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Tracking New England's Nitrogen and Carbon Pollution Through Time with KIRI Herbarium Specimens

By ALISON S. CARRANZA and KEITH T. KILLINGBECK

Herbaria worldwide preserve plants whose tissues have captured a history of environmental conditions from times past. For many plants, such as those growing in the salt marshes of New England, some of the nitrogen taken up from soils and carbon absorbed from the atmosphere persists in the preserved specimens' tissues, and thus can reflect the environmental conditions of the time and place in which they were growing. These specimens, therefore, provide a unique opportunity to study change over space and time.

Working with Dr. Erika Edwards at Yale University, Alison Carranza designed a study centered on the use of these rich repositories of specimens present throughout the Northeast to track pollution in New England salt marshes over time. The University of Rhode Island's KIRI Herbarium (see the *About KIRI* note at the end of the article) can help to answer an important question: Can these specimens help to identify trends in the environmental conditions of New England salt marshes?

By measuring stable isotopes of nitrogen and carbon, it is possible to track changes in their concentrations in the preserved plant tissues. Stable (i.e., non-radioactive) isotopes are chemically similar forms of an element that differ only in their number of neutrons. This study specifically is measuring the relative ratios of nitrogen-15 to nitrogen-14 and carbon-13 to carbon-12, which are referred to as *δ15N* and *δ13C*, respectively. These isotopic ratios can act as enduring fingerprints or unique tracers of the carbon and nitrogen pollution that was present in the plant's environment at the time that it was collected. δ15N can be used to identify sewage pollution in the environment, as human and animal waste has heightened levels of nitrogen-15; δ13C can be correlated with fossil fuel use and also can be used to better understand a plant's photosynthetic pathways (O'Leary 1988, Costanzo et al. 2001, Graven et al. 2020). This means that we can measure both of these isotopic ratios in herbarium specimens to better understand the pollution levels of the past.

Salt-marsh plants are especially of interest because they occupy the intermediate area between saltwater and dry-land environments, so they are some of the first plants to come into contact with any nitrogen-rich runoff or wastewater. By quantifying the nitrogen stable isotopes in a specimen's leaf, for example, inferences can be made about the amount of polluted water being deposited into the marsh where and when the plant was growing.

Perhaps more importantly, preliminary results from this study suggest that stable isotopes of carbon preserved in a plant's tissues may be used to explore the history of site-specific fossil fuel burning. Since the widespread burning of fossil fuels began during the Industrial Revolution, atmospheric δ13C has been decreasing. Because fossil fuels have lower δ13C values than the atmosphere, humans have introduced proportionally more carbon-12 than carbon-13.

In This Issue:

RHODE ISLAND NATURAL HISTORY SURVEY 30 YEARS 1994 ~ 2024

This has ultimately shifted the atmospheric ratio of carbon stable isotopes, which has been labeled the Suess Effect—named for Austrian chemist Hans Suess, who discovered its influence on the accuracy of radiocarbon dating (Keeling 1979, Graven et al. 2020). As plants take in carbon from the atmosphere through their stomata, the stable-isotope ratios of carbon within their tissues reflect this shift with time. The preserved herbarium specimens are, therefore, able to capture these historic decreasing isotopic ratios that are preserved within their tissues. This is especially important because there are rarely local records that would capture these quantitative data over such a long period of time. Herbarium specimens allow us to get a glimpse into a local history we may not otherwise be able to access.

Figure 1. Researcher Alison Carranza in the KIRI Herbarium, preparing to sample 30 specimens of salt-marsh species for nitrogen and carbon stable-isotope analysis.

With more than 12,600 preserved vascular plant specimens in the KIRI Herbarium, there is a wide range of species represented. This includes plants that were collected in the mid-20th century, which filled temporal gaps in the dataset being generated for this study (Fig. 1). That dataset also includes samples of herbarium specimens from Yale University, Brown University, Harvard University, the New York Botanical Garden, and the Marine Biological Laboratory/Woods Hole Oceanographic Institution. The herbarium specimens sampled in the KIRI collection included 3–8 individuals of 6 species originally collected between the late 1930s and the 1970s (Table 1). From each of these 30 plants, 3–4 mg of tissue was carefully removed for stable-isotope analysis (Fig. 2). Altogether, the combined specimens from these several herbaria constitute a significant time series of nitrogen and carbon stable-isotope shifts in the salt-marsh plant tissue.

Figure 2. Alison Carranza in the KIRI Herbarium removing a small sample of tissue from a specimen of *Solidago sempervirens* (seaside goldenrod) for stable-isotope analysis. The inset shows the size of the tiny sample needed—only 3–4 mg.

The KIRI specimens are important to this study because they were collected during a time of very limited plant collecting due to both World War II and a reduction in funding for collections as priorities began to shift away from natural history studies. Contrary to that latter mindset, this study demonstrates the continued use and importance of these collections as unique, invaluable markers of environmental conditions.

About KIRI: The acronym 'KIRI' is the official code name of the herbarium at the University of Rhode Island as it is listed in the Index Herbariorum, the official listing of the

(continued on page 4)

President's Corner: Welcome Back

Bonne rentrée! I hope your summers have provided you and yours with opportunities to get outside and explore, and you enter the fall season reinvigorated.

Sarah Gaines, President, Board of Directors

I am delighted to start my term as President of the Survey Board of Directors with an incredible team of Board members and staff, at an exciting time for all of us. A geologist by education, I have spent my career working globally on conservation issues. After a decade working in Paris with the Secretariat of the United Nations Educational Scientific and Cultural Organization, my husband and I returned to Rhode Island to raise our children by the sea, in a place where we have deep ancestral roots. I now work at the Coastal Resources Center of the University of Rhode Island on international conservation and development—primarily in Madagascar for the moment. Volunteering with the Survey has provided me with an opportunity to contribute to local issues, to learn more about local species and systems, and to demonstrate to my children the importance of being engaged. I hope to bring my international experience in natural resource conservation (both biodiversity and geoheritage), climate change resilience, and sustainable livelihoods to bear on local issues in our incredible little state. I am also motivated to work creatively and artistically to better understand—and communicate—our natural history. This is going to be fun!

Reflecting on the Survey's 30th anniversary, one of the many exciting things our Board has been working on over the past nine months is the development of a new five-year Strategic Plan. This process is board led and has involved extensive engagement with our partners, funders, stakeholders, and members. I hope you have heard from us during this process. We will formally unveil the Strategic Plan at our 30th Birthday Gala event on Saturday, November 16, at the Quonset O Club, but I would like to tease some of our initial findings. The Strategic Plan reinforces the focus and role of the Survey on providing biodiversity expertise in the state and commits that the Survey serves naturalists of all walks of life—across age, education, profession, and expertise. We have also developed clear value statements, that, among others, recognize the importance of understanding our natural surroundings to our own sense of place, and our larger well-being. At our meeting on September 10th, the Board formally adopted new mission, vision, and values statements—see the box on page 24 for a preview. I look forward to seeing you on November 16th for the full presentation of our work and hearing your reactions.

Participating in this year's BioBlitz—accompanied by my mother and daughter—convinced me we are well on our way to achieving the goals laid out in our Strategic Plan. Hopefully you had the chance to join us at our 25th BioBlitz in June at the Norman Bird Sanctuary in Middletown, with some 389 participants logging 1,325 species [1,396 as of Last Wednesday Tea on August 28th—*Eds.*] over 24 hours—a record for both our participation and species count! I'd like to acknowledge our hosts, who provided a spectacular location and facilities. In addition, special recognition goes to David and Kira who put in a herculean effort to pull off this event once again.

KIRI Herbarium Sampling (continued from page 2)

Table 1. The 30 20th century specimens of salt-marsh plants in the KIRI Herbarium collection that were sampled for stable-isotope analysis. All 30 were collected in Washington County, Rhode Island. Common names are those used by iNaturalist.

Species	Common name	Family	Year	Catalog #
*Spartina alterniflora**	Smooth Cordgrass	Poaceae	1948	KIRI-03313
Spartina alterniflora	Smooth Cordgrass	Poaceae	1937	KIRI-03314
Spartina alterniflora	Smooth Cordgrass	Poaceae	1975	KIRI-03317
Spartina alterniflora	Smooth Cordgrass	Poaceae	1976	KIRI-03316
Spartina alterniflora	Smooth Cordgrass	Poaceae	1948	KIRI-03318
Spartina alterniflora	Smooth Cordgrass	Poaceae	1948	KIRI-03319
Spartina alterniflora	Smooth Cordgrass	Poaceae	1976	KIRI-03320
Spartina patens#	Marsh Hay Cordgrass	Poaceae	1976	KIRI-03330
Spartina patens	Marsh Hay Cordgrass	Poaceae	1948	KIRI-03332
Spartina patens	Marsh Hay Cordgrass	Poaceae	1947	KIRI-03333
Distichlis spicata	Seashore Saltgrass	Poaceae	1975	KIRI-02856
Distichlis spicata	Seashore Saltgrass	Poaceae	1976	KIRI-02857
Distichlis spicata	Seashore Saltgrass	Poaceae	1948	KIRI-02858
Limonium carolinianum	Carolina Sea Lavender	Plumbaginaceae	1975	KIRI-06619
Limonium carolinianum	Carolina Sea Lavender	Plumbaginaceae	1948	KIRI-06621
Limonium carolinianum	Carolina Sea Lavender	Plumbaginaceae	1943	KIRI-06622
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1975	KIRI-12564
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1975	KIRI-12566
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1972	KIRI-12568
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1976	KIRI-12572
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1970	KIRI-12600
Solidago sempervirens	Northern Seaside Goldenrod	Asteraceae	1970	KIRI-12609
Salicornia depressa^	Virginia Glasswort	Amaranthaceae	1943	KIRI-06290
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1948	KIRI-06291
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1948	KIRI-06292
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1975	KIRI-06293
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1975	KIRI-06294
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1978?	KIRI-06295
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1972	KIRI-06301
Salicornia depressa	Virginia Glasswort	Amaranthaceae	1972	KIRI-06302

* Synonym – *Sporobolus alterniflorus*; # Synonym – *Sporobolus pumilus*; ^ Synonym – *Salicornia virginica*

world's formal herbaria (sweetgum.nybg.org/science.ih/)—over 3,500 of them. KIRI (shorthand for Kingston, Rhode Island) was founded in 1892, the same year that the name of the 2-year-old State Agricultural School was changed to the Rhode Island College of Agriculture and the Mechanic Arts (it became Rhode Island State College in 1909 and URI in 1951). An image of each of the 12,682 vascular plant specimens housed in KIRI can be found in the Consortium of Northeastern Herbaria website (neherbaria.org). After accessing the site, go to *Collections* in the Portal Menu, then scroll down and select *University of Rhode Island Herbarium*. General statistics about KIRI are provided on that linked page, but you will also be able to reach each individual specimen by selecting *Show Family Distribution* in the

yellow box at the bottom of the page. By selecting the number in parentheses adjacent to the family of the plant in which you are interested, you will be directed to the list of all individual KIRI specimens in that family. For example, after selecting the number 26 next to the family Alismataceae, you will arrive at the 26 specimens in that family housed in KIRI. Further selection of any one of those provides the detailed information associated with that specimen, including a high-resolution image of the actual herbarium sheet that was created during digitization of the entire collection.

Figure 3. The image of KIRI-03299 from the Consortium of Northeastern Herbaria digital collection (neherbaria.org).

There are gems to be found here. KIRI plant 03299 (Fig. 3) is a specimen from the family Poaceae originally identified as *Sorghum nutans*, not *Sorghastrum nutans*, Indiangrass. The specimen does key out to *Sorghum*, but it appears that the specific epithet "*nutans*" was misused. This plant was collected in Pennsylvania on 1 September 1863. Originally housed in the Herbarium of the Germantown Botanical Club, it ended up at Temple University and was later transferred to the Rhode Island College (RIC) Herbarium, and then transferred again to KIRI when RIC no longer supported an herbarium. The age and curious travels of this specimen are of interest by themselves, but the historical setting of its collection is the real eye-opener. On 1 July 1863, two months to the day before its collection, this plant was growing in the soil under the first volleys of a pivotal battle in the US Civil War—the Battle of Gettysburg.

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Contributions of Alexander Agassiz to the Natural History of Rhode Island

By STEPHEN S. HALE

Natural history studies in the US blossomed during the 19th century, when many of the marine species that live in Rhode Island were first documented and studied. When not working at his day job as the Army Corps of Engineers officer in charge of constructing Fort Adams in Newport, Joseph Totten indulged his passion for conchology (the study of mollusk shells) by taking dredge samples of the bottom sediments of Newport Harbor (Totten 1834, 1835). He identified several species new to science, including the tiny amethyst gem clam *Gemma gemma*. Joseph Leidy, a zoologist from the University of Pennsylvania who was on holiday visiting a friend in Narragansett, sampled the rocky shoreline and found and described several new species, including the polychaete worm *Naraganseta coralii* (Leidy 1855).

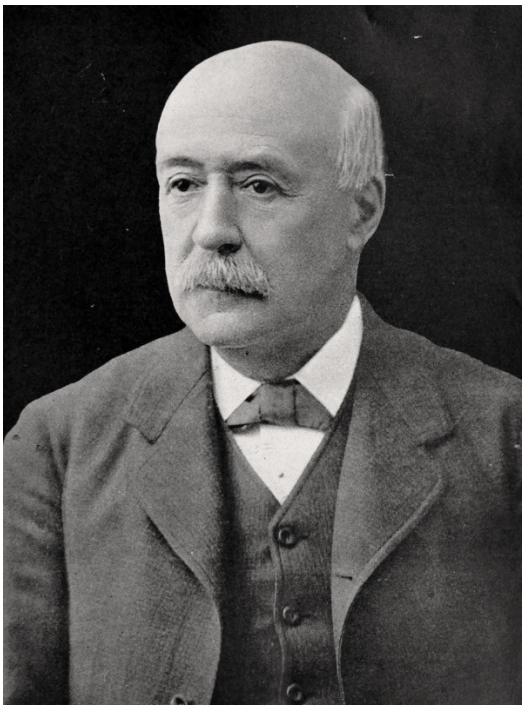

Figure 1. Alexander Agassiz (Wikimedia Commons).

But probably the most prolific marine zoologist of that period in Rhode Island was Alexander Emmanuel Rodolphe Agassiz (1835–1910) (Fig. 1), who documented and studied numerous marine species living in the state's waters. Alexander came to this naturally, as his father was the eminent biologist Louis Agassiz, founding Director of Harvard's Museum of Comparative Zoology (MCZ). In 1865, Alexander co-authored a popular account of seashore life, *Seaside Studies in Natural History,* with his stepmother Elizabeth Agassiz (Agassiz and Agassiz 1865).

In 1877, Alexander designed and built the Newport Marine Zoological Laboratory on the grounds of his summer home at Castle Hill in Newport. This was one of the first marine field stations in the US. The location at the mouth of Narragansett Bay, with cold-water boreal species and warm-water species influenced by the Gulf Stream, gives rise to an interesting diversity of marine fauna.

Agassiz described the Newport laboratory in a report he sent to *Nature* (Agassiz 1879). "Newport Island and the neighboring shores form the only rocky district in the long stretch of sandy beaches extending southward from Cape Cod—an oasis, as it were, for the abundant development of marine life along its shores." The well-appointed lab had aquaria with running seawater, reference books, and workbenches for sorting, dissection, microscope work, and illustration (Fig. 2). The microscope tables were placed on top of brick piers and arches independent of the main building so that people walking over the wooden floors of the lab would not disturb the people looking through microscopes. A windmill (later a 5-hp steam pump) brought in seawater, fresh water, and compressed air, all piped to the workbenches. A small cove behind the lab formed a natural boat harbor (Fig. 3). Mayer (1910) described the lab as an "attractive little vine-clad building nestled down on the slope of the shore, overlooking its little cove with the beautiful bay to the northward and the ocean on the south." The former lab building can be seen today on the grounds of what is now the Castle Hill Inn in Newport (Fig. 4).

Researchers used a steam launch with a trawl for collecting benthic species and bottom-dwelling fishes, and plankton nets for pelagic species. They collected with a zooplankton net from a rowboat in the cove and hand-collected specimens along the shore at low tide. Twice a day incoming tides from Rhode Island Sound brought a fresh supply of pelagic animals. In "Professor Agassiz's Laboratory" Ernest Ingersoll (Ingersoll 1883) wrote that eggs and larvae for studies of embryology and early development were taken from a surface tow "where the wandering, playful children of all sorts of sea life—fishes, mollusks univalve and bivalve, crabs and shrimps, jelly-fishes, sea-stars, urchins, worms, etc., etc.—swarm and drift in happy aimlessness."

Figure 2. Interior view of the Newport Marine Zoological Laboratory in Newport. Top: in Agassiz's time (from Popular Science Monthly, vol. 77, 1910; Wikimedia Commons). Bottom: present day (photo by the author).

Live specimens were carefully put into aquaria for further study. The well-equipped lab was able to maintain delicate, translucent siphonophores for two weeks, much longer than had been possible elsewhere. Ingersoll wrote "No mother attends to her infant with more tender and scrupulous care than the zoologist to these babies of the sea."

Figure 3. Castle Hill Cove. Top: in Agassiz's time (courtesy of the Castle Hill Inn). Bottom: present day, with the boats of the US Coast Guard Station Castle Hill in the background (photo by the author).

Agassiz had a lifelong interest in taxonomy, embryology, and early development of echinoderms (sea urchins, starfish, crinoids) and also worked on jellyfish, polychaetes, crustaceans, pelagic tunicates, and fishes. He invited graduate students and instructors from the Harvard Museum to study at the lab in summers. One student, W.E. Castle, in an article in *Science* (Castle 1893), wrote that the summer activities at the lab provided "a very paradise for the marine zoologist." He noted "Any day through the summer you may see half a dozen men here industriously bending over their microscopes, studying animals in their living form or preserving material for future study."

The lab documented numerous species that had not previously been recorded in Rhode Island. Agassiz's assistant J. Walter Fewkes published a paper on the jellyfish of Narragansett Bay (Fewkes 1881) and wrote a guide to the Coelenterata and Echinodermata of New England that drew upon specimens collected in Rhode Island (Fewkes 1891). Fewkes wrote, "For ten years I have kept watch of the medusae which appear in Narragansett Bay in summer months, and a season rarely passes in which some jelly-fish new to the known fauna is not observed" (Fewkes 1888).

The lab produced formal descriptions of species new to science, such as the new medusa genus *Hydrichthys*. Many reports describing marine animals and their life history were sent to the *Bulletin of the Museum of Comparative Zoology at Harvard College* under the heading "Studies from the Newport Marine Zoological Laboratory."

Later on in Agassiz's career, he organized and led oceanographic expeditions in the Atlantic and Pacific Oceans, continuing to make important contributions to systematics and taxonomy. (He died at sea, but it was on a passenger ship on its way from England to New York, not on a scientific expedition.) With publication of his *Revision of the Echini* (sea urchins) (Agassiz 1872–1874), Agassiz became the leading world authority on that group, and he wrote the volume on Echinoidea in the reports of the British Challenger Expedition. He published 145 papers on marine zoology, succeeded his father as MCZ Director (1874–1910), was President of the US National Academy of Sciences (1901–1907), and became one of the most prominent marine scientists of his day. Universities, learned societies, and countries around the world bestowed upon Agassiz their highest scientific honors. The influence of Alexander Agassiz on marine biology is illustrated by over 49 marine species with the honorific root "agassiz" in the species name (BEMON 2024), including *Ampelisca agassizi*, a common Rhode Island amphipod that is a tasty treat for many bottom-feeding fishes.

Figure 4. Present-day exterior of the Newport Marine Zoological Laboratory in Newport (photo by the author).

In a memorial address about Alexander Agassiz, Sir John Murray—who organized the collections and reports of the Challenger Expedition and is considered the father of modern oceanography—said Agassiz was a great man in many different spheres with a "yearning after a higher and better life [for humanity], which he held would become more attainable and more pronounced as mankind advanced in scientific knowledge" (Murray 1911).

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Marine Mammals of Rhode Island: Humpback Whale

By ROBERT D. KENNEY

Introduction and status

After the surprise appearance of a gray whale south of Nantucket this past spring, I was tempted to put off this humpback whale profile one more time. But I've done that twice already, so watch for gray whales in the Spring 2025 issue.

The humpback whale (*Megaptera novaeangliae*) was one of the species first listed as Endangered in 1970 under the Endangered Species Conservation Act of 1969. That law was replaced by the Endangered Species Act of 1973, which automatically included all species listed under the earlier law and which is still in effect. The classification applied to the entire species globally. In September 2016, the National Marine Fisheries Service published a Final Rule that re-listed humpbacks as 14 separate, identifiable, regional populations (Distinct Population Segments or DPSs in the legalese). Four of those were determined to be Endangered (Cape Verde/Northwest Africa, western North Pacific, Central America, and Arabian Sea) and one as Threatened (Mexico). The remaining nine were determined not to warrant listing at all, including the West Indies DPS that uses feeding grounds off New England. The reclassification was not without objections; the 62-page notice in the *Federal Register* included some 35 pages of responses to public comments received after the proposal was released. Humpback whales are still fully protected in the US under the Marine Mammal Protection Act.

The 2016 US listing is much more in line with the IUCN Red List, which already classified most humpback populations as Least Concern. Humpbacks are still included as Federally Endangered on the *Rare Native Animals of Rhode Island* list (Enser 2006), but that is now clearly wrong. That list has not been updated since 2006 and needs a critical review and revision.

The number of humpback whales in the North Atlantic was estimated at about 11,000 in 1992–93 by applying mark-recapture methods to the collection of photographs of known individuals (Stevick et al. 2003). That number is known to be an under-estimate and is now over 30 years old.

The population also is known to be increasing—most recently by around 3% off the US East Coast and by over 10% off Iceland and Norway. The current abundance is not well known, but a population growing at 3% doubles in 23 years (only 7 years at 10%). The North Atlantic Marine Mammal Commission's rough estimate for the entire North Atlantic of 35,000 humpback whales seems reasonable (https://nammco.no/humpback-whale/). Humpback populations do show finer-scale separation into "feeding stocks" (see the Natural History section below), and the Gulf of Maine feeding stock presently includes about 1,400 whales (Hayes et al. 2020).

Humpback whaling in the North Atlantic began in the 1600s in Bermuda and continued into the 20th century, peaking in the 19th century. Many thousands were killed, seriously depleting populations. North Atlantic humpback whaling in the 20th century was mainly from shore stations in Canada, Greenland, Iceland, the Faroe Islands, the British Isles, and Norway. Commercial humpback whaling was banned world-wide in 1966. The only North Atlantic hunting since that time has been the occasional take by subsistence hunters in West Greenland or by a small, traditional fishery that has survived in Bequia, a small island in St. Vincent and the Grenadines, West Indies. Average annual human-related mortality from the Gulf of Maine humpback stock killed by fishery entanglements and ship collisions was around 12, but increased beginning in 2016 (see the Fall 2023 issue for details of the humpback Unusual Mortality Event). Fisheries involved in humpback entanglements have included pelagic driftnets, sink gillnets, and the ropes on lobster traps (Hayes et al. 2020).

Figure 1. Illustration of a humpback whale, showing the characteristic long flippers and rounded hump in front of the dorsal fin (from http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/cetaceans/ humpback_whale_id.html; public domain).

Description

Humpback whales are probably the easiest whales to identify (Fig. 1, Jefferson et al. 1993). Adults typically range from 11 to 16 m in length. They have relatively robust bodies, but are not as rotund as right whales. The body is black, often with some amount of white on the belly. The dorsal fin can be extremely variable in shape, from small and rounded to prominent and falcate or hooked. There is a distinct, rounded hump in front of the dorsal, and a series of projections along the ridge from the dorsal fin to the tail.

Their most distinctive features are their flippers, which are very long (about a third of the body length)—the basis for their scientific name as the "big-winged New Englander." They are usually white in North Atlantic whales, with a relatively smooth trailing margin and a series of prominent bumps or tubercles (corresponding to the "knuckles" of their finger bones) on the leading margin. The shape has been shown to reduce turbulence. The Whalepower Corporation in Toronto, Ontario, Canada has been testing wind turbine blades that are similar in shape to humpback flippers (https://whalepowercorp.wordpress.com/).

A humpback's rostrum is broad and flat with a somewhat rounded tip. There are rows of rounded knobs down the center and along the edges of the rostrum and on the lower jaw, so the head looks a lot like a giant dill pickle. Each knob has a stiff sensory hair (a "whisker") in the center. There is also a prominent knob on the chin, which is covered by a clump of barnacles—acorn barnacles attached to the whale and stalked barnacles attached to the acorn barnacles (see the following article). There are also barnacles on the knuckles of the flippers, the margins of the flukes, the edges of the head, and scattered in other areas. The flukes have a deep central notch and a concave trailing edge with a ragged or serrated margin, and their underside is patterned in black and white (from all black to all white, most often black in the center and white toward the ends). The patterns are unique and can be used like fingerprints to identify individual whales.

Natural history

Humpback whales occur in all of the world's oceans, making some of the longest migrations known for any mammal between high-latitude feeding grounds and low-latitude calving and breeding grounds (Clapham 2018). North Atlantic humpbacks occur from the Caribbean Sea and Cape Verde Islands in the extreme south to as far north as Greenland, Iceland, Svalbard, and the Barents Sea. The vast majority of sightings in both the feeding and calving grounds are in nearshore and continental shelf waters, but the whales apparently migrate across deep oceanic regions.

North Atlantic feeding grounds are occupied from spring through fall, and are located in continental shelf areas.

Humpbacks show strong matrilineal habitat fidelity. A calf learns the feeding grounds from its mother during its first year, and then tends to return to the same feeding areas each year. The result is a series of "feeding stocks" that can be genetically identified via mitochondrial DNA (inherited only through mothers), with very little interchange between stocks. Separate feeding stocks have been recognized from the Gulf of Maine, Nova Scotia, Gulf of St. Lawrence, Newfoundland/Labrador, West Greenland, Iceland/Denmark Strait, and Norway, possibly with further subdivision on even finer scales.

During the winter, humpbacks from all those North Atlantic feeding grounds migrate south to calving and breeding grounds on shallow banks in the West Indies/Caribbean region, where they mix together. Because of this mixing, nuclear DNA (from both parents) shows fewer genetic differences between feeding stocks within a population. The peak calving and breeding season is during January–March, with some whales arriving as early as December and a few not leaving until June.

Within feeding ranges, humpbacks tend to aggregate at specific locations where prey is most abundant. Humpback whale habitat-use patterns and distributions on their feeding grounds change over time. The distribution of humpback whales off New England has changed from year to year, following shifts in the relative abundance of herring and sand lance, the two principal forage fish species in the Gulf of Maine. Herring and mackerel stocks were severely depleted by commercial fisheries in the 1960s and early 1970s, and sand lance populations expanded greatly in response. Humpback whales shifted from feeding mostly in the northern Gulf of Maine to concentrating in Cape Cod Bay and east of Cape Cod. In the early 1980s, sand lance populations declined and herring began to recover. Humpback and fin whales declined around Cape Cod, and were nearly absent in 1986 (see the Recent Occurrence section below for more detail).

Humpbacks are gulp-feeders like the other rorquals, but they display a much wider variety of feeding behaviors (Hain et al. 1982, 1995; Weinrich et al. 1992). They may lunge violently with the mouth open, or surface open-mouthed very slowly and gracefully. They also routinely use bubbles in feeding—either columns of large bubbles in partial or complete circles ("bubble nets," Fig. 2), or large volumes of tiny bubbles that are apparently released from the mouth rather than exhaled through the blowholes ("bubble clouds"). Some whales add tail-slaps or other vigorous splashing to the feeding behaviors. There is evidence that specific feeding behaviors are learned from the mother.

Humpbacks will probably eat anything that is small enough to swallow and in a school big enough to be worth the effort, including both krill and fish. The principal prey species in the Gulf of Maine are herring and sand lance. In the northern Gulf of Maine, krill are also important prey. Off Newfoundland a small fish called capelin is a dominant prey species, and in the mid-Atlantic they likely feed on menhaden and other fishes.

Figure 2. Aerial view of humpback whale bubble-net feeding at Stellwagen Bank off eastern Massachusetts. Two whales with their mouths wide open can be seen rising to the surface on the right side of the ring of bubbles (photo by the author).

Sexual maturity in both male and female humpback whales is reached at about 5 years of age on average, ranging from 4 to 9 years (Clapham 1996, 2018). Calving is strongly seasonal, with calves in the Northern Hemisphere born from January to March after a gestation period of about 11 or 12 months. Calves are born at about 4–5 m in length and reach 8–9 m by the time they are weaned. Calves are fully weaned at about 1 year old, but begin to feed independently while still nursing at only 5 or 6 months old. The intervals between calves are usually 2–3 years, although females occasionally give birth in successive years.

Historical occurrence

Historical occurrences of humpback whales in the southern New England region west of Massachusetts were very rare and were unknown to most early naturalists. Glover Allen's 1916 monograph (see the Fall 2020 issue) reported only one from Rhode Island, in 1836—"A note in the Providence Courier makes mention of a whale that had been seen several times off Newport, R.I., during the last of June. It was finally captured in Newport Harbor, 'north of the asylum; it measures fifty feet in length, and is of the Humpback species and is supposed to be the same which was seen off Pawtuxet on Wednesday morning last'." (The Newport Asylum for the Poor was built in 1822 on Coasters Harbor Island, which was turned over to the Navy in 1882. The

original asylum building is now the Naval War College Museum.) The only more recent historical record from southern New England was a calf stranded at Matunuck Beach in South Kingstown in June 1957.

There was one additional historical record of a humpback whale that was not included in any scientific publication or database. I was a graduate student of Prof. Howard E. Winn (1926–1995) at GSO from 1978 to 1984. It was common knowledge around the lab that a humpback had been seen in Mount Hope Bay at some time in the 1960s. A box of photographs salvaged during the cleanout of Dr. Winn's files after his death included an envelope with eight black & white prints of a humpback whale, labeled "Humpback; Bristol, R.I., 4 Nov. 1968." One image clearly showed the whale close to the Mount Hope Bridge (Fig. 3).

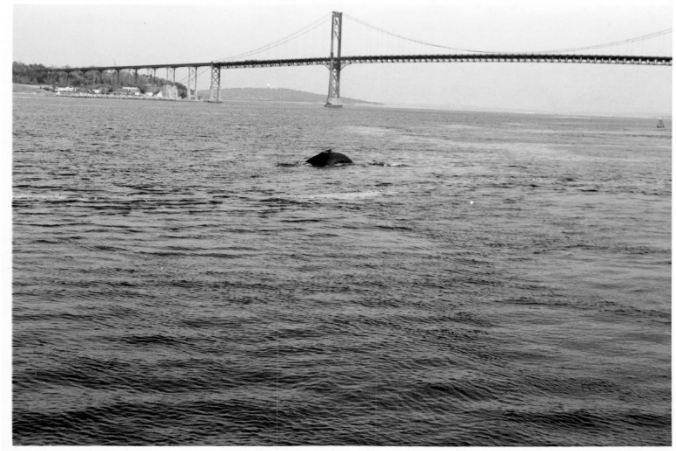


Figure 3. Humpback whale near the Mount Hope Bridge off Bristol, Rhode Island on 4 November 1968.

Recent occurrence

Humpback whales occur throughout the region in all four seasons, with many sightings from whale-watching boats concentrated south and east of Montauk in summer and late spring (Fig. 4, Kenney and Vigness-Raposa 2010). With those data, 71.2% of records assembled for the R.I. Ocean Special Area Management Plan were in the summer, 15.7% in the spring, 10.3% in the fall, and 2.6% in the winter. Without the whale-watching sightings, the seasonal differences are less dramatic and the peak season switches to the spring (45.8%), followed by summer (33.6%), fall (10.3%), and winter (9.7%). Sightings are distributed across the shelf, especially in the spring. Except for the summer concentration from the whale-watchers' data, the sightings tend to be more common in the eastern half of the area.

Humpback distributions in the Gulf of Maine have fluctuated markedly over the years, largely tracking patterns of abundance of their prey—herring, sand lance, and krill (Payne et al. 1990). In the years during the 1980s when humpbacks were scarce off Cape Cod, there were numerous humpback sightings between Long Island and Martha's Vineyard by Montauk and Galilee whale-watch boats (Kenney and Vigness-Raposa 2010). The peak year for sightings from the Montauk boat was 1987, with 63 sightings (compared with 2 in 1986 and 9 in 1988); 1987 was also the best year for the Galilee boat. In 1987, the whales targeted by the whale-watching boats slowly shifted eastward over the course of the season—from near Montauk and Block Island to near Martha's Vineyard. Sand lance populations in Cape Cod waters subsequently recovered, then went through another decline and recovery in the early 1990s, closely tracked again by whale sighting frequencies in the same area. There was similarly another increase in humpback sightings off Montauk in 1992 and 1993, and less dramatically in 1994 and 1991.

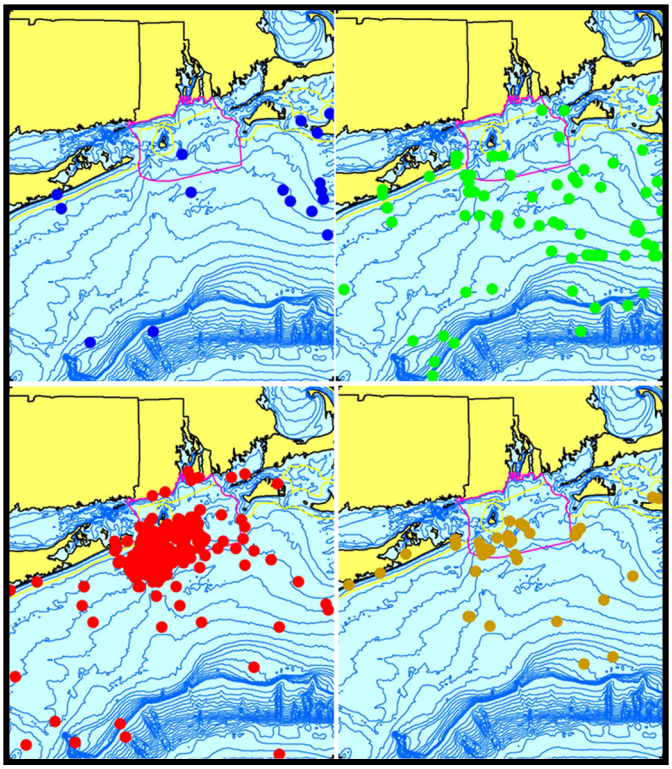


Figure 4. All records of humpback whales in the Rhode Island study area, 1608–2007 (n = 611): winter (blue symbols) = 16, spring (green) = 96, summer (red) = 435, fall (brown) = 63, unknown (not mapped) = 1) (from Kenney and Vigness-Raposa 2010).

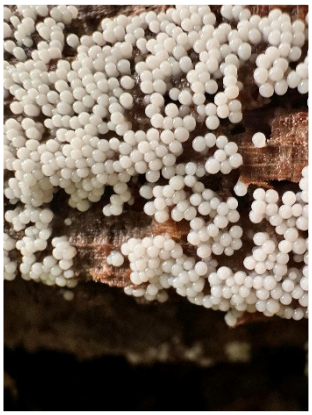
After an absence in the Rhode Island stranding record for more than 40 years since 1957, from 2001 through August 2024 there have been 21 dead humpback whales washed up in southern Rhode Island or on Block Island, or found floating dead nearby (the repository of stranding data for the

(continued on page 14)

BioBlitz 2024 at Norman Bird Sanctuary:

The Blitzers & the Blitzed



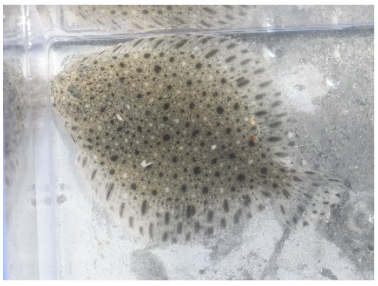














Photos contributed by Karen Beck, Dan Berard, chickenparmesan24*, George Christie, Dave Clayton, David Gregg, Melissa Guillet, Ray Hartenstine, Peter Lacoture, landarch202*, Karen Lee, Doug McGovern, Paul Miller, rayray*, Rick Rego, Alison Schwartz, Deana Thomas, Dann Thombs, Elise Torello, Jane Waters (*iNaturalist user name). See also the essay on p. 19.

Humpback Whales (continued from page 11)

Northeast is maintained at the Greater Atlantic Regional Fisheries Office of the National Marine Fisheries Service in Gloucester, Massachusetts). The increase over historical numbers is probably related to the growing population (see the Fall 2023 *Rhode Island Naturalist* for detailed discussion of increased humpback mortality). The average for the 24-year period was less than one stranding per year, 11 years had none, and there were 6 years with more than one—2001 (2), 2009 (2), 2016 (2), 2017 (2), 2022 (3), and 2023 (2). There may be an increase in detections of floating carcasses offshore, which is probably related to increased frequency of surveys surrounding wind farm development.

It is difficult to tease out patterns with such sparse data, but over the longer term and looking at the broader region, the data suggest that the occasional peaks of humpback deaths correspond to the years of peak abundance in southern New England/mid-Atlantic region. Those, in turn, are likely related to cycles of prey abundance over the entire feeding range of the Gulf of Maine stock. Unfortunately, we no longer have regular whale-watching records in the region after 1996, so it is not possible to do any detailed comparisons over the full time span. Furthermore, focusing on short-term changes in one locality without looking at what is occurring across the entire range of the stock is not the wisest course. A humpback whale could easily swim from the Bay of Fundy to Rhode Island Sound in only a few days, so changes in the numbers of whales locally (up or down) actually might reflect changes in their habitats elsewhere. It would be much better to focus on reducing human-caused mortality from the two sources where we have the capability to do so—entanglement in fishing gear and ship collisions.

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A Barnacle Stranding at Block Island

By ROBERT D. KENNEY

Wait a minute. Who cares about barnacles washing up on a beach? Isn't the beach where barnacles are supposed to be? But what if they're attached to a whale? Everyone gets excited about a dead whale on the beach, but sometimes it's the smaller things that few people even notice that can be the most interesting.

On Easter Sunday in 2016, a dead humpback whale was discovered on a rocky beach near Clay Head on Block Island (Fig. 1). Island resident and naturalist Kim Gaffett (an RINHS board member at the time) went to check it out. It was a relatively small animal, estimated at 6–8 meters long (which would make it a calf or maybe a yearling). But her naturalist's curiosity led her to look at more than just another stinky whale carcass. She noticed other animals that were attached to the corners of the whale's tail. They appeared to be barnacles, relatively large ones. And it looked like there were two different kinds—one a typical "acorn" barnacle entirely encased in a hard shell and the other a "gooseneck" barnacle with an elongated, fleshy stalk. So she took a picture of them and emailed it to me with questions (Fig. 2).

Figure 1. Dead humpback whale on the beach below Clay Head on Block Island on 27 March 2016 (photo by Kim Gaffett, The Nature Conservancy).

Kim was right—there *were* two species of barnacles. But only one was growing on the whale; the other was attached to the first kind of barnacles. *Coronula diadema* is an acorn barnacle that normally only occurs on humpback whales, hence the common name of "humpback whale barnacle." The occasional appearances on other whales are believed to be due to hanging around with humpbacks. They would be the hard, white, hexagonal barnacles in Fig. 2. They get a lot bigger than the barnacles we see on the rocks along the shore, sometimes over 7–8 cm across. The other species is *Conchoderma auritum*, the "rabbit-ear barnacle," and it only grows attached to *Coronula diadema*. In the gooseneck barnacles, the hard shells can be smaller and almost invisible in some species, although they can be partially seen as paired white structures in Fig. 2. Figure 3 shows a preserved specimen of *Coronula* with several attached *Conchoderma*. Since the fleshy parts of the rabbit-ear barnacles have not gotten all dried out from exposure to the air, the embedded shells cannot be seen at all.

Figure 2. A cluster of barnacles from the tail of the whale in Figure 1 (photo by Kim Gaffett).

Figure 3. Preserved specimens of a humpback whale barnacle and several attached rabbit-ear barnacles from Sitka, Alaska (photo by Paul Norwood; Natural History of Southeast Alaska; wiki.seaknature.org/File:Conchoderma_auritum.jpg; used under Creative Commons license).

Barnacles have always interested zoologists, and more than 1,200 species are recognized. Charles Darwin spent years studying barnacles and published four volumes on them between 1851 and 1854 (two on living species and two on fossil forms). They were long misclassified as mollusks because of the calcareous outer structures, but they are in fact crustaceans—related to lobsters, crabs, and shrimp. The barnacles comprise a separate group of crustaceans known as Cirripedia (literally, "hairy-footed"). Their legs are covered with tiny hairs that serve to filter small food particles from the water as the long, jointed legs are uncurled through the opening in the shell and then swept through the water. A barnacle was called "nothing more than a little shrimp-like animal standing on its head in a limestone house and kicking food into its mouth" by Louis Agassiz, 19th century zoologist and founder of the Museum of Comparative Zoology at Harvard (and if I trace back through six generations of graduate advisors, my academic "ancestor").

Figure 4 is an illustration of several *Conchoderma* attached to one *Coronula*, showing the long, feathery, multi-jointed legs of each of the gooseneck barnacles extended for feeding.

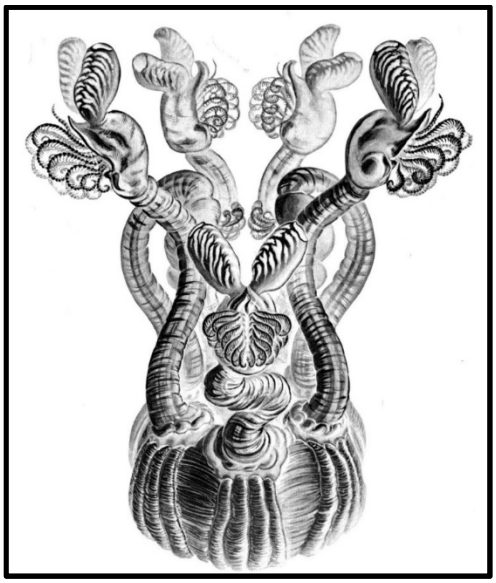

Figure 4. Illustration of a humpback whale barnacle with multiple attached rabbit-ear barnacles, showing the legs of the latter extended for feeding (taken from one part of plate 57 of "Kunstformen der Natur," by Ernst Haeckel, 1904, Verlag des Bibliographischen Institut, Leipzig and Vienna; the original illustration was white on a black background, but photo software was used to reverse the image to better show the details).

You might be asking yourself, how does a barnacle get onto a whale? Or why? A number of barnacle species have evolved to be specialists—living only attached to another organism, including whales, sea turtles, mollusks, crustaceans, corals, and sea snakes. They are not true parasites, since there is no real harm done to the host animal. This sort of relationship is called commensalism—where one species gets a real benefit (the humpback whale barnacle gets a place to live and free transportation to lots of areas where there might be good food resources) while for the other it's essentially neutral.

All barnacles go through a similar life history. Most species are hermaphrodites, simultaneously male and female. Every barnacle can mate with every one of its neighbors that is within reach of its elongated penis. The fertilized egg hatches into a small larval stage called a nauplius, which is released into the water. The nauplii feed on tiny plankton, grow, and molt into larger nauplii. After six naupliar stages, they molt into non-feeding larval stages called cyprids. It is the cyprid that seeks out the appropriate substrate for settlement. A pair of Japanese researchers published a neat study in 2006, where they raised *Coronula* nauplii in the laboratory, and found that the cyprids would only settle in petri dishes with small bits of humpback whale skin. There is likely some chemical cue that each species of barnacle uses to identify the appropriate settlement location.

Since the nauplii spend a couple of weeks swimming around on their own before settling down on the whale, the process works best when and where the whales are aggregated. For North Atlantic humpback whales, animals from multiple feeding grounds gather in the winter on shallow banks off the West Indies for calving and breeding (see the preceding article). That is also the season for barnacle reproduction.

Once the cyprid settles on the whale, it moves around until it finds a good spot. They appear to select places where there will be good current flows, like the head, the flippers, and the tail. It metamorphoses into a juvenile, attaches, and begins to secrete six plates of calcium carbonate that will become the "house." The walls of the shell have hollow spaces in them, and the whale's skin grows into those spaces, which attaches the barnacle very firmly. In Fig. 2, the triplets of black spots around the rim of each shell are the tips of small fingers of whale skin growing up through the hollow spaces in the wall, visible where the outer part of the shell has worn away. In the lower right, one shell is broken, showing the entire lengths of those whale skin segments inside the wall of the shell.

Figure 5. The head of a humpback whale photographed in the spring in the Gulf of Maine, showing that year's crop of small *Coronula diadema* barnacles and lots of scars from larger individuals from the previous years (photo by the author).

Oddly enough, the barnacles appear to go through that entire life cycle every year. Some of them get torn off during aggressive encounters with other whales, especially for adult males. But apparently most or even all of a whale's barnacles (which might weigh half a ton all together) die and fall off during the winter in the tropics. The underlying cause is not known—it could be a genetically programmed life span or some environmental factor like lack of food or

warm temperatures. The result is whales returning to their feeding grounds in the spring with a new crop of small barnacles and a collection of larger circular scars from the ones that came off (Fig. 5).

Humpback whales have barnacles attached to their skin, and those barnacles have other barnacles attached to them in turn. It would not be a surprise to find that the rabbit-ear barnacles have some other commensals of their own. As Jonathan Swift put it in 1733:

> So, naturalists observe, a flea
> Hath smaller fleas that on him prey;
> And these have smaller still to bite 'em,
> And so proceed ad infinitum.

This article was originally published as a "Rhode Island Naturalist" blog on the Survey website in 2016.

Executive Director's Journal: The Blue Dasher Swarm of 2024

By DAVID W. GREGG

I visited Block Island on Friday, July 26, for Moth Night, an event organized every summer by The Nature Conservancy naturalist and former Survey president Kim Gaffett. While we were setting up the moth light and sheet, Nigel Grindley, a local amateur entomologist and Survey member, told me about a strange phenomenon he'd just seen: a huge swarm of dragonflies had come ashore on Block Island from the northwest. Having made a study of Odonata (dragonflies and damselflies), Nigel was able to tell me this swarm was composed mostly, if not entirely, of blue dashers (*Pachydiplax longipennis*), a medium-small species and one of the most widespread and numerous dragonflies in our area. As we waited for darkness and moths, we were able to watch a lingering cloud of blue dashers chase mosquitos and each other around a small yard. After a terrific night watching moths with some two dozen islanders, and identifying nearly 100 species, I boarded the ferry the next morning blissfully unaware of the entomological tempest I was headed back into.

Saturday afternoon, back on the mainland and a bit sleepy from mothing, I checked my email and found a note from Dan Cole, Napatree Point Conservation Area Manager. He said thousands of dragonflies had just been seen swarming over Napatree Point in Westerly. He was asking if the swarm was, in fact, blue dashers, even though the species is not typically part of odonate migration swarms seen on our coastal barrier beaches. Furthermore, it was about a month too early for seasonal migration swarms associated with Odonata such as green darners (*Anax junius*). If they are blue dashers, he asked, how could I account for this extraordinary occurrence?

Having been unknowingly primed by Nigel, it only took a quick look at the pictures Dan sent to confirm most if not all of the swarm consisted of blue dashers. Other photos and videos on social media also showed almost entirely blue dashers. It was off to the Survey's reference library to see what the books said about this species' occurrence and behavior.

The blue dasher swarm at Napatree Point (photo by Dan Cole).

Blue dashers are one of the most common and widespread dragonflies in the US, occurring between northern Mexico and southern Canada and east of the Rockies. Virginia Brown, in her Rhode Island Odonata Atlas project, found that among the 138 Odonata species documented in Rhode Island, blue dashers are one of the most common . . . one of only 8 dragonflies and 3 damselflies to have been found in all 39 cities and towns. In her 2020 book *Dragonflies and Damselflies of Rhode Island*, Brown notes the blue dasher's wide habitat tolerance, "Blue dashers are found in a great variety of habitats including ponds with dense vegetation, lakes and reservoirs, impoundments, bogs, fens, temporary pools, swamps, and slow-moving rivers. They have been reported from pristine ponds and wetlands as well as eutrophic or otherwise degraded sites" (p. 344). Although tied to waterbodies for breeding and maturation, once adults emerge from their natal ponds, they can be found foraging across many terrestrial habitats, typically small open spaces, such as yards, surrounded by vegetation.

Whether at pond edges or the edges of yards, blue dashers are known for territoriality. Many dragonflies will defend a territory, taking up conspicuous perches and flying out to

defend mates or food from other odonates, but blue dashers are known for being especially energetic and feisty, all the more so considering their moderate size. I exchanged emails with Brown, who calls this species "spunky" and she confirmed the details of the blue dasher's life cycle and my working hypothesis that this was no migration.

Blue dasher male (photo by Jimmy Smith, Flickr).

Thinking about the blue dasher's flexibility in habitat along with remarkable territoriality, I began to get a hunch about how to answer Dan's question about the meaning of the Napatree swarm. Still thinking this was a curious but isolated incident, I pursued my hunch by reading some scientific papers on dragonfly swarm behavior. One I found particularly informative—Baines et al. (2020).* This paper is largely a mathematical exercise to model swarming behavior in insects, but the blue dasher itself was one of the authors' reference species. The gist of the study was that among territorial insects, as the season goes along and the population density goes up, the urge to swarm (that is to leave the natal pool in search of better habitat) goes up, but the fitness for any such journey goes down due to food scarcity and stress. When the lines cross, any individual is most likely to move. When the slopes of the intersecting population and stress lines are steep, a swarm is most likely.

In a good year, blue dashers can be extremely abundant, which for a territorial species would already make for a tight situation in the habitats they prefer. But then when the hot summer weather hits and starts to dry up pools and ponds, or the mosquitos start to run out in a certain area, there's even less space for the dragonflies to "sort out their differences" with each other. Once a few reach their breaking point and head off in search of better habitat, they probably push others to move, and those push more, and so on, and pretty soon it's a cascade. This can be more or less abrupt depending on how the emergence of adults is timed and how fast the suitable habitat is declining. If an especially good spring for blue dashers came to an especially abrupt end, it might account for extraordinary swarms.

The wave of blue dashers piled up when they reached the coast. There are sand-dune and salt-pond types of dragonflies, but blue dashers aren't one of them, so they will keep moving, looking for suitable habitat. The swarms only lasted a few minutes, consistent with insects that are there for incidental reasons and still moving.

The swarms would not be migrations, then. The typical migratory species in our area is the green darner, and they are usually seen on barrier beaches such as Napatree Point. There's another species known for long-range mass

Blue dasher female (photo by the author).

*Baines, C.B., J.M.J. Travis, S.J. McCauley, and G. Bocedi. 2020. Negative density-dependent dispersal emerges from the joint evolution of density- and body condition-dependent dispersal strategies. *Evolution* 74(10):2238–2249. https://www.jstor.org/stable/48594866.

movements, the wandering glider (*Pantala flavescens*), which is actually a global species that undertakes trans-oceanic migrations, most famously between India and East Africa. A huge swarm was blown onto Block Island after Hurricane Henri in August 2021.* Nor was the blue dasher phenomenon a feeding aggregation—sometimes seen in certain Odonata species. Rather these swarms are probably dispersals, perhaps similar to wintertime irruptions seen among boreal finches.

By Sunday the blue dasher swarm had blown up, as they say. Not only had it manifested on Block Island and at Napatree, thousands had covered Misquamicut Beach and thousands performed at the Newport Folk Festival, dragonflies dancing with music fans on the lawn at Fort Adams. Videos appeared on social media and the phone calls and emails began. Reporters calling their usual natural history sources, such as at URI, ecoRI, or RIDEM, were also referred to the Natural History Survey for explanation and comment. On Sunday and Monday we spoke to USA Today (includes the Providence Journal), WJAR, ABC6, Boston channels 5 and 7, the Boston Globe, the URI Public Information Officer, and even the Washington Post. The Providence FOX affiliate, WPRI, sent a reporter down to the Survey office to interview me. The WPRI story got picked up by FOX affiliates nationwide, and by midday Monday the Survey was being cited in Georgia, Pennsylvania, Tennessee, Michigan, Alabama, Minnesota, and elsewhere. Later in the week, a producer for the BBC Natural History Unit contacted us asking for advice on where to go to film dragonfly swarms for their Hidden Planet documentary.

The focus of all this public interest is instructive. Much of the questioning was directed at explaining the swarm. Many people already knew that dragonflies could be migratory (which is great) and assumed this was a migration. When told it was not, they were curious about what else in a dragonfly's life could create such swarms, and this opened the door to talk about other ecological concepts such as habitat and territoriality. There was also a lot of concern for these dragonflies and dragonflies generally. Was this swarm a sign of something wrong? One more instability brought on by climate change? Was there anything we should do to help the dragonflies? On the opposite end of the spectrum, some reporters decided to lead with their entomophobia, saying they'd run away if they saw such a swarm. Was there something that could be done to control or manage the dragonflies? My answer to all this was the same: these are dragonflies doing what dragonflies do.

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*Gregg, D. 2022. A delicate departure: Bugs and insects take flight. *Watch Hill Conservator* 11(3):7.

Just marvel at their colors and flying ability. They will sort themselves out. They don't sting or bite, and the worst thing that could happen is they eat up all your mosquitos.

It is part of the Survey's mission to encourage you to observe your surroundings, be curious about what you see, and share your observations with others. We also cultivate networks and gather resources to provide information about the natural world to all those who can use it. The swarm of blue dasher dragonflies that swept over Rhode Island's coastline on July 26 and 27 was a particularly dramatic natural historical phenomenon, in high visibility places, with a particularly charismatic organism, and it garnered a lot of public interest.

*The Survey's Executive Director **David Gregg** is celebrating his 20th anniversary in the position, and he was a Board member for two years before that. Although his professional training is in archaeology, he has been an avocational entomologist since he was a boy.*

Blue dasher (photo by John Flannery, from Wikimedia Commons)

Essay: Confessions of a First-time BioBlitzer

By KAREN LEE

What was Rhode Island 2024 BioBlitz at Norman Bird Sanctuary? I imagine there are as many answers to that question as there were identifiable species found, 1,396. Or at least 389, the number of volunteer participants, who came from far and wide, experts and amateurs—all enthusiastic about the diversity of lifeforms to be found when you slow down and take the time to look closely. BioBlitz was 24 hours, from 2 PM Friday to 2 PM Saturday, of finding and identifying any and all species in the 300-acre preserve,

(Rick Rego)

from the ospreys majestically flying overhead to those colonies of single-celled organisms that are most often mistaken for evidence of a poorly digested meal regurgitated by some mammal.

Basically, I like, even love, every living creature, including protozoans like the well-named dog vomit slime mold. And I am not afraid of any organisms, even the big ones with fearsome claws and teeth, or poison ivy. I know how to be sensible and avoid confrontation.

But ticks? Egads! I hate those little %$#@! I should be more sympathetic, and really place the blame on *Borrelia burgdorferi*, the spiral-shaped bacterium they carry from host to host. But 20 years ago I got a stealth bite while doing a street tree survey in Providence. The resulting infection went undiagnosed for a full year and I got very ill. Whether others like it or not, I am an evangelist for the First Commandment of meandering the woods and fields—"Don't get bit by a tick!"

Nature is like that though; every organism is involved in its own battle to survive. Ticks simply must have blood to go through their life stages, and the spirochetes inside them are just cleverly taking advantage of this fact.

Plants are the only ones that aren't, by and large, involved in eating other species, even if they do compete among themselves. They are the miracle workers that make life possible; they "eat" sunlight and carbon dioxide through the magic (chemistry) of photosynthesis and in the process produce enough carbohydrates and oxygen to keep most everything else on the planet alive.

On the opposite end of the spectrum are the carnivores and omnivores. One of the biggest of these during BioBlitz was a huge snapping turtle. I didn't get to see it in person, but enjoyed looking at the photo of the expert turtle wrangler holding it by the sides of its shell, with the bitey end aimed in the opposite direction from his own tender bits. A wise move.

Common snapping turtle, *Chelydra serpentina* (by Rick Rego)

BioBlitz is 24 hours of hanging out with people who like to find creatures, large or small, then identify, document, and talk about them. In other words, I was with my people. I don't have many people I can ask about things such as what their favorite fungus is, or just exactly how to tell the difference between a red oak and all the other oaks. I get more takers on question #1.

Identifying oak trees is harder than you'd think, especially since they hybridize. I surmise it comes down to observing tiny details that vary depending on the season: in summer—the absence or presence, location, and color of stellate hairs on the undersides of the leaves; in autumn—the shape and characteristics of acorns that still have their caps on; and in winter—the scale patterns of the buds on the terminal twigs.

See? Either you are bored already, or curious, or perhaps have formed an opinion about my interests that places me in the category of the "odd" people. But if this, or trapping moths or mammals, netting butterflies or beetles, or mucking about looking for crabs—if any of that piques your interest, then know one fact for certain. BioBlitz is where you belong.

My time at BioBlitz was spent for the most part with the lichen team, mainly because they were going at a suitable speed for me. After a prolonged illness, I am just beginning to be able to walk any distance at all, albeit with a rollator. So a 20-yard stroll to a rock wall, followed by 30 minutes of staring at the lichens on the wall with fancy loupes loaned by the RISD Nature Lab, was perfect. On day one our team walked a mile and a half in 3 hours. My pace. A slow amble

with the lichen team leaders taught me enough about lichens to realize how little I knew about them. We saw the bushy beard lichen, the bright orange sunburst lichen, the rock shield lichen, dust lichens, and many other species.

Xanthoria parietina, Common sunburst lichen (all photos by the author unless noted otherwise)

There were bonus species for the slow examiners of trees and rock walls. Near the old cemetery we also found a wolf spider, carrying her egg sac, an arachnid with maternal behavior! And, let me just say, the walls were lousy with rough-backed wood lice—oddly not an insect, but rather a crustacean like lobsters, crabs, and their kin. I love learning things I didn't know!

On day two the lichen team stuck close to the huge party tent, or rather Science Central, where I table-hopped to visit with the various teams. I visited with the moss people staring at mosses under the microscope, apparently the only way to distinguish species. I do appreciate mosses and love nothing more than getting down on my belly to take a macro photo of their fantastical fruiting bodies, but after glancing at the three encyclopedic texts the team needed to assist in the identification, I decided . . . maybe next year.

Then I stopped by the moth team's table where I found an older man and an adolescent pinning moths to boards for preservation. I asked the younger person why they liked moths. The answer—"Pinning moths is the most relaxing thing I know of." There is something for everyone.

Pinning moths is relaxing.

I asked one of the fungi team about his favorite mushroom, mentioning that mine was the indigo milk cap, which when cut open is white, but turns deep indigo in 3 seconds. After sorting through a huge number of photos on his phone, he showed off some of huge, edible, and tasty morels found elsewhere. I asked what the total number of photos were in his library, and he said, about 300,000. I felt better then about my species photo obsessions. I'm a mere piker with only 26,000, after extensive deletions. The fungi team had all their finds sorted out on their table. I was lucky enough to witness the "reveal party" of the spore prints from mushrooms left overnight on paper plates, showing starburst patterns of black, rust, brown, and white.

Checking the spore prints.

The vascular plant team, which was large, was completely silent in concentration, sorting out grasses, while reading long identification keys—pages of text that require choosing one characteristic of the plant over others. I didn't dare interrupt their concentration. Last year I spent that kind of time sorting out the six identifiable oak tree species of Lincoln Woods, and knew the kind of focus that is required to get into the weeds, so to speak.

I have to admit that my favorite team was the team of Navy Newport scientists who were field testing a device that can detect, magnify, and digitize the textures of anything. It looks like a microphone, with a rubbery membrane on the end. They showed me a finely detailed image of a dragonfly's veined wings.

The lichen team leader, Kay Hurley, was teaching pretty much non-stop for two days and blew my mind. She was mostly talking in Latin about the crustose, fruticose, and foliose forms (what I call crusty, fluffy, and leafy lichens). By the time we got into the Latin names for the various structural parts, I decided I'd have to learn those later, and keep it simple by saying things like "little cup," and "tiny pink lollipop." Kay said that was fine by her.

Usnea strigosa, Bushy beard lichen.

She patiently explained that lichens are fungi who have encapsulated algae inside, in a mutually beneficial relationship—trading protection for food. She gave a 15-minute lesson in their means of reproduction, which makes it seem a miracle that they exist at all. Given that they break down rocks and make soil, they are in fact the reason plants were able to move from the sea to the land, and plants are the reason I get to eat and breathe. So lichens deserve my respect.

However, I wasn't really hooked on lichenology until she took out her 365-nanometer ultraviolet flashlight, with the brand name of "uvBeast." She shone it on a rather flat, nondescript, pale olive, crustose lichen and it lit up with neon blue bumps. I am delighted to realize that there are still new things to see and learn—with the right equipment.

A lichen glowing neon blue under UV light.

Thus, having earned my fascination, it came to pass that I asked her what the best books were for lichen learning, and rather than recommending her own book, *Lichenpedia: A Brief Compendium*, she recommended *Macrolichens of New England*, by James and Patricia Hinds, a compendium of 30 years of field work in which they identify about 900 species of lichens in New England. I wanted this book, and I wanted the uvBeast, but when I got home to the internet, I found that I had to choose. The uvBeast costs $60, but the book on Amazon was going for $160, and used on Abe Books for $90 with $25 shipping from England. Thus, when I found it for $60 from the New York Botanical Garden, I jumped, and explained to my husband . . . later. Maybe I'll ask Santa for a uvBeast this year.

The best part of BioBlitz? The people. I had fun the whole time, and met lots of interesting people—both generalists like myself and specialists like the people who have been studying freshwater turtles for more than 30 years. There was lots to talk about, and the Friday night dinner was good. I hear the opossums raided the dessert table later that night. And I realize now, even with all my table-hopping at Science Central, that I've only touched the surface of the Rhode Island BioBlitz, and can't wait to return next year and discover more.

Karen Lee *meanders the wild places, senses open, slowing down, entering awe, and shedding notions of separation from the web of life. She works one-on-one as a yoga therapist specializing in trauma recovery. You can read her blog at https://providenceferal.wordpress.com.*

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The **Rhode Island Natural History Survey** is a nonprofit organization dedicated to **Ecosystem Resilience Through Biodiversity**

Our Mission

To promote ecosystem resilience, the Rhode Island Natural History Survey collects, organizes, and disseminates information on the State's biodiversity and ecosystems. We engage curious observers of all ages—professionals and amateurs, scientists and artists—in field-based experiences that build connections to science, conservation, and the natural world.

Our Vision

To prompt a sense of wonder that inspires people to value and protect biodiversity through a deeper understanding of the world around us.

Notices

Natural History Week: November 16th–24th. Two events are already scheduled. Watch our *News to Use* email newsletter for more details and registration.

- The week will kick off on Saturday the 16th with our 30th Anniversary Gala at the Quonset O Club in North Kingstown. This can't-miss evening will feature presentation of this year's Distinguished Naturalist, Founders', and Golden Eye Awards; roll-out of our five-year Strategic Plan; heavy hors d'oeuvres; cash bar; raffle and silent auction; and socializing with old friends and new acquaintances.

- The Lisa Lofland Gould Native Plant Program is scheduled for Saturday, November 23rd at 3:00 PM in Gaige Hall Auditorium on the Rhode Island College campus. Co-hosted by RINHS, Rhode Island Wild Plant Society, URI Continuing Education Center, and the RIC Environmental Club, the two-part program will feature an overview of the newly created Plant Insect Community Network, and an introduction to the regenerative land stewardship being undertaken by the Ocean Hour Farm in Newport.

Save the Date—Annual Open House and Natural History Art Exhibit: Tuesday, January 21st (weather date the 22nd), 5:00–7:30 PM, at our offices in Building 14 on URI's East Farm. If you are interested in submitting nature related artwork for consideration, contact Kira Stillwell kstillwell@rinhs.org.

Save the Date—2025 Rhode Island Nature Video Festival: Sunday, February 23rd (weather date March 2nd), starting at 3:00 PM, Rhode Island College. Start working on your submission now! You can warm up in advance by watching the complete reels from the previous years on our YouTube channel—rinaturalhistory.

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