | Margery Josephson | Mitchell Kahn | Madhavi | Kanetkar | Parag Kanetkar | Gwen Leibel | Kristina Leonetti | Barbara Lobeck | Amy Lokhin | Erin Lynch | Jeanne Maloney | Francisca Mathews | Melanie McCarthy | John McCartney | Christina McCartney | Jennifer McCaughan | Robert McWilliams | Michael Missailidis | Jane Moloney | Suzanne Murdoch | Sharon Nakazato | MaryAnn Naughton | Cynthia O'Connor | John O'Donnell | Masumi, O'Donnell | Elka Perrone | Jessica Pratt | Steven Purtle | Brendan Quinn | MaryAnn Ralph | Erica Schlaug | Suzanne Telsey | William Toffey | Tee Vozella | Stephanie Warren | Elisabeth Whitten

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