Promoting research, education, and stewardship throughout the Great Bay Estuary
GET TO KNOW GREAT BAY

5 SUCCULENT SALTMARSH PLANTS

Atlantic Sea Blite, Marsh Orach,
Common Glasswort, Sea Milkwort,
Seaside Plantain

1973

Mummichogs were the first fish to go into space

10 LITERS OF OXYGEN is produced by 1 square meter of seagrass each day

99% OF AN OSPREY’S DIET IS FISH

4 SPECIES of horseshoe crabs in the world only 1 in North America

2 WEEKS male pipefish incubate eggs in their brood pouch before they hatch
People like to believe that things can stay the same. It may be the economy, politics, the environment, our home town, our jobs, or your own life—we hold onto the idea that a perfect static condition exists, and that we should do all we can to maintain it or to bring it back. In reality, however, everything is always changing in remarkable ways and at improbable time scales. As a big nerd, my favorite example of impermanence is evolution. The continual adaptation of species to physical conditions, other plants and animals, and seasonal shifts guarantees thousands and thousands of winding pathways that could lead to success. We also know that natural selection is not the only reason for evolution; random genetic mutations account for much of the variation on earth. I like knowing there are reasons for some of what I observe in nature, and that some of the fantastic creatures we come across just ended up that way by chance. As you read this issue of Great Bay Matters, I hope you are awed by the extraordinary plants and animals that live in our Reserve and reminded of the importance of protecting ecological biodiversity both locally and globally. We have much to learn from plants and animals and people that seem strange at first glance. A diverse world keeps our genetics and our minds evolving, and constant change leads to so many perfect conditions.

Cory Riley, Reserve Manager, GBNERR
When we think of unusual or unique plants and animals, our mind usually takes us on a fantastic journey to remote and wild locations around the world.

The Titan arum is a plant found growing among the dense brambles of tropical Indonesian forests. It grows for several years, reaching a staggering 3 meters before it can bloom for the first time. The bloom lasts a fleeting few days, releasing a strong musty odor compared with that of rotting meat, hence the name “corpse flower.”

New Hampshire, to those of us who have grown up here, mostly feels predictable and easy to live in, notwithstanding an occasional blizzard, ice storm, or heat wave. We watch sugar maples turn a brilliant scarlet almost before our eyes and breathe in the delicious spring scent of purple lilacs as a necessary ritual before summer can officially begin. The familiar plants, shrubs, and trees we sometimes take for granted here are actually some of the most biologically unique species of plants anywhere in the world.
Take the *Drosera*, or sundew plant, found in swamps and bogs within the Great Bay watershed and throughout New Hampshire. It is in fact a carnivorous plant, meaning that in order to receive the nutrients it needs it feeds on insects. It does so because it typically grows in poor soil and areas that lack adequate nitrogen for it to grow properly. *Drosera* has adapted to this challenge by having leaves with hair-like feelers covered in a sticky, sweet-smelling, dew-like substance that attracts insects. Lured by the irresistible sweetness of the sundew, an insect will land on the sticky feelers, and like a hungry boa, it slowly wraps its stem around the insect, secreting digestive enzymes which then consume its prey. Its cousin, the Venus fly trap, is so impressive that major motion pictures and Broadway plays have been produced in its honor.

Next on the list of truly special flora found in New Hampshire is a plant you will likely see when you get anywhere near Great Bay or the twisting, turning creeks of the estuary along the coast. *Spartina alterniflora*, or smooth cordgrass, looks like a potentially bland and boring uniform green sea of grass fringing the edge of estuaries up and down the East Coast. The anything-but-boring smooth cordgrass is a biological marvel with superhero-like characteristics.

Because it grows immediately along the root zone, removes the excess salt with its salt glands, and then balances itself osmotically with organic solutes. In addition to this adaptation, the dense interlocking root/rhizome system solidifies this plant as an ecological necessity, serving to buffer flood runoff, control erosion by binding sediments, microbially processing organic and inorganic wastes, and, thankfully, acting as an exceptional carbon sink. This magical and watery green carpet is also a nursery ground for many of the commercial and recreational fish and shellfish we like to eat.

Last but not least, is a potentially deadly genus of microscopic phytoplankton (*phyto* meaning plant and *plankton* meaning wander or drift) known as dinoflagellates. In particular, *Alexandrium fundyense* produces toxic harmful algal blooms that cause paralytic shellfish poisoning, or PSP. In New Hampshire, *Alexandrium* “blooms,” often referred to as red tide, can occur in the spring and summer months. Humans who consume this dangerous neurotoxin by eating affected shellfish may experience damage, impairment, or even destruction of nerve tissue.

When water conditions are ideal, the cells of the toxic alga reproduce exponentially; a single cell can result in the reproduction of several hundred cells in just a few weeks. If these blooms move closer to shore, filter-feeding shellfish can accumulate dangerous levels of PSP toxin, making shellfish closures necessary. By the end of fall, *Alexandrium* cells settle in offshore ocean sediments in the form of cysts, lying dormant for the winter. In spring, the cycle may repeat itself once again as they germinate into free-swimming, reproducing cells. There are thousands of different kinds of phytoplankton but fewer than 100 that produce poisonous biotoxins. It is hard to imagine that some of these biotoxins can be more deadly than cobra venom, but the shellfish or fish that eat them don’t usually get sick. Animals further up the food chain, from fish to dolphins to whales and even humans, can fall victim to this powerful little plant. Look around, and remember, just because it lives in your backyard, doesn’t mean it’s ordinary. There are pretty powerful plants all around us!

**Kelle Loughlin, Education Coordinator, GBNERR**
Woodland Clams

Filled with water by rain and snow, vernal pools are isolated water features that completely dry out most years. This makes them devoid of fish and consequentially an important breeding habitat for several amphibian species. Many vernal pools are also inhabited by tens of thousands of small freshwater clams no larger than the nail on your smallest finger. Just like their estuarine cousins, these “fingernail clams” are filter feeders, ingesting algae and detritus suspended in the water. Fingernail clams store their eggs in a special compartment in their gills, affectionately termed a “marsupial sack” where embryos develop until just 2 to 24 young are released as tiny fully formed clams.

So how do these highly specialized but sedentary animals without feet or wings move to new waters? Amazingly, they often clamp themselves to the toes of salamanders, such as the Jefferson Salamander, and hitch a ride! They can even hibernate with their host salamander staying attached to toes underground and away from water for nearly a year.

Sandpipers in the Forest

Otherwise known as the “timberdoodle,” “night partridge,” or “bogsucker,” anyone who has seen the American woodcock’s amazing courtship dance or heavy-footed walk will love this bird. Video of it has even been paired with several funky beats on YouTube (yes, they can walk like an Egyptian, but they are even better at “Staying Aliiive”). Males display acrobatic mating flights during which they fly up into the air 100 to 300 feet. As they get higher their wings make a twittering sound produced by air passing through three outer wing feathers. They quickly come spiraling down to land and make their distinctive “peent” call hoping to attract the attention of one or more females.

Fascinatingly, the woodcock is actually a shorebird that has evolved to live in upland settings. Features from its coastal past work to its advantage in its present-day shrubby field and young forested habitat. Mottled brown markings help it blend superbly with leaf litter and other debris. Its large eyes are set well back and high on the sides of the head to allow it to watch for danger in all directions, even with its head down feeding. Other amazing adaptations include having bills that are prehensile at the tip to help seize prey. When feeding, a woodcock probes its bill into soft soil to locate earthworms, which typically make up about three-quarters of its diet. When born, woodcock eggs split lengthwise, unique among birds, and chicks leave the nest only a few hours after hatching.

The American woodcock is about 5 inches high with an 18-inch wingspan.
**Sea Lamprey** (*Petromyzon marinus*)

The Great Bay Estuary is filled with charismatic creatures, such as the slippery American eel or the hardy horseshoe crab. There are many unique species crawling on the bay floor and swimming through the eelgrass beds. One of the not-so-typical species is the sea lamprey. Sometimes called vampire fish, these jawless fish inhabit the Atlantic Ocean and its coastal rivers and estuaries. Unlike bony fishes, such as trout or cod, lampreys lack scales, fins, and gill covers. But like sharks, their skeletons are made of cartilage. A sea lamprey looks similar to an eel but has a circular mouth filled with rings of teeth. Fully mature adults can reach 3 feet in length, are dark brown and yellow in color, and breathe through a distinctive row of 7 circular gill openings located behind their mouths and eyes. The larvae do not have fully developed eyes or teeth but have the same 7 circular gill slits as adults.

These creatures might appear ordinary at first glance, but up close a sea lamprey can look like something right out of a horror film. As parasitic organisms that feed on the blood of other fish, they are certainly scary worthy, but they do not feed on warm-blooded mammals so are not a danger to humans. Their unique disk-shaped mouth with its 11 or 12 rows of teeth allows them to attach onto the side of a fish. Once attached, the lamprey bores a hole into its host with its rough tongue and feeds on the tissues and bodily fluids. Although this feeding technique may seem morbid, as a parasite, the lamprey’s “goal” is not to kill its host so that it may potentially provide another meal in the future.

Sea lampreys spend most of their adult lives in the ocean or an estuary like Great Bay. To spawn, lamprey migrate into coastal rivers and swim upstream like salmon to appropriate spawning grounds. They create nests in the substrate called redds by moving around rocks with their mouths. A female lamprey lays around 172,000 eggs. While this may seem like a large number, not all of them will survive to adulthood. Most will serve as a food source for other organisms such as salmon which also build redds. In the Great Lakes, however, sea lamprey are invasive and are living up to their nickname of vampire fish by wreaking havoc on vulnerable species such as lake trout.

**Kelsey Hanson, Naturalist, GBNERR**

**Crabs in Our Yard?**

The flower crab spider, known as *Misumena vatia* to its scientific friends, is often found on goldenrod and can change its color from yellow to white as camouflage to match the background it is hiding on. Instead of building a sticky web, it actively hunts its prey by waiting on a flower or low vegetation watching for a tasty insect to come along. Named because of its short, wide, and flattened body, it holds its front legs out open like a crab ready to grab passing prey. Found in herbaceous open areas throughout New England, the crab spider is one of those “hidden wonders” we could easily spot in our own backyards.

Constantly learning from the wild world we live in, humans have based some of our best technologies on adaptations discovered in nature. Radar evolved from studying bat echolocation, whale fins inspired turbine blade design, and a simple dog walk resulted in Velcro as George de Mestral detangled burs from his pet’s coat. Evolution has had millions of years to perfect its designs so is a “natural” muse for us to learn and draw inspiration from—whether in an estuary or the woods.

**Rachel Stevens, Stewardship Coordinator, GBNERR**

**Estuary Almanac**

**Kelsey Hanson, Naturalist, GBNERR**
THE DODDER YOU NEVER KNEW: GREAT BAY’S PARASITIC VINE

The dodder vine, *Cuscuta*, is a parasitic vine that resembles a tangled mess of yellow-orange thread, which covers its host in web-like fashion. A parasitic plant takes nutrients from other plants rather than making its own food via photosynthesis. It does so because it contains little to no chlorophyll, thus the orange color of the vine, rather than green. The dodder vine uses slender structures called haustoria, which latch onto and penetrate the host, enabling the parasite to draw water and nutrients from its “prey.” Haustoria penetrate the plant stem and cause the roots of the dodder vine to wither away, as it fully relies on its host for nutrients. It is scarce in Great Bay, but it has been found on the grounds of the Great Bay Discovery Center on the upland edge of the salt marsh. The dodder vine can latch onto various herbaceous and small woody plants. In our case, it takes hold of seaside golden rod, commonly found in the higher elevations of the marsh. Although it has been known to invade and spread, it hasn’t gotten out of hand in Great Bay. This interesting plant has many whacky names such as angel hair, devil’s hair, devil’s ringlet, goldthread, hairweed, strangleweed, and more!

By Nikki Vanelli, GBNERR’s NOAA Hollings Scholar
Educational Offerings

FREE!

BAYVENTURE
Grab ’n’ Go Activity Kits

These kits include a themed craft or game, and a seasonal discovery for families to make on the grounds of the Discovery Center campus or, in some cases, their own backyards. Themes change weekly, and on Monday mornings new kits are placed in a bin outside the front doors of the Discovery Center. Approximately 200 kits are crafted by staff and volunteers each week. Come join in on our Bayventures!

SEPTEMBER
9/7-9/12 Monarch Madness
Have you seen these butterflies or caterpillars in your yard?
9/13-9/19 Pirate Patrol
Arrgh! Who sailed along the NH coast?
9/20-9/26 Hurry Up and Migrate
Why is Great Bay a good rest stop?
9/27-10/3 Three Sisters
Why were corn, beans and squash so important to the Squamscott people?

OCTOBER
10/4-10/10 Nuts About Squirrels
What kind of food are these critters collecting?
10/11-10/17 Colors Among the Trees
Why do leaves change color?
10/18-10/24 Saltmarsh Farmer
Could you climb a staddle?
10/25-10/31 Spider Hiders
Where do spiders go when it gets cold?

NOVEMBER
11/1-11/7 Bearly Awake
Have you seen a bear in NH?
11/8-11/14 Oh Deer! A Moose!
Could you carry antlers around on your head?
11/15-11/21 Colonial Kids
How were Colonial kids’ lives different?
11/22-11/28 Turkey Talk
How often do you see wild turkeys in NH?
11/29-12/5 All Aboard!
What is the history of the railroad next to the Discovery Center?

DECEMBER
12/6-12/12 A Taste of Winter
Could you survive like a person in the Squamscott Tribe?
12/13-12/19 Trekking for Tracks
What tracks are in your yard?
12/20-12/26 “Cone” you believe it?
How many seeds are in a pine cone?
12/27-1/2 “Bay”cicles
Does Great Bay ever freeze over?
As the inaugural Margaret A. Davidson Fellow at Great Bay NERR, graduate student Anna Lowien, is excited to be investigating the biogeochemistry of the Great Bay Estuary. Biogeochemistry refers to the study of the chemical, physical, geological, and biological processes that influence the movement of nutrients (i.e., nitrogen and phosphorus) and carbon throughout an ecosystem or even the globe. Her research will provide new perspectives regarding Great Bay Estuary’s biogeochemical role in processing inputs of nutrients, carbon, and sediments and will help identify thresholds of material flux that the estuary can ecologically handle.

Her work utilizes a mass balance, black box approach that accounts for the inputs of nutrients, carbon, and sediment to the estuary and the output of those same materials. The boundaries of this black box are defined as Great Bay, south of Adams Point, and include the mouths of the Lamprey, Squamscott, and Winnicut Rivers. By accounting for the inputs and outputs, it is possible to estimate the amount of nutrients, carbon, and/or sediments that remain stored within the estuary (the black box). We do that by using the following equation: Outputs – Inputs = Storage.

Inputs, outputs, and storage are reported as a flux measurement, which is a unit of measure referred to as mass/time. For example, a nitrogen flux would be reported as kilograms of nitrogen per year. The output of materials from Great Bay is defined as the movement of nutrients, carbon, and/or sediments out of Great Bay via low tide. Inputs of nutrients, carbon, and sediments into the estuary include precipitation, river flow, groundwater, coastal runoff, and high tide flow into Great Bay. The difference between the output and inputs provides an estimate of the amount of nutrients or carbon remaining in the estuary.

There are three broad possible outcomes from the black box analysis. First, inputs into Great Bay could equal output from Great Bay. In this scenario, nutrients, carbon, and sediments are said to behave conservatively, and Great Bay simply transports them onward to the ocean. The second possible outcome is inputs are greater than the output, which indicates more nutrients, carbon, and/or sediments enter Great Bay than leave Great Bay. The third possible outcome is inputs are less than output, indicating another source of nutrients, carbon, and/or sediments is contributing to the flux. For example, if more nitrogen is leaving Great Bay than enters it, that indicates that Great Bay itself may be contributing additional nitrogen from within the black box. This could be due to another, unmeasured input or production of nitrogen within the estuary.

Results of the black box modeling approach will then be compared with ecological response variables, including coverage of eelgrass, seaweed, and phytoplankton abundance and coverage. By comparing the biogeochemistry to the ecological response in the estuary, we can look for patterns between transport/retention of material fluxes and biological prominence of important species in the ecosystem. Anna’s findings will be available in the fall of 2021 and will help inform future work to protect the biogeochemical and ecological integrity of the estuary in the face of anthropogenic stressors.

Anna Lowien collects a water sample from Great Bay as part of her research.

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**Volunteer for Great Bay!**

**Fall Educator Training:**

Help us connect 3rd and 4th graders with Great Bay by getting them outdoors and teaching them about the cultural history of the Bay. All training is provided and new volunteers shadow experienced volunteers until they are ready to lead a group on their own. Training is September 9, 9:30 a.m.-4:30 p.m., and lunch is provided. Register for training by emailing beth.heckman@wildlife.nh.gov.

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**Getting Back to Normal:**

In many ways, 2020 seems like a lost year, and in fact when many of our staff say “last year” we are thinking of 2019. What was volunteerism like last year and how is it returning to normal? Check out a recent blog post by our Volunteer Coordinator at greatbay.org to learn how the Discovery Center navigated its challenging year.
At a meeting in early summer, one trustee said to another, “You’re taller than I expected.” It was a startling reminder of how long we’d been meeting on Zoom, and how the two terrific new board trustees who joined the Great Bay Stewards this year were just then meeting others in person.

Despite so many virtual meetings and the gradual return to “normal,” 2021 has been such an exciting year for the stewards. Celebrating our 25th anniversary throughout the past months has allowed us to reflect on all of the dedicated volunteers who came before us, and on all we have accomplished over the years. We hope you have enjoyed the interviews with past board chairs and other friends of the stewards on our blog as much as we’ve enjoyed doing them. This spring, we spent a day with board trustees and other stewards cleaning up the Community Wildlife Garden at Chapman’s Landing, a spot we have long supported that demonstrates the easy decisions that can be made to attract pollinators and other animals to backyards.

We kicked off our anniversary with our most successful annual appeal yet, raising more than $40,000 to meet our goals around conservation, education, research, and advocacy. These funds have gone toward and will continue supporting work to: welcome underserved audiences to a new sensory garden being developed at the Center; build a new exhibit that interprets the research done on the salt marshes around Great Bay; repair outdoor interactive elements at the Discovery Center, including the Gundalow and lobster boat; continue lab analysis for our environmental DNA monitoring; bring students from socioeconomically disadvantaged schools on Discovery Center field trips; and support an emerging soundscape research project to assess biodiversity, phenology, and animal and bird activity around the estuary. None of this would be possible without the strong support of stewards and friends of Great Bay like you.

This year’s Great Bay 5K is an extra special one, as we return to an in-person event after going virtual. We again postponed Art of Great Bay, but can’t wait to return in 2022 to celebrate the estuary and the coast through the art work and fine crafts of our amazing participants. And of course, on the evening of October 14 we will celebrate our 25th anniversary—we hope to see you there! Follow us on Facebook or through our newsletter to find out more.

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Deb Alberts, Chair, Great Bay Stewards

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Allison Knab, Executive Director
Join the Great Bay Stewards in becoming a Tide Turner!

The small changes you make contribute to a healthier watershed. It’s easy and you may already be doing many of them, such as planting native plants, using less fertilizer, or picking up your pet’s waste.

Participants pledge to do five of seven actions to ensure the health of Great Bay and receive a yard sign with the Tide Turner logo, welcome packet, and information on special events and opportunities.

Find out more at greatbaystewards.org