Promoting research, education, and stewardship throughout the Great Bay Estuary
Weekends it rained in Concord, NH in Summer 2023.

- 21 inches of rain fell in New Hampshire in June, July, and August 2023.
- 12% increase in annual precipitation in the past 120 years.
- 6 of the 10 wettest summers in New Hampshire have happened since 2000.
- 14 out of 17 rainy weekends in Concord, NH in Summer 2023.
- 8 inches above average rainfall in 2023 since record keeping began.

2: Number of days in June that it did not rain on the seacoast of New Hampshire.
It’s pouring outside. I could stay in bed all day, listening to the rain and drinking tea. Instead I get up, take my time in my cozy house and then reluctantly dash to my car. The rain does not disrupt my day too much; a minor inconvenience. But it is much harder to downplay what we saw this past summer. The reality of how rain affects wildlife, water quality, and the ecosystems of Great Bay were startling this year. In this issue, we take a closer look at how the extraordinary amount of rain changed the rhythms of spring and summer for our natural world. In 2019, the University of New Hampshire produced the New Hampshire Coastal Flood Risk Summary in partnership with the Coastal Flood Risk Science and Technical Advisory Panel and the New Hampshire Department of Environmental Services. The report highlights three key points in the “precipitation” chapter: 1. daily extreme precipitation events have increased in magnitude by 15–38% in New Hampshire’s coastal watershed since the 1950s; 2. the frequency of extreme precipitation events is projected to increase over the course of the next several decades, especially in the springtime; and 3. the magnitude of future flooding will depend in part on how much the effective impervious surface changes in the coastal watershed. We can read the technical report, hear the osprey crying as they vainly search for fish in murky waters, or look out our window any morning this past June—there is ample evidence that it is getting wetter out there. This trend is affecting our lives and our Bay and we need to be ready.

Cory Riley, Reserve Manager, GBNERR
In recent years, dry spells and drought have been at the forefront of climate concerns in New Hampshire. For that reason, one might assume that this summer’s almost record-setting levels of precipitation would be a welcome change.

Although there are many animals and plants that thrive in a damp environment, many more faced complicated challenges because of the rain. The Great Bay Estuary is a brackish body of water. With freshwater flowing in from several rivers, and saltwater brought from the Gulf of Maine, the species in and around the bay have adapted to survive in the unique estuarine habitat. With a disproportionate level of freshwater entering the bay and ecosystems around it, salinity levels dropped, soil became oversaturated, and animals faced weather conditions different from what they would normally endure.

The atypical uptick in rainfall this summer can be attributed to the jet stream. This weather system is a channel of air that divides cooler air from the north and warmer air from the south. During the summer months, the jet stream was positioned over the Northeast, clearing the way for storm systems to drift over and dump above-average amounts of precipitation. Another contributing factor is the climate change–induced acceleration of our hydrologic cycle. Our water cycle works as follows. Water is evaporated from oceans, rivers, lakes, or released into the air by transpiration. Transpiration is the process whereby plants release water from their leaves into the surrounding air. Once this water reaches a high enough elevation, the vapor condenses to form clouds which eventually release the water as precipitation. This precipitation is absorbed by plants and brought into underground aquifers via root systems. It then returns to the ocean and other waterways. Human disruption has altered this natural process. Loss of vegetation causes large amounts of precipitation to become runoff. This is water that hits Earth’s surface and instead of being absorbed into the ground, flows into neighboring ponds, lakes, or oceans (commonly washing with it harmful pollutants into those bodies of water). Climate change also influences precipitation patterns, affecting the amount and severity of extreme weather events. The result is an unbalanced cycle that disrupts the natural sequence of plant and animal transformations throughout the seasons.

If you noticed anything off with the leaves and trees this fall, you’re seeing more ecological impacts from our wet summer weather. The vibrant reds, oranges, and yellows synonymous with autumn foliage in New England arrived fashionably late this season, if at all. This is due in part to the ability of fungal spores to spread much more easily in a moist environment. Having heavily saturated soil with inadequate drainage is a breeding ground for devastating plant diseases such as root rot, which causes stress on trees and leaves to turn brown and fall. Trees rely on subtle cues from their environment to determine when to drop their leaves. Typically, as days get shorter and cooler during the fall months, trees stop producing chlorophyll. This allows the leaves’ natural colors of yellow and orange to emerge. At the same time chlorophyll production halts, trees begin to produce anthocyanins, which are deep red and
purple pigments found in plants. Eventually the veins connecting leaves to branches close off, disconnecting the leaf from the tree and causing it to fall to the ground. With longer stretches of warm weather, and an overwhelming amount of precipitation, trees are not receiving the necessary signal to trigger the leaf changing phase.

Foliage was not the only process affected by substantial rainfall this summer; wildlife faced challenges as well. The turbidity of Great Bay from constant churning and rainfall caused the estuary to become cloudy with soil and silt, severely restricting visibility. Animals that use the bay as a feeding ground encountered fiercer competition, with some travelling further distances to freshwater sources in search of food. Cold, windy, and wet conditions were dangerous for juvenile animals still developing their adult fur and feathers. One of the species that underwent hardship was ospreys. These birds were slammed with severe weather while raising their young. The bonded pair of osprey observable from a game camera on Great Bay were bombarded by difficulties while raising their three chicks. Reserve staff were able to determine that the fish being brought back to the osprey pair’s nest were mostly freshwater species, indicating that these birds were travelling further for their food and expending more energy to hunt. This meant less food for their chicks to eat and resulted in emaciation. This, coupled with an unfortunate onslaught of storms, resulted in two of the three osprey chicks falling out of the nest in late June. One was able to be renested on site, but the other was admitted to the Center for Wildlife in Maine, with multiple fractures and had to be euthanized several days later. By early July, the smaller of the two remaining chicks showed signs of emaciation and seemed to be declining in health, eventually succumbing to the intense rain and starvation. In early July, the remaining chick fell from the nest again and was brought to the Center for Wildlife where it succumbed to injuries and starvation. Reports from around the estuary indicated similar outcomes for many other osprey pairs. This unfortunate ending illustrates the intricate balance of an ecosystem and forecasts a gloomy future should intense weather systems continue to strike.

Tess Vennard, Naturalist, GBNERR
Parts of New England experienced record rainfall this summer. With heavy rainfall comes many repercussions, both positive and negative, for all plant and animal species. Although the soggy weather may have put a damper on our own summer plans, for mushrooms around Great Bay the influx of rain led to a summer of success and abundance.

So, what exactly is a mushroom? Mushrooms are the sporophore, or fruiting body, of certain fungi species. Worldwide, there are between two and three million species of fungi that produce spores, which eventually turn into the mushrooms that we are familiar with. Most mushrooms have a stem that is covered by a smooth cap. Underneath that cap are thin gaps called gills. In the gills of a mushroom are the tiny microscopic reproductive units of the mushroom known as spores. Each mushroom contains hundreds of thousands of spores that are so small they look like a layer of dust covering the gills. Spores are passively carried by wind to new hosts or habitat patches, and when conditions are optimal, they transform into one of the hundreds of mushroom species that we find here in New Hampshire.

Wet, humid conditions are most favorable for fungi species, encouraging the fruiting bodies to proliferate, so it is no surprise that we observed a bumper crop of mushrooms this summer. Generally speaking 2–10 days after rain events are when mushrooms are most abundant, emerging from the ground and covering shady areas with their sporophores. As the soil begins to dry out following a period of rain, the fruiting bodies disappear, but the network of fungal colonies that lives within the soil persists. These extensive colonies, known as mycelium, consist of a branching network of thin fungal strands called hyphae. They are the key to healthy soil and to the growth of mushrooms in our yards and along our trails. Hyphae secrete digestive enzymes onto their food sources, which most often consist of dead organic material, breaking it down and...
creating healthy soil for plants, bacteria, and animals. With the excessive amount of rain this summer, the woods were “flush” with fungi! Simply put, a flush is the term used to refer to a crop of mushrooms.

Currently, scientists are studying the connection between these spores and the formation of rain clouds. Mycologist Arthur Henry Buller discovered that mushrooms sometimes form water droplets between their gills, and upon further inspection, saw that this water was actually forming on their spores. These droplets, appropriately named Buller’s drops, form on the very edge of a mushroom spore and are powered by a catapult mechanism. This results from the rapid movement of the drop of water over the spore surface, which then launches both the water droplet and the spore into the air. With an individual gilled mushroom having the ability to release as many as 30,000 spores into the atmosphere every second, there can be billions of spores floating in the air at any point in time. As they float around, the spores and their water droplets attract each other, forming a cloud made up of billions of water droplets. So, it is no wonder that during periods of rain we see so many different mushroom species emerging: the rain encourages the growth of mushrooms, and the mushrooms release their spores, which leads to even more rainfall.

So the next time it rains, be sure to keep your eye out for some of the numerous mushroom species that we have here in New Hampshire. You never know what you may see!

Katherine McGovern, Biological Research Assistant, GBNERR

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**Estuary Almanac**

**Dwarf Spike-Rush** (*Eleocharis parvula*)

Have you ever had an uneasy feeling when coming across something completely out of place? A sock on the kitchen floor, lobster in ice cream, or a flamingo in Virginia (which happened this year). If so, you’re not alone. In Great Bay, extreme weather has led to several ecological examples of this. Reserve staff started finding species that were migrating north with warming oceans such as blue and fiddler crabs. We’re also finding plants growing in new locations because of historic rain this year. Meet *Eleocharis parvula*, commonly known as dwarf spike-rush. This plant is small in stature but is making a big statement by occupying the lower edge of the salt marsh, a location it has never been before.

*Eleocharis parvula* is a perennial aquatic plant that can be found across the world. Its range covers parts of Europe, Asia, and North America. *Eleocharis parvula* can be translated to mean “small, graceful, found in marshes” and has many common names including dwarf spike-rush, small spike-rush, little-headed spike sedge, or dwarf hairgrass. The thin hair-like texture of the plant, as well as its striking green color, substantiates the whimsical representation of these monikers. Adding to its fairy-like appearance, spike-rush only grows 3 to 5 inches tall. The roots are thin, white, and form a dense mat when fully mature. The stems appear spongy and thread-like and have flowers that are surrounded by scales, which form oval-shaped spikelets. Geese, ducks, and muskrat feed on the flowers of dwarf spike-rush, and its dense composition provides a habitat for fish and other small marine animals along the shore during higher tides.

GBNERR’s Research Coordinator, Chris Peter, has been studying New England marshes for the past 20 years and has never seen it occupy the lower edges of the marsh before. In fact, the low marsh is so physically stressful, being flooded by high tides several hours twice per day, that only one vascular plant species, smooth cordgrass (*Spartina alterniflora*), is able to thrive in it due to its unique adaptation to high salt concentrations. Dwarf spike-rush lacks these salt adaptations and is typically found in a much less stressful habitat, occupying completely freshwater wetlands or the upper edge of tidal marshes where it has been freshened by ponded groundwater or rain.

With the excessive amount of rain this summer, the salinity levels in Great Bay dropped to as low as 8 parts per thousand (ppt), something rarely seen. Usually Great Bay summer salinities fall somewhere in the range of 25 to 30 ppt. For comparison, a day at the beach off the coast of New Hampshire will have you swimming in approximately 32 ppt, which means that about 35 grams of salt is present in each 1 liter of seawater. The presence of healthy spike grass in this zone is just one more indicator of the extreme rainfall this region experienced and the impact it had on local flora and fauna. In just one short Great Bay growing season, conditions were different enough to sustain a plant in a location it has never been seen before.

Tess Vennard, GBNERR Naturalist and Chris Peter, GBNERR Research Coordinator

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The Evelyn Browne Conservation Award was established in 1996 to honor the memory of a remarkable woman who dedicated her life to protecting the Great Bay Estuary. The award is presented annually by the Great Bay National Estuarine Research Reserve to an individual(s) who has made a significant contribution toward the protection and conservation of the Great Bay Estuary. With 2023 marking the 50th anniversary of the oil refinery threat to Great Bay, the Reserve is very pleased to announce that this year’s award goes to two Great Bay stewards: Don and Carol Tordoff of Deerfield, New Hampshire.

Don and Carol began formally volunteering at the Reserve more than a decade ago, but actually have been involved with the Reserve and the Great Bay Discovery Center for close to 30 years as they supported and watched their daughter, and now Assistant Education Coordinator, Beth Heckman begin her career here. Throughout those years, Don and Carol have taken on a variety of roles and have been working to support the mission of the Reserve.

As the former Reserve Facilities Manager, Don carried his knowledge of the buildings and grounds of the Discovery Center forward by coming weekly to volunteer to continue grounds maintenance, upkeep, and troubleshooting, as well as helping on a variety of special projects working hand in hand with other volunteers. His talent and knowledge of landscaping and hardscaping has been the foundation upon which the unique stream feature and native trees and shrubs around the campus began. Don has been a welcoming and true ambassador to the Reserve and Great Bay. No matter what Don was involved in, he would stop to introduce visitors to the estuary and the Center. In fact, current volunteers Steve and Julie Simon indicated that the only reason they volunteer at the Center today is because of Don’s welcoming and informative invitation to get involved.

Carol for her part has become the bubbly face that greets visitors in the Discovery Center each week with her vast knowledge of not only the estuary, but nature and wildlife in general. Her dedication to keeping the “what’s blooming” vases full has created a beautiful connection to the flora of the grounds that makes visitors want to discover even more. Carol also volunteers in the summer Bayventures programs, an action-packed full day of discovery and exploration for young visitors, and she supports special programs and projects such as the Grab and Go activity kits that were so popular during COVID.

After the warm days of summer fade to fall and winter, Don and Carol still come to the Center to support programs throughout the year. This dynamic duo go beyond just showing up and carry with them a true and genuine love and philosophical support of conservation and wild discovery. For this reason we congratulate and honor our 2023 Evelyn Browne Conservation Award winners, Don and Carol Tordoff.
**Bayventure programs are for children in grades 1-6**

**No School Bayventure Day**
Friday, January 12

**Birding by the Bay**
Do you like to birdwatch? Bird watching is a hobby that can be enjoyed for a lifetime. The Discovery Center has participated in Project Feederwatch for over 20 years and would like your help counting birds at our feeders. Join us for a day of bird identification, counting, and tallying our feathered friends. Enjoy games and crafts too.

**No School Bayventure Day**
runs from 10:00 am - 2:00 pm
$25 GBS member • $30 nonmember

**February Vacation Bayventure Days**
Monday, February 26; Wednesday, February 28; or Friday, March 1

**Trekking for Tracks**
Join us as we look for animals and their “autographs” in different habitats around the Discovery Center...on snowshoes, snow permitting! We will look for fisher, otter, and coyote tracks to name a few. Make a craft to take home.

**Vacation Camp Bayventure Days**
run from 10:00 am - 2:00 pm
$25 GBS member • $30 nonmember

**No School Bayventure Day**
Tuesday, March 12

**Syrup on Snow**
The ice is melting and the sap has started to flow. Join us for a day of maple sugaring. We will use tree tapping tools and make our own to try. Give maple sap a taste straight from the tree, participate in our maple syrup taste test on pancakes for lunch, and make a craft to take home.

**No School Bayventure Day**
runs from 10:00 am - 2:00 pm
$25 GBS member • $30 nonmember

**Register at** greatbay.org
**Email** beth.heckman@wildlife.nh.gov with questions
**Great Bay Discovery Center**
89 Depot Rd, Greenland NH 03840

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**“Once Upon a Winter Estuary”**
Bundle up your 2- to 5-year-olds and come join a wild and wintery program at the Great Bay Discovery Center. Programs begin in January and run through March. Click the QR code for program dates and details.
A National Perspective: From the Estuary Files—Reserve Data Mysteries

ominous blobs, shoreline shrimp slaughter, a catastrophe on Bang’s Lake… who said science was dull? In honor of the return to school this past fall—and maybe the next Halloween blockbuster—educators across the Reserve System served up locally inspired data mysteries.

These activities are designed to help middle and high school students explore real estuary events and make predictions about future ones. In the process, students connect with estuaries and the challenges they face by using data from the NERRS System-Wide Monitoring Program (SWMP).

SWMP is a nationally unique program that monitors local changes in weather and water quality. By combining data from SWMP and local research projects, these mysteries encourage educators and their students to explore the estuary in their backyard or another in the Reserve System.

Each mystery poses a question about a past event. What, for example, killed millions of grass shrimp on Cape Cod? Did a tsunami really hit the New Jersey coast? Why did one hurricane suck most of the water out of Weeks Bay and the next one cause flooding?

Using the SWMP Graphing and Export System, students assume the role of a scientist looking for data-driven patterns and trends and draw their own conclusions regarding what happened. Each mystery meets next generation standards for learning about science.

“Data mysteries are another example of reserves coming together nationally to create tools that any educator in the country can use,” says Rebecca Roth, NERRA’s Executive Director. “Activities like these not only enrich education everywhere, they help stretch state and local education budgets by offsetting costs for curriculum development.”

Data mysteries were developed through a successful collaboration between reserve education and research coordinators and SWMP technicians. So far, the project has created seventeen mysteries, with more on the way. You bring your magnifying glass and we’ll bring the data. Let’s solve a mystery!

Reprinted from the National Estuarine Research Reserve Association Newsletter, July 25, 2023

Volunteer for Great Bay!

- **Volunteer Educators:** Help us teach students about the natural history of Great Bay. Spend time outside and connect children to Great Bay. Training is all day April 24, lunch is provided, and registration is required.

- **Exhibit Room:** Help visitors learn about Great Bay, hold a horseshoe crab, and more. Training is April 30, 9:00 a.m.–12:00 p.m.

- **Do you love to get outside?** We have flexible opportunities beginning in March, including phenology, adopt-a-garden, wildlife garden weeding crew, and more.

Contact Melissa at melissa.brogle@wildlife.nh.gov or 603-778-0015 with questions or to be added to our list of volunteers.
I f you have been reading this letter over the last few years, you know one of my favorite hobbies is gardening. You will not be surprised to hear then that I was home with a terrible case of poison ivy when former Chair Jack O’Reilly called me from a board meeting to ask if I would consider serving as vice chair.

Glenn Cove represents a site of historical importance and beautiful new open lands to better connect people to Great Bay—one of the foremost goals of the Stewards. We’ve been thrilled by the potential of this property as we explored it over the last several years and helped plan its future with the Reserve staff. It is important to note this project will now provide easy access to the beauty of Great Bay for those with limited mobility.

I am so glad I answered his call. Without a doubt, the 6 years in which I served as the vice chair and then chair have been among the most fulfilling of my retirement. I am incredibly proud of all of the work the board members have accomplished because of your support—including launching the Tide Turners program, opening the Estuary Inclusion Garden, collaborating alongside like-minded organizations in the region under the Great Bay 2020 and then 2030 initiatives, and working toward opening public access at Glenn Cove in Greenland.

But as gardeners know, the weather has its own agenda, and in recent years we are seeing the significant impact the climate crisis is having on the Great Bay Ecosystem. Wetter summers and warmer winters are now critically impacting eelgrass, saltmarsh sparrows, and osprey, and bringing more invasive species to the region. At our annual members meeting this fall, speaker Peter Wellenberger described the fight 50 years ago against Aristotle Onassis. Today we are in a new fight, one against the realities of changing climate and rising seas. Just as the three key women and New Hampshire voters decades ago defeated Onassis, we too can be victors in the newest battle for the health of Great Bay. While I am both pleased and proud to hand over the chair of the Stewards to the eminently qualified Steve Paquette, I will still be by his side, and by yours, fighting for a healthy future for Great Bay. I thank you all for your partnership through encouragement and support of our work.

I believe we can all do this together. It’s a great time to make a difference.

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Deb Alberts, Outgoing Chair, Great Bay Stewards

And meet Steve Paquette! We are thrilled that he is a part of our board. Since joining just over a year ago, he has played a valuable role in our Advocacy and Outreach Committee and supporting the Glenn Cove project. Steve joined us following his retirement from his role as President of WSP Global’s U.S. Earth and Environment Division. At WSP, Steve also developed and led the U.S. Inclusion and Diversity Program and ran the U.S. sustainability and Environment, Social Governance practice. Steve spends his downtime hiking and photographing the Bay and coastline, and we are thrilled to have him take on the role of board chair.

### Great Bay 5K

Thank you to the nearly 900 participants who signed up for the 25th anniversary of Great Bay 5K race, and congratulations to Adam Martin Caldwell for setting a new course record with a time of 14:28! We thank the sponsors of the Great Bay 5K: Sprague Operating Resources, M&T Bank, Oyster River Running Company, Northeast Delta Dental, Seacoast Prosthetics, Holy Rosary Credit Union, D.F. Richard, Coca-Cola Bottling Company of New England, Bodywise Physical Therapy & Wellness, Durham-Great Bay Rotary Club, Calico Graphics, Starbucks, and First Student, Deciduous Brewing Company, Liars Bench Beer Co., Sawbelly Brewing, North Country Hard Cider, Stoneface Brewing Co., and Tributary Brewing Co., with The Franklin offering a half dozen oysters to race participants who visited the same weekend.

**PLEASE JOIN US!**

All interested parties are cordially invited to become Great Bay Stewards. Members receive *Great Bay Matters* and other pertinent mailings.

Annual dues may be paid by check made payable to the Great Bay Stewards and sent to: GBS Membership Committee, 89 Depot Road, Greenland, NH 03840

- Guardian $150
- Protector $75
- Steward/Family $35
- Student $20
- Other $__________

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Working together to help others navigate life’s journey well is our mission. When we guide our friends, family, and neighbors toward a better place, we reach the best of destinations.