41°N

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CAGE FIGHT

OYSTER GROWERS WORK THROUGH THE PATH OF LEASE RESISTANCE

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41°N

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COPING WITH CRISIS

DEAR READERS,

We hope this issue of *41°N* finds you well—and still interested in Rhode Island's ocean and coastal news! It was written before the COVID-19 crisis was fully understood, and as we approached going to press, we wondered how Jennifer Scappatura, the face of our cover story, was faring.

Ellen Liberman followed up with Scappatura in mid-April, and found her, thankfully, still in operation:

"Quonnie Oyster is in a good position because we are small and don't have all the overhead," Scappatura said. "Our website will sell our own silkscreen t-shirts/hoodies and other oyster home products, such as platters and shucking knives. In addition, we will be teaching—people need to become familiar with ways to cook oysters and shuck them too. Quonnie Oyster is also adjusting to the pandemic by starting home deliveries grouped with other local land farmers. We are working on a 'meal-in-a-box' concept with recipes and a link on our website. We are seeking approvals from the state Department of Health so that we can supply oysters to nonprofits that need food, like homeless shelters. This crisis has bonded the farmers and although stressful at times, it has brought us all closer to help each other keep our industry going. Ironically, it's a great time for local food."

I want to thank all our writers, photographers, editorial team, and art director for all they do to capture and tell Rhode Island's ocean and coastal stories. Their efforts are always appreciated, but even more so in this uncertain and difficult time. And I want you, our readers, to know that we are committed to working over the summer to bring you another edition of *41°N* in the fall. See you then!

—MONICA ALLARD COX
Editor

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Climate migrants altering marine communities

by **Todd McLeish**

Photographs by **Jesse Burke**

"WE STILL HAVE THE SAME CAST OF CHARACTERS ... BUT THEIR ROLES HAVE CHANGED"

AS HEATHER KINNEY ZIGZAGGED ACROSS UPPER Narragansett Bay in her Nature Conservancy workboat last fall, she stopped at 12 sites within 100 yards of shore to check the fish traps she had set four days before. The traps—small eel pots and others similar to lobster traps—were deployed to assess the abundance and diversity of fish that spend at least part of the year in the upper bay from Rocky Point in Warwick to Watchemocket Cove in East Providence.

"When the Narragansett Bay Commission reduced the nitrogen output of its wastewater plants by 50%, there was no record of how that affected the fish population," says Kinney, The Nature Conservancy's coastal restoration science technician. "There was anecdotal evidence that more fish were coming into the area, but no one was quantifying it. We want to see what the juvenile fish population is up here."

While she has been somewhat surprised by the abundance of fish she found in her traps, it quickly became obvious that reduced nitrogen levels could not completely account for the fish she was catching. It was especially noticeable when she pulled up the eel traps, which caught large numbers of juvenile fish just a few inches long. Most of the fish in the traps—sometimes 30 or 40 or more at a time—were young scup and black sea bass, two species that have grown in abundance in Rhode Island waters in recent years. Both prefer warmer water.

The abundance of those two species, according to Kinney and other scientists, is a signal of the changing climate.

The temperature in Narragansett Bay has increased by nearly 3 degrees Fahrenheit since the 1960s, which has made the water more hospitable to an increasing number of fish species and marine invertebrates that were intolerant of the bay's previously cooler water. While scup and black sea bass have been found in Narragansett Bay in small numbers for many decades, they are now among the dominant species in the region for much of the year.

"Fish and other marine species are very closely tied to their environment, to a specific range of temperatures and productivity," says Anna Mercer, chief of the Cooperative Research Branch of the National Oceanic and Atmospheric Administration's Northeast Fisheries Science Center in Narragansett. "As climate has changed, those conditions and where they're occurring have altered—warmer waters are extending farther north, pushing cooler waters offshore or even farther north. So that intimate connection between fish and

Oceanographer Jeremy Collie says warming waters are altering Narragansett Bay's food web.

their environment has forced them to shift their location to stay in the environment they are adapted to live in."

Black sea bass is a prime example of species that scientists are calling "climate migrants," those that have shifted their range northward due to the warming waters and other factors driven by the changing climate. Mercer says that black sea bass have traditionally been found in the waters of the mid-Atlantic states. The bulk of the commercial fishery for the species is in the Carolinas, Virginia, and Maryland. But now they are common in Rhode Island waters.

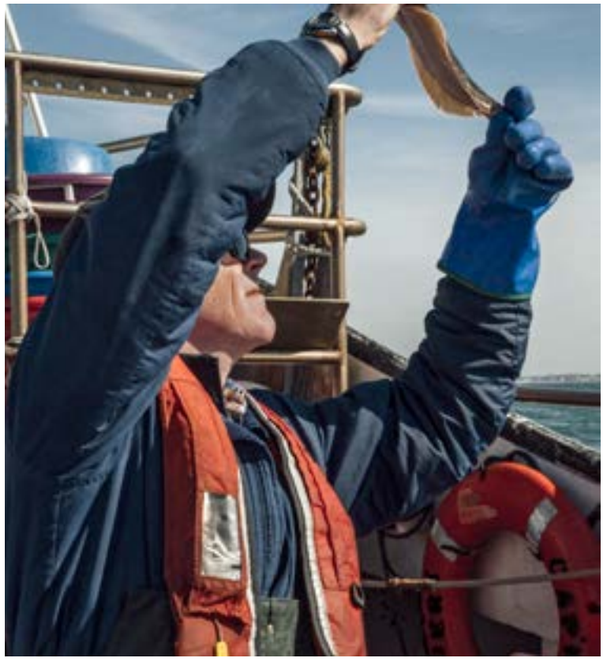
"The reason so many people are talking about black sea bass is because they're prevalent and visible. Temperatures have become more hospitable for them here," says Jeremy Collie, a professor of oceanography at the University of Rhode Island's Graduate School of Oceanography who studies the changing fish populations in the region. "Recreational anglers, when they throw their hook in the water, they often come up with black sea bass whether they're trying to catch them or not. They're plentiful in trawl fisheries, too."

Collie manages a weekly fish trawl research project at two locations in Narragansett Bay that has been taking place for 60 years, the results of which illustrate how the fish community in the bay has changed as the water temperature has increased. When the study began in 1959, the dominant species captured were cold-water fish like winter flounder, cunner, and hake. Now scup, butterfish, and other warm-water species are predominant.

"For the most part, we still have the same cast of characters in the bay, but their roles have changed," Collie says. "Winter flounder was at the top of the bill back in the 60s and early 70s, and now it's just a bit player. When you look at the phenology, the timing of when species come and go, the northern species are spending less time here, and the southern species are arriving earlier and departing later."

The changing abundance and species composition of marine life in the bay is triggering other changes as well. Collie points to striped sea robin as a climate migrant that is having a significant impact on the marine environment. It was quite rare in the early days of the fish trawl project, and some years it wasn't caught at all. But in recent years it has been recorded in Narragansett Bay more than 200 days per year.

"They just fly over the bottom and vacuum up everything in their path, including juvenile lobsters and flounder," Collie says. "Their thermal habitat has expanded, and now they're having an ecological impact on the food web of the bay."



The decline of lobsters in Rhode Island waters due to their intolerance for warming waters has triggered another kind of change. According to Collie, lobsters prefer water temperatures of about 61 degrees Fahrenheit, with 68 being their upper limit. But since Narragansett Bay usually warms above 68 in the summer, lobsters have declined precipitously in the bay and are now predominantly found in the Gulf of Maine and in deep, offshore waters where they find refuge from the warmth. Their decline has corresponded with an increase in Jonah crabs.

"Jonah crabs are a [northern] species, so there's no reason they wouldn't have been here all along, but maybe they've benefitted from fewer lobsters," Collie says. "It seems that the climate impact is on the lobster, not on the crab."

Collie noted that the increasing abundance of climate migrants in Rhode Island waters is most apparent in Narragansett Bay. It's happening offshore as well, but in a slightly delayed manner.

"The difference is that estuaries are more atmospherically forced; they respond more to weather because they're shallow," he explained. "In deeper water on the continental shelf, the forcing becomes less atmospheric and more driven by the strength of the

Collie manages a weekly fish trawl on Narragansett Bay that has seen changes in species over the last 60 years.

currents. We see shifts in species abundance and productivity in estuaries first because they're shallower and more responsive. But we see the same signals on the shelf, just a little bit later."

Many of these changes to the composition and abundance of fish species in local waters have had an impact on commercial and recreational fishing.

"Changes in the environment have forced the fishing industry to explore alternative fisheries and alternative ways to support their businesses," says Mercer. "North of Cape Cod, the declines in groundfish have been extremely hard on the fishing community, but the fishermen in Rhode Island are uniquely poised because they have access to not just northern species that have shifted north but also to southern species that are just coming into the area."

Jonah crabs are a good example, she says. As lobsters declined and Jonah crabs seemingly took their place, many fishermen who had targeted lobsters have made the transition to harvesting crabs using the same gear. The transition happened at the same time the market for crabs expanded.

Offshore lobsterman Jim Violet always caught a few Jonah crabs in his traps as bycatch, but about 12 or 14 years ago he noticed that he was catching fewer and fewer lobsters and more and more crabs. Now he's a full-time crabber.

"If we tried to catch both species at the same time, we probably wouldn't do as well with either one," he says. "Now that the lobsters have moved to deeper water and the crabs are so abundant, it made no sense to try to catch lobsters anymore."

Violet says that about half of the lobstermen he knows have switched to crabs, though some still target lobsters for part of the year.

David Spencer, another long-time offshore lobsterman, still fishes for lobsters most of the year, but half of his yearly income now comes from Jonah crabs. And while the rapid changes taking place in the marine environment are challenging to adapt to, he doesn't see it as a negative for the fishing industry.

"When people talk about climate change, it always seems to be accompanied by doom and gloom for fisheries, but fishermen can adapt just as fish can adapt," he says. "Having a supply of crabs to harvest has been a boon to southern New England fisheries, both inshore and offshore."

It hasn't been bad for recreational fishermen either. Rich Hittinger, vice president of the Rhode Island Saltwater Anglers Association, has been fishing since he was a kid in the early 1970s. Some of the species he caught back then, like winter flounder and striped bass, are harder to find these days, but he's happy to catch some of the climate migrants that have moved into the area.

"From a recreational perspective, we have a surplus of some of the new fish in our waters, like black sea bass, which are delicious … you can get yourself some really good table food on a regular basis," he says. "I'm even catching some cobia now. They used to be rare around here, but now we're getting them more often."

Scientists and fishermen alike note the challenges the rapidly changing fish populations have placed on efforts to effectively manage local fisheries. Many of the quotas in place for commercial species are based on data from the 1980s and 1990s, before many of the species shifted their ranges northward. The Rhode Island quota for black sea bass, for instance, is quite small, despite its abundance in local waters, because the quota was set from data collected when the fish was still primarily found off the mid-Atlantic states.

"Fisheries management is not nimble," says Mercer. "There are lots of different layers and processes involved, and it makes it difficult to manage fisheries adaptively, which is what we need in a changing climate."

It's not just fish and invertebrates that are climate migrants, however. Some whales are, too, though the link to the changing climate is indirect.

According to Robert Kenney, emeritus marine scientist at the URI Graduate School of Oceanography, North Atlantic right whales—one of the rarest marine mammals on Earth—feed almost exclusively on the dominant species of zooplankton in the northwest Atlantic, *Calanus finmarchicus*. But the changing climate is shifting where the large patches of *Calanus* are found, forcing the whales to travel great distances in search of their prey.

Offshore lobsterman Jim Violet has switched completely to catching Jonah crab.

"Right whales go to the places they went to with their mother in their first year of life to find food," he says. "That's how they learn where the good places are to eat. But now there might not be food there, or the patch might not persist as long, so they wander around and end up in new places. The more they wander, the more at risk they are for running into a ship or getting entangled in fishing gear."

"Eventually they do find a new food supply, but many of the whales aren't getting enough to eat," he added. "They're finding enough food to survive but not enough to reproduce, so the population continues to decline." All of which results from the warming temperatures and shifting currents caused by the changing climate.

Few other marine mammals are considered climate migrants—yet—but as environmental changes continue, it's likely that some may become so, and many other creatures will as well.

Jim Violet hopes that whatever additional changes are coming won't force him to fish for something other than lobster and crab.

"I should never say never, though. I always thought the lobster industry was so well-managed that I'd never have to fish for anything but lobster. But I ate my words on that," he says. "I hope Jonah crabs will be around for the foreseeable future."

It may be wishful thinking.

A RIVER RUNS THROUGH IT

A CHANGING CLIMATE, INCREASING DEVELOPMENT, AND AGING, ANTIQUATED DAMS ARE PUTTING RHODE ISLAND CITIES AND TOWNS IN PERIL

by **Bob Gulla** Photographs by **Monica Allard Cox**

THE DAM AT THE SOUTHERN END OF THE John L. Curran Lower Reservoir in Cranston is, like so many dams in Rhode Island, tricky to find. Tucked away down a dirt road and a few hundred feet along a woody footpath, the structure reveals itself quietly, a modest earthen dam lining the southern shore of the reservoir.

The dam is a few hundred feet long and about 12 feet high on the downstream side. The downstream embankment is steep and wooded, heavy with brush, weeds, rocks, and small trees. At the base of the embankment, there's the lower-level outlet, where water runs through the dam. The crest of the dam is a worn dirt path about 5 feet wide. At the end of the crest lies what is called the spillway, an exit point that keeps the water level from rising too high. Walking along the crest, you can hear the gurgle of the reservoir's run-off.

At the spillway, branches of scrub trees and weedy growth hang low over the moving water. Nearby, a few gadwalls wade in the dark, cold water, diving for aquatic vegetation. It's sunny, but the shallow edge of the reservoir is rimmed with a thin sheet of ice.

The Curran Lower empties into Clarke Brook on the downstream side, which in turn flows briskly into the North Branch Pawtuxet River and eventually the Pawtuxet River proper. A few miles later, the Pawtuxet meets the Providence River at Pawtuxet Village in Cranston, which dumps into Narragansett Bay on its way to the ocean. Along the way, it winds through some thickly populated areas, making the Curran Lower Reservoir, like many of the state's inland water bodies, rather consequential.

At this moment, though, it is wearing a peaceful guise. The idle hush of a Rhode Island winter has given the earthen dam a quiet, if deceptive, beauty. Because, the fact is, all is not well here.

The reality of the situation

State and federal inspectors have warned of problems with Curran Lower, a century-old structure owned by the state, since the early '60s. The spillway is cracked and worn. The lower-level outlet, designed to relieve pressure from pending floodwaters, is clogged with debris and completely ineffective. Deep-rooted trees are punching holes in the dam itself, enabling water to seep through where it shouldn't. In 1981, the U.S. Army Corps of Engineers determined that flood conditions could lead to a breach. The report recommended repairs within one year, but those repairs were never made. The Rhode Island Department of Environmental Management (DEM) inspected the dam in 2010 and determined the dam was unsafe, meaning there was an unreasonable risk of failure that could result in death. Today, it remains damaged and dangerous, with no resolution in sight.

"It really is in poor condition," DEM dam safety expert Stacey Pinto says, observing the structure. "It's beautiful, and it's created a nice natural area, but it's also very delicate, if that's the right word. And it's in dire need of repair."

Rhode Island has 669 inventoried dams across the state. Of those, 96 are classified as high hazard and 82 are deemed "significant" hazards. According to DEM's definition, "high hazard" means that "failure or misoperation of the dam will result in probable loss of human life." "Significant hazard" refers to a dam in which failure or misoperation would not result in loss of life, but "could cause major economic loss, disruption of lifeline facilities, or impact other concerns detrimental to the public's health, safety or welfare."

A dam's classification determines the frequency of inspection. Visual inspections of high hazard dams are required every two years, significant hazard dams every five. Low hazard dams are required to be inspected every five years to determine whether downstream conditions have changed enough to warrant raising the hazard classification.

In addition to their hazard classification, dams may also be described as "unsafe" or "potentially unsafe," depending on the actual physical condition of the dam. According to DEM's 2018 annual report on the dam safety program:

"At each inspection, the condition of the major components of the dam—the spillway, lower level outlet, and the embankment—are subjectively rated as good, fair, poor, or unsafe. Good is defined as meeting minimum guidelines, where no irregularities are observed and the component appears to be maintained properly. Fair is defined as a component that requires maintenance. Poor is defined as one or more components that has deteriorated beyond a maintenance issue and requires repair. Unsafe means the condition of a dam creates an unreasonable risk of failure that will result in a probable loss of life or major economic loss. Unsafe characteristics include: excessive vegetation preventing an adequate visual inspection, excessive seepage, erosion problems, inadequate spillway capacity, inadequate capacity and/or condition of control structure(s) or serious structural deficiencies, including movement of the structure or major cracking."

Ten state-owned and dozens of privately owned dams are officially "unsafe."

Towns are required by statute to create emergency action plans for high and significant hazard dams, at the dam owner's expense. A number of towns have not yet done so.

Most dams in Rhode Island have not been reclassified in nearly two decades. A dam classified as low hazard 20 years ago might now actually be rated as high hazard.

The dilapidated Curran Lower Reservoir dam has been a concern for decades.

"Many areas of the state have experienced significant growth in the same areas that would flood if a dam fails. The potential for downstream destruction and loss of life has increased quite a bit," says Paul Guglielmino, the principal civil engineer of DEM's dam safety program.

"Our biggest concern right now is to restore the high hazard dams to the condition in which they were originally built. That's been the push since 2007, and we feel we're making some good progress."

Who owns this dam anyway?

About 35% of the high and significant hazard dams are privately owned. Repairing these dams can cost in the hundreds of thousands of dollars, well beyond the means of most private owners. "Because it means significant money," says Guglielmino, "many of the private dam owners aren't willing to be compliant and they choose to go to court. The only recourse they have is to fight us."

In 2018, DEM pursued enforcement actions against 60 unsafe dams. Since then, only three have been brought into compliance. No enforcement actions have been issued against 32 of those dams because DEM has had no success yet determining actual ownership of the dams. For high and significant hazard dams determined to be unsafe, this poses a risk to Rhode Islanders statewide. Without clear ownership, these unsafe conditions will persist and pose further threat to Rhode Island cities and towns.

DEM is, given its limited resources, pushing forward as best it can in an attempt to identify the owners of the many private dams across the state, says Guglielmino. "We've hired title attorneys as well as some engineers to help us find out who owns these structures and then help repair them. Some, when informed, didn't even know they owned a dam."

DEM also participated in a multi-agency informal working group on dam safety, and that group, with funding from the Rhode Island Office of Housing and Community Development, commissioned a study of Rhode Island dam owner liability in light of climate change. Read Porter, senior staff attorney in the Marine Affairs Institute at the Roger Williams University School of Law and the Rhode Island Sea Grant Legal Program, who led the study, says, "My hope is that DEM can bring this info to bear when they're talking to

private dam owners. The fact that people can be liable if something bad happens, even if they didn't realize it was their responsibility, can really impress upon them the urgency of the issue."

A dam shame

Built for flood control, water supply, hydropower, recreation, or even grist mills, the state's dams are, on average, over a century old. The waterbodies created by many of these dams provide crucial benefits to Rhode Islanders, from drinking water and flood safety to recreational opportunities and scenic beauty. These benefits enhance the quality of life for many Rhode Islanders and also provide valuable wetland habitats—both upstream and downstream—for a vast variety of animal and plant species.

Yet while they are critical structures, they have, in so many cases, not been properly maintained. Some are no longer adequate to handle the intense rainfall and floods of a changing climate. Yet they are being relied upon to protect more and more people as housing developments spring up nearby.

The failure in 1998 of California Jim's Dam in South Kingstown, classified at the time as a low-hazard dam, was a wake-up call for dam safety statewide.

"I remember it very well," says Jon Schock, environmental engineer in South Kingstown's public works department. "We received a call from someone in town saying there was water coming down Kingstown Road (a main thoroughfare). I didn't think it was possible. Hadn't happened before in my experience. But there it was. Thirty million gallons of water through the streets of town."

The South Kingstown dam featured a low level outlet, but debris had accumulated and stopped the flow of water. Water found its way around the outlet pipe, and began eroding the dam itself. The breach happened below and around the dam, not over the top of it.

"These dams are not as influenced by the amount of water as they are by development," says Schock. "What we see is, when these dams were built at the turn of the century, demographics were different. Today, there's much more building, and more impervious surface. In the old days, a lot of rainwater would infiltrate the ground and there was little danger of dam breach. Today, the scenario is very different."

In 2010, as a record rainfall fell throughout Rhode Island, the Blue Pond Dam in Hopkinton collapsed, sending 179 million gallons of water rushing through Hopkinton, Richmond, and eventually Westerly. DEM had expressed concern about the century-old, privately owned dam following an inspection and subsequent written warning in 2008. Talks between DEM and the dam's owner were in progress but didn't move fast enough. The 2010 storm proved formidable. Water over-topped the dam and destroyed it, along with a handful of surrounding roads and bridges. It was one of five dams that failed in Rhode Island during the storm. Since that event, DEM has taken ownership of the dam, including 67 acres around it, and converted it into a wildlife management area. The structure has not been rebuilt.

A changing climate

Perhaps what environmental lawmakers and dam safety groups fear most is a changing climate. "There's just a lot more rain in our rainstorms," says Porter. He and his students studied the liability associated with dam owners, how that liability compares to other states, and what impact climate change will have on these dams and their owners. "The two biggest problems in this area," he says, "are changing patterns of land use and a large increase in precipitation due to climate change."

"The increased amount of water in our rainstorms will really be challenging our dams," Porter says. "It will provide a test to see how much water they can truly hold back. Are legacy dams, dams that were constructed in 1830, adequately designed to contain today's stormwater? I think we know the answer to that, and that's worrisome."

"It's a very hot topic right now," admits Pinto. "We talk about it a lot. Unfortunately, we don't live in a perfect world, which would allow us to address the issue and handle all of the other significant issues we're dealing with at the same time. We just don't have the bodies."

On average, Rhode Island sees a foot more rain annually than it did a century ago due to the changing climate. Sea levels have risen a total of 8 inches (measured in Newport) since 1930. The new normal in terms of water volume makes these dams highly susceptible to flood.

"We worry very much about the reality of climate change," says Porter. "Newer, more modern dams are built for a pre-determined maximum flow. But so many of these legacy dams just aren't built to handle the kind of conditions we'll likely be seeing in the not-too-distant future. If you don't account for climate change in precipitation and you're getting a lot more rain, you could lose your entire dam. Nature is changing things, humans are changing things, and the dams and the dam owners are sitting in the middle."

BACK TO SCHOOLS

Restoring fish populations to the Pawtuxet River

For 200 years or longer, dams have blocked a number of important species of anadromous fish from completing their lifecycle. Alewife, blueback herring, and American shad are just a few of the anadromous species that live their adult life in salt water but return to fresh water to spawn and whose populations had virtually disappeared from the Pawtuxet River watershed following the Industrial Revolution.

"If you put a dam in a flowing body of water, you can use water to power America," says Robert Nero, chairman of the Pawtuxet River Authority. "That's what Samuel Slater did, and the Brown family in the late 1700s. They copied what they saw in England at the time of the original industrialization of this country and began using hydropower to run looms. Dams started popping up all around the state."

In Pawtucket, where Slater built his company, Rhode Island rivers were teeming with Atlantic salmon. Once the dams were built, that population, and many other indigenous species, disappeared. "They just died out here," says Nero. "They couldn't make it back to their spawning grounds. You can be certain that most of the rivers in New England that empty in the ocean … every one had major fish populations for thousands of years until the Industrial Revolution."

The smaller freshwater fish were forage for larger saltwater fish and other animals, so when that important food source disappeared, so did the species feeding on them. The entire ecosystem changed as the dams were constructed.

Ruing the absence of fish and wildlife in the area, Nero had a vision. Inspired by the progress made restoring fish populations in the Wood and Pawcatuck rivers, he set his sights on doing the same for the Pawtuxet, where a 250-year-old dam at the foot of Pawtuxet Village obstructed anadromous migration patterns. "We just wanted to return the river to what it naturally was," says Nero. "We wanted to restore these fish populations to the Pawtuxet. But in order to do so, we had to remove the dam."

At DEM, dam removal is the last option. But Nero, working with fish and wildlife experts, demonstrated that removal in this case was for the greater good.

In the culmination of a nine-year effort, Nero oversaw the deconstruction of the 150-foot Pawtuxet Falls dam in 2011. The $600,000 project, which involved DEM, the Pawtuxet River Authority, the Narragansett Bay Estuary Program, and other partners, removed the center section of the dam, enabling water to flow freely over the natural bedrock falls for the first time in over two centuries.

Since then, the river has come beautifully back to life, restoring vital connectivity between Narragansett Bay and the streams and ponds of the Pawtuxet. Massive migration is underway once again, with schools of herring and shad now able to reach their spawning grounds. "It's amazing to see these species return to the area," says Nero. "We took their freshwater pathway from them, and now we're returning it to them."

OYSTER FARMERS FACE OFF AGAINST OBJECTORS TO THEIR EXPANSION PLANS

by **Ellen Liberman** Photographs by **Jesse Burke**

THERE IS PEACE ON THE POND. THE WINTER SUN spreads its milky light on the water and its warmth on the faces of Jennifer Scappatura and her daughters as they winch an oyster cage up onto to the lip of the boat. Scappatura has been farming the bottom of this 1-acre patch of Quonochontaug (also known locally as Quonnie) since 2014, about half a mile from the sandy shore in a small cove east of the Charlestown Breachway.

Scappatura, twins Sophie and Norah, then 16, and Isabel, then 17, stand the cage on its short end, and Quonnie's abundance wriggles onto the weathered wooden platform. The quartet sweeps tiny mud crabs and juvenile tautog back into the protection of the water, and the oysters clatter onto the deck. January is a slow month in the aquaculture calendar—orders drop off after the holidays, and the oysters are dormant, trying to survive the coldest months until warmer waters in March commence oyster filtering and growth.

Valentine's Day often gooses demand, and Scappatura wants to be ready if and when her wholesaler calls. She scrutinizes each oyster and sorts them by size—smaller oysters grow better and more quickly when they aren't caged with larger peers that capture all the phytoplankton. Crouched in her cold-weather coveralls with a smear of green bottom mud drying on her cheek, she quickly creates two piles. Categorizing livestock is rhythmic—almost therapeutic—and diametrically opposed to her former career in New York City as a stylist for high-end lifestyle brands like Martha Stewart, Scalamandre, and Ethan Allen. But Scappatura brings the same intense focus to oyster farming as she did to selecting the perfect red fabric for a photo shoot.

"In a past life, I wrote stories about how to decorate and designed products that weren't very good for the environment," she says. "In this part of my life I want to give back, and that's the whole concept of my company."

In 1998, Scappatura and her husband bought a little cottage on Green Hill Pond as a weekend getaway place, and she began planning a move out of her Manhattan life. She was intrigued by the oyster reef in the waters near her house. Wild oysters were plentiful, but inedible—the pond was too polluted. Scappatura made herself a life goal to restore Green Hill Pond to health, but she was still seeking design work. She was about to apply to Alex and Ani, when she ran into a friend of aquaculturist and restaurateur Perry Raso. That conversation sparked a career shift.

"It's not easy getting into this industry as a woman and an outsider, but this is the best job I've ever had," she says. "I'm so into promoting Rhode Island oysters—we honestly grow some of the best on the East Coast because the landscape creates many different flavors. It's a golden area."

Quonochontaug Pond, a 1-square-mile salt pond on the northside of a barrier beach, is highly saline, with healthy eelgrass beds that make it an excellent nursery for shellfish and juvenile finfish. Its striking natural views, proximity to lengths of sandy beaches,

CAGE FIGHT

and boating access to Block Island Sound also attract upscale residential development.

Scappatura's lease sits in the sight lines of $2-million-plus homes, and their owners, among others, registered objections with the Coastal Resources Management Council (CRMC) to her first application, claiming it would interfere with navigation and other recreational activities—even though she grows her livestock on the cove bottom and the area is strewn with rocks large enough to bust a hole in a hull.

"The two neighbors personally threatened to hold up the lease for years," she recalls. "A prominent marina owner told me that my lease wasn't going to work out because I wouldn't be able to access it. The bullying is endless. Sometimes it's like cowboys and Indians out here."

These conflicts on the pond were not entirely anticipated. In 1999, the CRMC's annual aquaculture report tallied 15 leases, of which, eight were running. The council then forecasted that this sector was poised for steady growth, and that "people will soon realize that aquaculture is a 'green' industry that can contribute significantly to a diverse economic base and coexist with traditional marine-based industries."

That prediction was half right. By 2019, the number of farms had increased by more than 900%, to 81 farms cultivating 339 acres. But the world has not opened its arms to aquaculture. Rhode Island waters are golden for oysters—and also for sailing, fishing, waterskiing, wild harvesting, and other uses. Increasingly, aquaculture lease applications meet with vehement, organized, and well-financed opposition.

David Beutel, the CRMC's aquaculture coordinator, says that every lease application now raises objections.

"The opposition has gotten more astute in objecting to aquaculture—in that they've read the CRMC regulations and cite what they see as the more legitimate avenues they have to oppose. People fear change, and the people who live along the waterfront have a lot of money and are accustomed to getting their own way," he says. "Because of user conflicts, every new aquaculture site we approve makes the next one harder."

Bureaucratic battles seem far away on a warm January afternoon, when the pond is at rest, and birds are your only company. In two weeks, Scappatura's application for a 4.4-acre expansion will go before the full CRMC. The same objectors—or their lawyers—will surely be there.

"The funny thing about these conflicts—it's just those eight summer weeks," she says. "Most of the time those users aren't even here."

"EVERY NEW AQUACULTURE SITE WE APPROVE MAKES THE NEXT ONE HARDER."

Aquaculture's shifting fortunes

The Colony of Rhode Island and Providence Plantations granted its first oyster lease in 1798; by the 1850s the General Assembly began encouraging shellfish aquaculture with laws that permitted private operations to take oysters from public beds for seed stock. More than 60 years later, commercial aquaculture hit its peak.

In 1911, oyster farms had 21,000 acres under cultivation, blanketing the bottom of Narragansett Bay and its coastal ponds, says Michael Rice, aquaculture professor in the University of Rhode Island Department of Fisheries, Animal & Veterinary Science. It was the state's third largest industry, concentrated into the hands of seven families who ran their operations like textile mills, with tenement housing and company stores. The waterfront bustled with processing plants and steam ships hauling some 1.4 million bushels to East Coast buyers.

At today's value, those sales would be worth $500 million, Rice says. "We haven't reached that by any stretch of the imagination."

Nonetheless, aquaculture's economic footprint is significantly bigger than the CRMC and U.S. Department of Agriculture figures suggest, says Thomas Sproul, a URI associate professor of Environmental & Natural Resource Economics. His team set 2016's total impact, including spillover effects on other sectors, at $26.3 million and 371 jobs.

"We are giving the oyster farms credit for the value added in their product—it's not just something that goes in cans, it's something that's sold directly to consumers and sometimes bundled up in an experience eating fresh shellfish in Rhode Island. That's worth more to the local economy than you would expect based on the official government estimates."

From 1910 to the 1950s, commercial aquaculture suffered a series of blows—raw sewage from flush toilets, soil erosion, and effluent from metals-plating factories fouled the bay. The Hurricane of 1938

Jennifer Scappatura tends her oysters on Quononchontaug Pond in sight of numerous objectors.

Perry Raso faced objections to expanding his oyster lease by 3 acres, even from people who enjoyed his restaurant.

destroyed the shucking sheds, the Great Depression devastated prices, and World War II decimated the labor pool.

"By the 1950s, the political landscape had changed and the families that controlled the oyster industry were on the outs. The men returning from the war didn't want to go back to those high-labor, low-wage jobs," says Rice. And "in the 1970s and 1980s, there was huge resistance to aquaculture coming back."

In 1978, the state granted the Blue Gold Mussel Farm a 60-acre lease in the East Passage next to the defunct naval base in Middletown, prompting protests from wild quahoggers, a moratorium on new leases, and an onerous application process.

In the late 1980s, Robert Rheault, now executive director of the East Coast Shellfish Growers Association, applied for a 3-acre lease to grow oysters in Point Judith Pond. The resistance was fierce—600 letters of objection—and the permitting process was a slog of 14 hearings over 2½ years. But Rheault's experience became a catalyst for major changes in the regulatory process. Oyster farmers coalesced as the Ocean State Aquaculture Association (OSAA) to educate policymakers. In 1996, a new state law streamlined CRMC regulations.

In 2009, the CRMC adopted a 5% cap on the number of acres that could be leased for aquaculture on the coastal ponds, based on a study of the biological and ecological carrying capacity of a mussel farming area in Australia. The 5% cap was also thought of as a social carrying capacity—meaning that was the amount of aquaculture a community would accept. That cap would leave 95% of a pond's acreage for other users. The decision followed discussion with multiple stakeholders, such as the commercial quahoggers.

"Five percent was seen as a reasonable number by everyone," recalls Rice. "There were handshakes and happiness and people moved forward. The players are different now."

Today, only Point Judith Pond has hit the 5% limit. Ninigret Pond is a close second—if all pending leases are approved, it would near capacity. The other ponds are nowhere near the limit. Quonochontaug, for example, has a little more than 1% of its acreage under lease. The yearly growth has slowed. In 2018, 23.2 more acres were leased, an 8% increase for the year.

From the aquaculture industry's point of view, the struggle to get anywhere near capacity on the coastal ponds is a limitation on the industry's ability to expand or to use good management practices. Graham Brawley, manager of the Ocean State Shellfish Cooperative, which, in 2019, marketed and distributed some 4 million oysters from 15 farms, says the fight for space on the ponds is likely to drive future farms into the bay, where the challenges are financial—higher initial capital costs, such as larger vessels and more expensive gear—and environmental—more extreme tides and winds.

"The guys who are established are okay," Brawley says. "Any new farmers have no room to grow or to move to use beneficial management practices. If you're doing bottom culture in one area, it would be beneficial, after you finish this season, to let that area sit for a year or two. If you line all farmers in one area, you are limiting the amount of food."

An elusive balance

David Latham grew up in landlocked Kansas, but his heart has always been firmly located on Potter Pond in South Kingstown. In 1970, his grandparents bought a half-acre of land on the pond's southern end. The home they built there became the family's summer gathering place, and it lives in Latham's memory as the high point of each year.

"The first thing I would do is run down to the dock and start saltwater fishing," he recalls. "We spent our lives on the water. It was super—crabbing in the morning, clamming, and flounder fishing. Everything was magical to me, right there out of the front door."

Latham now lives in Brooklyn, New York, but he and one of his brothers still head up to Rhode Island in the summer, where they have their own places nearby. The last half-century has brought a lot of changes to Potter Pond—more houses, bigger houses, and aquaculture.

In 2002, Perry Raso successfully sought a 1-acre lease there and founded Matunuck Oyster Farm. In the next five years, he expanded it by another 6 acres, and his farm became the source for the signature dishes at his wildly popular restaurant, the Matunuck Oyster Bar. None of his applications had objectors.

"Every year it got a little bigger and gear got more obtrusive. Nobody knew who was approving it, and nobody was being notified," Latham says. "I vowed if something like that happened again, I would do something."

In 2017, Raso submitted a fourth application to farm scallops and oysters on a 3-acre spot on Segar Cove, at the pond's southern end. Raso thought he had carefully selected an area that was deep enough for aquaculture and dead enough to overcome any objections from the regulators or the public.

"I've lived on the pond for quite some time, and I knew the location as one of the more lightly used areas of the pond," Raso says.

Gene Corl, a 20-year resident whose house looks out upon the cove, takes another view.

"That's about the only public access to the pond system," he says. "It's a popular spot for kayakers to enter and one of the few places on the pond that's deep and big enough for waterskiing. They can get three people skiing in this cove at the same time. If he takes the 3 acres, there no way you can do any of that."

Latham happened to find out about it two weeks before the comment period closed and immediately printed up some fliers alerting other homeowners and suggesting they comment if they had strong feelings; 120 people responded, and the overwhelming majority objected.

The Battle of Segar Cove was joined. The Shellfish Advisory Panel, which represents commercial and recreational shellfish harvesters, supported the proposal, 9-2. The South Kingstown Waterfront Advisory Commission was unanimously opposed. The Rhode Island Marine Fisheries Council was evenly divided. Typically, the permitting process takes slightly more than a year from first application to final decision. Raso's application has idled for two, as the CRMC wades through 147 letters of objection.

"I VOWED IF SOMETHING LIKE THAT HAPPENED AGAIN, I WOULD DO SOMETHING."

It isn't supposed to happen this way. Aquaculture applications start with a pre-determination report to see if the site is suitable. The intent is to ferret out any potential issues and see if they can be addressed by modifying the location or the technique, Beutel says. He discourages applicants from proceeding if it's clear that the application is likely to be contentious. Each full application is then open to public comment and goes through multiple reviews at the federal, state, and local level—including from the state Department of Environmental Management, the U.S. Coast Guard, the Army Corps of Engineers, the Rhode Island Historical Conservation and Preservation Commission, and other local advisory boards.

Waterfront landowners are not notified because the lease is sought on submerged state land. But nongovernmental groups, like the Salt Ponds Coalition, also keep a close eye on new applications.

"We support aquaculture as long as it's properly located and operated," says coalition president Art Ganz. "Rhode Island is a small state with one of the largest populations on the water. Everyone wants to use our resources for their own purposes. We try to get in on the ground floor to work with the applicant to minimize the impact."

After these reviews, Beutel writes his final report. Lease applications that raise no red flags are approved; all others go before the CRMC for a full hearing.

Mike McGiveney, president of the Rhode Island Shellfisherman's Association and a member of the Shellfish Advisory Panel, says that the process has been helpful in managing the competition for space with the wild fisheries. He estimates that "Seventy to 80% that come through have no opposition. It's a rarity that we oppose. I see much more contention among landowners."

And landowners raise all manner of objections, claiming that aquaculture scares away wildlife such as turkeys, deer, rabbits, and humming birds and pollutes the ponds, and that floating gear is unsightly. Oyster farmers, who see themselves as environmental stewards, working the commons to provide food, call the cap "the 95% rule" to emphasize the amount of surface area of a pond available to other uses. They grow weary of some of the more disingenuous claims and tactics. Raso, for example, protests that some of his neighbors are using photos that distort the size and the look of his proposed farm on a website created to rally the opposition.

"The floating gear has become an issue because of the visual impact," he says. "I understand their perspective. I was a wild harvester for years and aquaculture used to bother me. I understand that resistance to change, but growing shellfish is a benefit to the ecosystem, and it can work in unison with other user groups—if we all work together."

Rheault, who, for decades, has tried to educate the public, puts it more bluntly.

"These people don't want to see fishermen—we don't wear enough Land's End gear. We don't have nice, shiny boats. We aren't their kind of people. But they don't own the water. The water is declared public lands of the state, held for the benefit of the [state]—not just the waterfront home owners—and its incumbent upon the state to protect that resource for the benefit of the [state]."

Ironically, Latham sees it the same way: "The state is removing public property from public use. And it will keep coming up anytime people want to take the water column away."

Finding harmony

"Buttery. Briny. Better." Walrus and Carpenter oysters are grown on a 6-acre lease in Charlestown's Ninigret Pond, where farmer Jules Opton-Himmel makes sustainability a major element of his brand. He markets the farm itself, as much as his oysters, with tours and farm dinners. Foodies slurp oysters at an in-the-water raw bar, play with his dog Tautog, and then repair to a long table dressed with white linens for a gourmet meal prepared by top-line chefs. Currently, Opton-Himmel is developing a community supported agriculture program to market directly to fans of fresh oysters.

As skilled as Opton-Himmel had become with communicating his story directly to consumers, he discovered that he had failed with his neighbors. Opton-Himmel's Ninigret Pond lease used bottom racks and was approved with a minimum of controversy, but he wanted to incorporate more efficient—and profitable—husbandry practices. The current best practice for aquaculture technology dictates floating cages. An oyster farmer's math includes a raw calcula-

tion between the number of seed-stock oysters, and 18 months later, the number that reach market size and shape, with a nice cup to the shell. Growing methods below the water's surface are less efficient and more labor-intensive. Farms lose a significant percentage of the juveniles to predators, reduced oxygen, and less access to food. The difference on a farmer's balance sheet is literally hundreds of thousands of dollars. Given the community resistance to floating cages, CRMC guidelines encourage low-profile versions—but they are not required.

In 2015, Opton-Himmel won a two-acre lease in Jamestown's Dutch Harbor, west of Conanicut Island at an entrance to Narragansett Bay, where he intended to finish in floating cages the stock started in the rack-and-bag cages on the bottom of Ninigret. His wasn't the only farm operating in that patch of water, but it was the closest and most visible to the shoreline.

"It's important for future community relations to be a good member of the community. People are not fully aware of the fact entrepreneurs are encouraged to seize opportunity. That's rewarded in our society," he says. "But you're farming in the commons. It's a privilege, not a right. For me, personally, that did not sink in for a while."

Dutch Harbor homeowners Ted Sybertz and his wife, Sharon Purdie, loved the soul-stirring sight of sunsets over conservation lands, long swims, and kayaking—right from their lawn's edge. In the summer of 2016, the waters seemed to have suddenly sprouted hundreds of floating cages. West Wind homeowners began complaining—to the town and the CRMC.

"We had all these black barrels 100 feet off our shoreline, and it changed the most scenic view on Narragansett Bay into what amounted to an industrial aquaculture location," Sybetz says.

The homeowners' biggest gripes, says Purdie, were "we were not told about it until they were approved and Jules had twice as many cages as he was allowed."

Opton-Himmel reached out to the Center for Mediation & Collaboration Rhode Island, which runs a U.S. Department of Agriculture funded program that mediates disputes for farmers. This was the center's first case on submerged acreage, but the process is the same—a series of voluntary, confidential, facilitated discussions among the parties to air their grievances, listen to the other side, and brainstorm a creative consensus.

"Mediation sets the stage—let's go in with an open mind," says Rhonda Bergeron, the center's operations director. "People can come in very angry, but we're not asking them not to feel their emotions. It's an opportunity to clear up a lot of miscommunication, and it shifts the culture of the discussion from a malicious intent to a culture of goodwill."

Opton-Himmel and the residents met several times, and came up with a plan: Opton-Himmel would seek a new, larger lease that would move the farm away from the neighbors, and the neighbors would not object to his application.

"Mediation helped us to get to the sincerity of Jules to work with the homeowners; I absolutely didn't have that feeling before," says Purdie. "I thought of him as a person who just wanted to push and push the limits. We found we could make a lot of progress without the CRMC involved."

The discussion also led to a connection with Johnson and Wales University Associate Professor of Design Walter Zesk, who turned the visual blight of floating cages into an ongoing problem-solving exercise for his students.

"They've generated concepts that intrude less on the experience of being on the water," he says. Some of the more "feasible and plausible solutions involve camouflaging the cage with different coloring, or clip-on, semi-reflective material to make the cage look like a wave."

Increasingly, the industry is turning to education as a strategy to lower the temperature of lease battles. Dan Torre was granted his first 3-acre lease last December. The farm, on the Sakonnet River in Portsmouth, lies in view of the Glen Manor House, a special-occasion venue, and homes on Heidi Drive, whose owners strenuously fought the proposal. Torre created a website to explain his project and oyster farming.

"It was clear there wasn't a great understanding of oyster farming," says Torre. "People complained that it would affect parking and traffic, smell, and add to pollution. The goal was to gather a bunch of facts to teach them about aquaculture to be comforted about what was going on there."

It didn't completely neutralize the opposition, but Gretchen Markert, a Seaberry neighborhood resident, found it helpful. She wondered how Torre's farm would affect the seascape or the town beach, so she submitted a query asking for more information.

"Dan replied very quickly with a thoughtful email and a link to his website, which showed a high level of planning and provided interesting points about aquaculture having a beneficial impact on water," she says. "Given that it would not impact swimming or fishing and it's a locally sourced food, I think it's great."

Late last year, the OSAA hosted a workshop for coastal town officials to educate them about the permitting process and aquaculture. It was so successful, the organization plans to make it an annual event.

"Communication—it's always key," says OSAA president and oyster farmer Matt Behan. "[Town officials] really don't know the farmer. All they know is the waterfront homeowner who keeps complaining and threatening legal action."

Still, some are clamoring for a more global approach. Dick Pastore, the Rhode Island Saltwater Anglers Association's representative on the Shellfish Advisory Panel, says it's time for another moratorium until the CRMC writes a Special Area Management Plan for aquaculture.

"We've got oysters. They are a high-end product making some great strides, and it's an industry getting a foothold in Rhode Island. This is wonderful, okay? Let's not wait until this whirls into a range war, where everybody's suing everybody," he says. "Let's have a plan, so we can guide this industry to national prominence."

Moving on

In a windowless gray meeting room on Smith Hill, Scappatura waited patiently with her daughters, Isabel and Sophie, for her expansion application to come before the full CRMC.

Getting the farm going was hard, but the past five years have taught her a lot. She pestered Beutel with dozens of questions, takes and retakes the required aquaculture course at Roger Williams University, and interned with Opton-Himmel. She lost her first crop entirely and was begging for shucking jobs to keep going. Her second crop produced a tiny harvest. But what she lost in quantity, she won in quality. In March 2019, she entered her Quonnie Sirens in Oyster Madness, a blind taste test pitting local farms against each other for the title of Best Oyster in Rhode Island. Scappatura considered her entries donations to the cause of promoting local oysters. She was stunned to win first place; a wholesaler bought her entire harvest.

"Slowly, slowly, I'm getting a tiny paycheck and getting accepted as a serious player," she says.

With 4 more acres, she could use the rack-and-bag system on her current lease as a nursery for juvenile oysters, and once they are predator-proof, plant and finish them on the cove's bottom.

Her application was last on the agenda, and the room's population had dwindled to a handful. Beutel gave the council a dry summary of the proposal and his recommendation for approval. He teed up each objection—interference with a mooring field, recreation, navigation, and the pond's ecology—and then batted each aside with an "it's-challenging-for-me-to-believe-that-bottom-culture-could-impact-any-of-those" counter-argument.

But there was enough tinder to spark anger. A neighbor accused Scappatura of bad citizenship for making her lines and buoys invisible to boaters by painting them blue; Scappatura tried to respond, prompting CRMC Chair Jennifer Cervenka to admonish both to only address the council and to give each speaker the floor.

Scappatura pleaded her case.

"We have produced an incredible product that has a high demand," she says. "I painted them blue to reduce the visual impact. I'm trying to do everything as proper as possible, and we respect the rights of other users. But these objections are just 'not-in-my-backyard' objections. And I can't make a living on 1 acre."

The discussion among CRMC members was scant; the decision swift. Her expansion was unanimously approved.

"It's a giant leap for more things to come," says Scappatura, who eventually wants to diversify her product line. "Rhode Island only produces a fraction of the oysters on the East Coast. We are so far behind other states. But this is going to keep me afloat."

The meeting adjourned, and one objector shook her hand. She headed to her favorite tavern to celebrate, and there was the neighbor who blamed her for fouling his boat motor. To her surprise, he congratulated her on the new lease, joking about getting free oysters.

And when Scappatura left, he picked up the tab.

Architecture for the birds, the bees, and the rising seas

by **Monica Allard Cox** Photographs by **Dana Smith**

INSTALLATION IN TOUISSET REFUGE PROVIDES ENVIRONMENTAL EDUCATION, ECOLOGICAL HABITAT

NEAR THE ENTRANCE OF THE TOUISSET AUDUBON property in Warren, Rhode Island, visitors are greeted by the first of a series of 21-foot-tall square poles rising out of the grounds of the refuge. Dramatically tall, but charred to blend in with their surroundings, the poles feature lines of circular and oval indents, punctuated by a handful of wooden dowels.

Architect and landscape designer Leonard Yui, assistant professor of architecture at Roger Williams University (RWU), is the mastermind behind these poles, which were installed by a team including RWU students and Audubon staff. He calls the poles "ecological piers" that represent many layers of meaning. One of these is how climate change will impact habitats like those in the refuge that are close to sea level. That connection, Yui says, was inspired in part by the "sea level rise stick," a hand-held, 6-foot-long pole that extension specialist Teresa Crean of the Coastal Resources Center and Rhode Island Sea Grant marked with different sea level heights to help people visualize where future sea levels will be.

The ecological piers, though much taller than the sea level rise stick, mimic its shape and will include steel markers that show where sea level will be at these sites in years to come.

"That's one element that they are meant to express: changing coastal habitat over time," Yui says.

Besides the sea level rise projections, the piers include segments of texts from renowned 20th-century environmentalists including Rachel Carson and John Muir encoded in the indents on each pole—the dots and dashes of Morse code. The dowels, placed where commas or periods would go, are intended as perches for visiting birds. The indents themselves are designed to be habitat for solitary bees, whose habitats are threatened.

The mile-long walking trail through the refuge encompasses pasture, forest, wetlands, and grasslands. A pier has been erected at each type of landscape and engraved with a quotation from the environmentalist most associated with that particular ecosystem, which Yui says "is meant to highlight and provide a little bit of a spiritual connection with the locations that are around here."

If all that might be lost on the average visitor, Yui points to spaces on the poles where his students will install QR codes that, when scanned with a smartphone, will take people to a webpage that will explain all this and, Yui hopes, will include additional information, such as interviews with climate change experts.

What Yui says makes this installation different from other work on sea level rise is how it connects impacts to a specific location. "Sea level rise oftentimes is studied from kind of an aerial perspective," looking at the vast numbers of people who will be harmed by it, he says, "And that information is definitely important … However, from an individual perspective, it's really hard to relate to … So the strategy here that I think is really unique is to say, let's have people understand the site first. What is the ecology of the site currently, what do you enjoy about the site, and then overlay one aspect of how sea level rise might affect this space."

"I mean all these are really not about the structure. It's really about helping people to look at the landscape more carefully."

Though every inch of these "piers" has meaning, "these are really not about the structure," says architect Leonard Yui.

THE BIRTH OF OCEAN SCIENCE IN RHODE ISLAND

by **Stephen S. Hale**

WHEN ALEXANDER AGASSIZ AND JOSEPH FIELD launched their Rhode Island marine laboratories in the late 1800s, they didn't imagine that the fledgling labs, beset by rivalries, funding difficulties, and modest support from their institutions, would last only a few years. Nevertheless, the enthusiasm and accomplishments of these two people helped bring ocean science to the Ocean State.

The late 1800s to early 1900s was the Golden Age of American natural history, and Rhode Islanders enthusiastically joined in. Natural history societies flourished in Providence and Newport. Joseph Totten was one of the first to collect specimens from Narragansett Bay for science. In the early 1830s, when not working his day job as the Army Corps of Engineers officer in charge of constructing Fort Adams in Newport, he satisfied his passion for "conchology" (the study of mollusk shells) by taking dredge samples from the bottom of Newport Harbor. He identified several species new to science, including the tiny amethyst gem clam (*Gemma gemma*). Later, he cofounded the National Academy of Sciences. In 1855, Joseph Leidy, a zoologist from the University of Pennsylvania, while on holiday visiting a friend in Narragansett, sampled the rocky shoreline and described several new species, including the polychaete worm (*Naraganseta coralii*).

Interest in establishing marine field stations swept through the United States during this period. The first ones were largely energized by the biologist Louis Agassiz, who had founded the Museum of Comparative Zoology at Harvard College (later Harvard University). In 1854, he added a marine lab to his summer cottage in Nahant, Massachusetts. In 1873, he established the Anderson School of Natural History on Penikese Island in Buzzards Bay for field collections and laboratory work. The study of nature, not textbooks, was the mission.

Alexander Agassiz in 1896. Agassiz launched the first Rhode Island marine lab in 1877.
Photograph courtesy of the Museum of Comparative Zoology Archives, Harvard University

Agassiz and assistants examine specimens at the Newport Marine Zoological Laboratory. Illustration by H.A.Ogden, 1878.
Image courtesy of the Museum of Comparative Zoology Archives, Harvard University

After Louis Agassiz died at the end of 1873, his son Alexander took over the Penikese facility. However, the expense of running a school and lab on the island became insurmountable, and the trustees petitioned John Anderson—the wealthy merchant who had offered the island to Louis Agassiz and funded the first year—to move the facility to Woods Hole. Anderson declined and did not provide operating funds for the second year, whereupon Alexander covered the expenses.

Some of the instructors at Penikese went on to start other marine labs, including Alexander, who in 1875 added a laboratory room to his summer home at Castle Hill in Newport, Rhode Island, 23 miles from Penikese as the seagull flies. In 1877, he launched the Newport Marine Zoological Laboratory.

Twenty years later, the second marine lab in Rhode Island was established by George Field of the Rhode Island College of Agriculture and Mechanic Arts (later the University of Rhode Island), when the college built a lab at Buttonwood Point on the west shore of Point Judith Pond, South Kingstown. Although neither of the two Rhode Island labs survived for long, they produced many seminal scientific publications and gave marine research in Rhode Island a strong initial boost.

Newport Marine Zoological Laboratory (1877–1910)

In 1877, Alexander Agassiz designed and had built at his own expense a separate marine laboratory on the grounds of his summer estate at Castle Hill (now the Castle Hill Inn). Driven by his desire to continue the legacy of his larger-than-life father, he wrote that he hoped to replace the work that might have been carried on at Penikese.

Agassiz earned his substantial wealth from developing and managing the largest copper mine in the world, the Calumet and Hecla mine in Michigan. Charles Kofold, in an article on Agassiz's contributions to marine biology, wrote that Agassiz had a "singular pertinacity of purpose and continuity of effort." Memorial biographies by Alfred Mayer and Henry Walcott noted that Agassiz had a quiet and reserved demeanor but was "a hercules of energy and executive power" and "a genius of activity" with a "remarkable ability as an organizer."

Agassiz chose Newport in part because he wanted a rocky coast to collect specimens. In addition, cold waters from the north and warm Gulf Stream-influenced waters from the south led to a wide diversity of marine fauna. As one of the wealthiest individuals of his time, he might have found Gilded Age Newport society to be agreeable. But Agassiz devoted himself to science. Maud Elliott in "This Was My Newport" describes the intellectual culture that flourished in Newport at the time, represented by the Town and Country Club, and that is the substrate where Agassiz chose to settle. The club, organized by Julia Howe ("Battle Hymn of the Republic"), included many professors, authors, artists, and other luminaries, mainly from Boston. The club put on lectures, plays, and readings of poetry and literature. Agassiz hosted them at his laboratory with a lecture on fishes. Julia Howe wrote that the wit and nonsense of the club meetings made the gorgeous fetes given by those Gilded Age people who made luxurious living the main purpose of their lives seem dull.

George Field's marine lab on Point Judith Pond lasted only three years.
Photograph courtesy of the University Archives, University of Rhode Island Library

Agassiz described the Newport laboratory in a report he sent to the scientific journal *Nature* in 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 workbenches for sorting, dissection, microscopic work, and illustration. An innovative Agassiz design was placing the microscope tables 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-horsepower steam pump) brought in seawater, fresh water, and compressed air, piped to the workbenches. A small cove behind the lab formed a natural boat harbor. Researchers collected specimens from a steam launch with pelagic nets and bottom dredges.

That Agassiz would embark on such a remarkable enterprise was driven in part by the 1873 death of his revered father, Louis, followed by Alexander's beloved wife, Anna, who caught pneumonia caring for her father-in-law and died eight days later. This hard blow left disconsolate a man previously described by Sir John Murray—when Agassiz visited the *HMS Challenger* expedition during a port call in Halifax—as filled with the "overflowing joy of life." Agassiz never remarried but resolutely threw himself into his scientific work.

At the lab, Agassiz worked mainly on taxonomy, embryology, and early development of jellyfishes, sea urchins, starfish, polychaete worms, and fishes. He invited graduate students and instructors from the Harvard Museum of Comparative Zoology to study at the lab. For 20 years, Newport was an active center of marine research. One student, W.E. Castle, in a *Science* article in 1893, described the summer activities of the lab as "a very paradise for the marine zoologist." He wrote, "Any day through the summer you may see half a dozen men here industriously bending over their

OPPOSITE
Agassiz and his assistants gather samples from Narragansett Bay.
Illustration by H.A.Ogden and courtesy of the Museum of Comparative Zoology Archives, Harvard University

microscopes, studying animals in their living form or preserving material for future study." The students stayed at a boarding house in town and were taken to the lab each day.

Beyond these happy summer days at Newport, tensions were developing at the museum in Cambridge between Agassiz and E.L. Mark, who became the museum's director of the embryological laboratory. Mark favored instruction, while Agassiz favored advanced research. While Agassiz generously invited others to study at the Newport lab, the fact that it was part of his private summer estate sometimes created difficulties. Mary Windsor in her history of the museum noted that Agassiz in 1892 proposed that Harvard expand the Newport facility with a second laboratory building, a dormitory, a large seagoing launch, an aquarium, and a 200-ft research steamer. He promised to leave the lab to Harvard in his will. Although the Newport lab had been a significant part of science at Harvard for years, Harvard did not accept the offer, perhaps influenced by Charles Whitman, director of marine biological laboratory (MBL) in Woods Hole (and a former assistant of Agassiz at Newport), who wrote of "rival schemes" and advocated for the superiority of strong central stations over many weak ones. Agassiz was livid.

Agassiz and his assistants and advanced students at the Newport lab published numerous scientific articles, and several people who studied there became well known throughout the scientific world. Agassiz hosted grad students at the lab through 1897. He stopped inviting them in 1898, disappointed by the lukewarm interest of Harvard in his proposal to expand the facility. He used the lab by himself until his death in 1910.

The estate stayed in the family until 1938 and served as an informal Navy base and officer's quarters during World War II. Now, the laboratory building is used by the Castle Hill Inn as a charming conference room.

The Biological Laboratory at Point Judith Pond (1897–1900)

In 1897, the Rhode Island College of Agriculture and Mechanic Arts (later the University of Rhode Island) built a marine lab at Buttonwood Point, on the west side of Point Judith Pond in South Kingstown, just north of the YMCA's Camp Fuller. In their article on the lab, C.L. Devlin and P.J. Capelotti wrote that Rhode Island was the first state land-grant college to establish a marine lab. Land-grant colleges at their beginning focused on agriculture, with little attention to fisheries.

The college had hired in 1896—from Brown University, where he was a professor of cellular biology—George Field as associate professor at the Rhode Island Agricultural Experiment Station. Field quickly got the Buttonwood Point marine lab operating in 1897. The next year, the college catalog promoted marine studies: "Proximity to seacoast renders possible the study under natural conditions, as well as in aquaria, of the habits and development [of] many marine animals .... " The building had laboratory benches to accommodate four to six investigators and large windows to accomodate dissection and microscopy. Field ordered a skiff equipped with a dredge, oyster tongs, and nets. In an 1898 article in *The American Naturalist,* Field described the Planktonokrit—one of the more notable devices he helped design—a 400-lb metal centrifuge powered by a steam engine that he used to measure the volume of plankton in a water sample.

While many marine labs at that time focused on taxonomy and species life history, Field and his assistants also conducted research on physical, chemical, and geological factors that influenced marine life. He measured seasonal variations in water temperature and levels of dissolved oxygen in the pond using the new Winkler titration method. He studied the life cycles of bivalves, methods of attachment of spat, methods to prevent sedimentation of shellfish beds, and effects of food availability and oxygen on plankton.

In his 1896 report "The Oysters in the Point Judith Pond," Field identified two potential causes of a decline of the pond's main fisheries (oysters, white perch, herring, eel, flatfish, smelts): storms periodically filling in the natural breach to the sea, and sedimentation and pollution from sewage and textile mills in Peace Dale and Wakefield on the Saugatucket River. Field wrote that periodic closures of the opening to the sea blocked fish movement in and out of the pond, increased sedimentation that smothered shellfish and made the bottom unsuitable for the settlement of spat, and led to increased growth of seaweed. He said that it would be sad if an area so valuable as Point Judith Pond should be allowed to be transformed from "a beautiful sheet of water to a miasmatic bog-hold." He began to argue for the construction of a permanent breachway.

Another interest of Field's was the potential of the pond for aquaculture. In his 1892 article "The Problem of Marine Biology" in *The American Naturalist*, he foresaw a time when marine fisheries would become depleted by a growing human population and pollution. He passionately advocated for aquaculture, arguing that "the economic results of intelligent and successful oyster culture, always bountiful, are frequently marvelous." He wrote that Rhode Island, with its warm, shallow, protected bays and brackish ponds teeming with plankton, was an ideal spot for aquaculture. However, aquaculture was not well-received by the local fishermen, who discouraged several attempts to establish shellfish beds. Eight bushels of scallops laid down in beds went missing, presumably found by what Field called "appreciative fishermen."

Walter Wilson in his biography of Field notes that colleagues described Field as a "pleasant, quiet, scholarly type" and a warm, fun-loving person. However, in promoting marine aquaculture, Field sometimes lacked political savvy. He wrote in one of the Agricultural Experiment Station's annual reports that "Farming land of wonderful fertility, or vast mineral resources, are not here [in Rhode Island]." That could not have gone over well with the main users of the station's research. Field became discouraged by the lack of support for a permanent breachway and aquaculture for the pond. In the summer of 1899, he taught a summer course on echinoderms at MBL and conducted research at the adjacent U.S. Fish Commission lab. In July, he resigned from his position in Rhode Island.

Late in 1899, the college ordered the disposal of the marine lab at Buttonwood Point and dismantled it in 1900. (Had it survived that, it likely would have disappeared when the 1938 hurricane swept Buttonwood Point clean.) Although the lab lasted only three years, Field established a precedent that other state colleges would follow, including Rhode Island itself 37 years later. Wilson wrote that although Field was "to some extent an unrealistic visionary," many of Field's ideas, such as those in aquaculture, pollution control, and over-harvesting, are being implemented today.

The settling, death, and reincarnation of the spat

Like many oyster spat that, after drifting in the plankton, find a favorable substrate on which to settle, but then do not survive due to predation and competition, the two early Rhode Island marine labs did not endure. Basically, Rhode Island lost to Woods Hole both the Newport lab and the Buttonwood Point lab. Ironically,

WOMEN IN EARLY MARINE SCIENCE

Although women in late-1800s America didn't enjoy equal status with men in many areas, they were well represented at the early marine schools/labs. One-third of the students at the Anderson School of Natural History on Penikese Island were women, as were three of the six students that Alexander Agassiz invited to the first year of the Newport lab. This was partly in fulfillment of a promise the Harvard Museum of Comparative Zoology had made that it would serve Massachusetts by reaching out to schoolteachers. The Agassizes' enlightened attitude toward women's education was no doubt influenced by Louis' wife Elizabeth Cabot Cary Agassiz, who contributed to the founding of the coeducational Anderson School and who later became the first president of Radcliffe College. At meetings of the Town and Country Club in Newport, Alexander met Julia Ward Howe, a leader of the women's suffrage movement. Another member of the club was Colonel Thomas Higginson, a strong advocate for women's rights. Joan Burstyn, in her article on the influence of the Penikese summer sessions, wrote that the 30 women who studied at Penikese later played a significant role in U.S. women's education. The Woman's Education Association of Boston, founded in 1871 to "promote the industrial, intellectual, aesthetic, moral, and physical education of women," provided funds to launch the Marine Biological Laboratory at Woods Hole; women comprised nearly half the students at the first summer session.

Agassiz's Newport lab may never have existed had John Anderson agreed to move the Penikese facility to Woods Hole in 1874. Both the early Rhode Island marine labs were essentially one-person operations without sufficient support from their institutions. Although marine research in the state faltered in the last two years of the century, a glimmer of the future emerged in 1898 when the Rhode Island Commissioners of Inland Fisheries established a pioneering lobster hatchery and experiment station on a floating barge in Wickford Harbor. This later became a marine fisheries field station. And the state made a glorious recovery in 1936 with the founding of URI's Narragansett Marine Laboratory (now the Graduate School of Oceanography).

Both Agassiz and Field recognized Rhode Island as a fruitful place to conduct marine studies. Both men realized that to understand marine life, one also needed an understanding of physical, chemical, and geological conditions. Agassiz was more interested in exploration and pure research, while much of Field's career dealt with applied research. Whereas Agassiz was recognized as one of the most prominent marine scientists of his day, both in the U.S. and around the world, Field seems to have gotten little attention. Agassiz published numerous articles in scientific journals and books, while Field had few. But Wilson suggested that Field's experiences in applied research and management enabled him to become one of the most important prophets for conservation at a time when few in America were paying the topic much attention.

Both men were ahead of their time. Today, an ocean-going research vessel, the 185-ft *R/V Endeavor* operated by the Graduate School of Oceanography, has fulfilled Agassiz's 1892 proposal to Harvard to acquire a 200-ft ocean-going vessel for his lab in Rhode Island. There is a permanent breachway to Point Judith Pond. Aquaculture is a booming business. And the need for conservation is widely recognized. In a reprise of Field's lab, URI returned to Point Judith Pond in 1968 when it set up the Marine Experiment Station near the breachway at the southern end of the pond, in the village of Jerusalem, about 2.5 miles south of Buttonwood Point. In short, the visions of both men for marine research in Rhode Island have been amply realized.

GREEN CRAB CUISINE

A CULINARY SOLUTION TO INVASIVE SPECIES

by **Todd McLeish**

Photographs by **Marianne Lee**

WHEN CATHERINE PUCKETT WORKED FOR THE Block Island Shellfish Commission in the early 2000s, part of the island's shellfish management plan involved trapping and killing green crabs, an invasive species that has been implicated in wiping out the region's soft-shell clam industry.

Native to Europe, the abundant crabs have had a significant impact on other elements of local biodiversity, too. According to University of Rhode Island marine ecologist Niels-Viggo Hobbs, native snails now grow thicker shells to avoid being eaten by green crabs.

"The crabs are voracious. We'd trap and kill them and dump their bodies offshore," says Puckett, who owns the Block Island Shellfish Farm and Block Island Kelp and goes by the name the Oyster Wench. "It sounds awful and it was so wasteful, so it got me wondering if there was something better we could do with them."

Now, rather than fighting the invaders, she's eating them.

Puckett is one of a growing number of shellfish harvesters and chefs who advocate eating invasive species as one strategy for reducing their impact on local ecosystems. She and shellfish commission member George Davis went to a forum in Maine last year to meet like-minded people and came back to Rhode Island with ideas for earning income by encouraging people to eat green crabs.

"It's all about combatting an invasive species by turning it into a delicacy," she says.

In July, Puckett caught several buckets full of green

Chef Yulia Kuzmina of George's of Galilee has developed recipes around unusual seafood species.

OPPOSITE
Kuzmina makes stock with green crabs.

BELOW
Crab bisque is a popular item at George's of Galilee.

crabs and brought them to her friend Phil Walsh, the chef at Finn's, a restaurant and fish market on Block Island. He crushed them and made a crab stock that he used as a base for green crab bisque, crab chowder, Thai curry, seafood gumbo and other recipes. The crabs that were captured just after molting were cooked and served as soft shell crabs.

"He's excited about it because it's a new ingredient that nobody else is into yet," says Puckett. "If I can catch him some big ones, he wants to do a crab boil."

Puckett isn't the only one who has found value in one of the marine environment's most irksome invasive species.

Yulia Kuzmina, the executive chef at the Point Judith restaurant George's of Galilee, has been using green crabs in her recipes for four years. Her green crab curry and crab bisque with corn are especially popular.

"It started with a conversation with our oyster guy," she recalls. "He mentioned that every time he was on the water, the green crabs were everywhere. So I went for a walk with him to the docks to talk to other fishermen, and the crabs are apparently a problem for all of them. So I said, 'Let's start eating them.' I made a couple of stocks and found it to be pretty tasty."

Kuzmina makes a point of serving nontraditional seafood on her menu, including sea robin, scup, skate, and other species that fishermen often consider bycatch.

"Sometimes my customers are skeptical, but we try to educate them as much as we can," she says. "We tell them to give it a try, and now they're saying, 'What else do you have for us?'"

The engine driving much of the region's efforts to eat our way out of the green crab problem is the Green Crab R&D Project, a Massachusetts-based nonprofit with a mission to develop culinary markets for green crabs. The organization partners with chefs to create recipes using green crabs and develops supply chains so restaurants can purchase live crabs.

Mary Parks, the group's executive director, travels to area festivals to share information about the crabs and offer tastings as a way to get the next generation of seafood consumers excited about them. She also co-authored *The Green Crab Cookbook* with Thanh Thai, who runs the blog Green Crab Café, which explores the culinary potential of the species. Written for the home chef, the book not only provides recipes and preparation techniques but also methods for processing the crabs based on traditional techniques in Asia.

Building supply chains so chefs have a reliable means of acquiring green crabs is the biggest challenge.

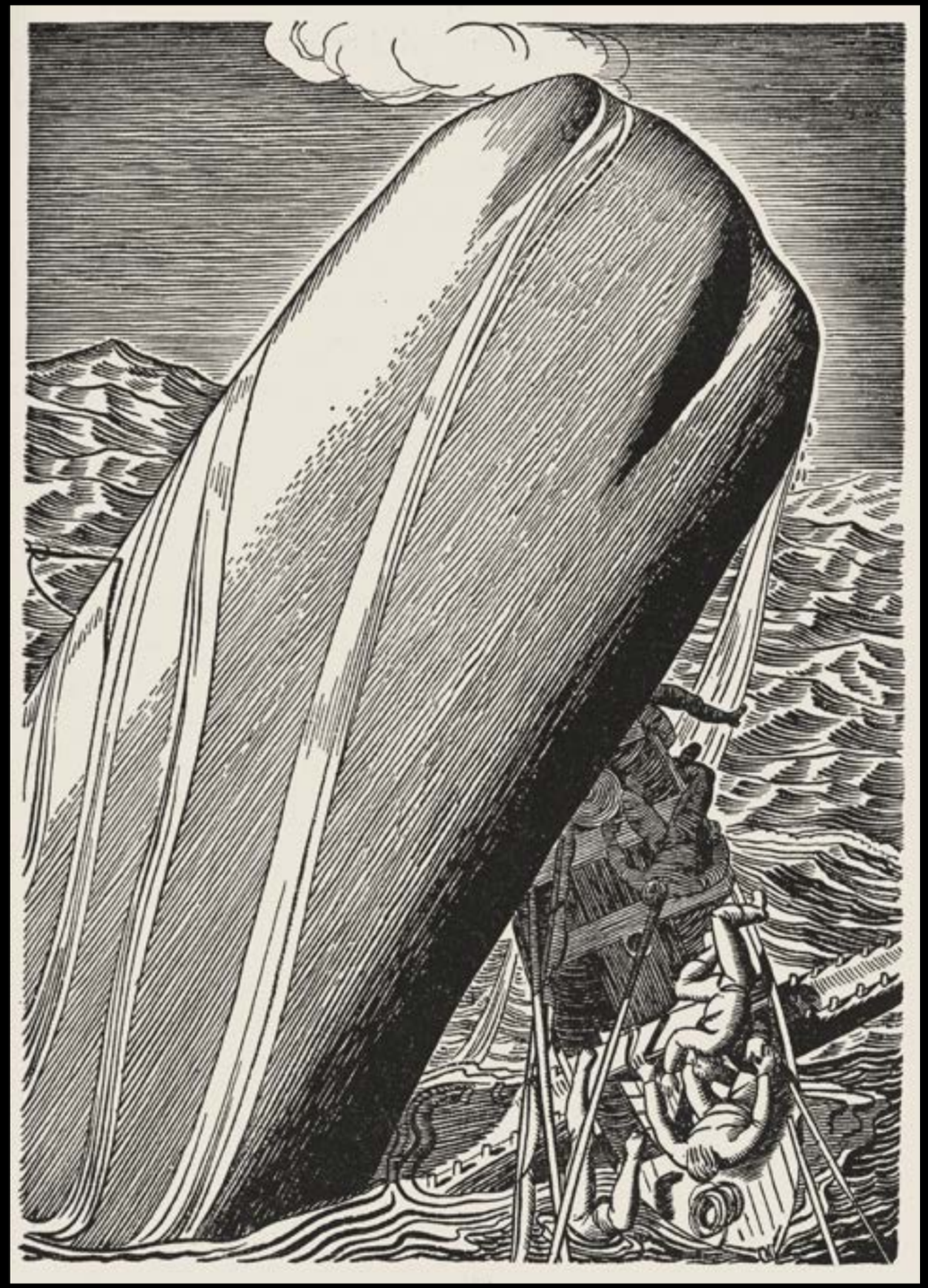
"Green crabs can't be transported live across state lines because they're an invasive species, though that could change as they become a more popular food source. But they can be transported if frozen or if they're processed into a stock or soup," says Parks. "We're working with wholesalers in Boston and New York City who have access to green crabs or to fishermen who could get them green crabs, which has opened up a huge market. We also hear from fishermen who have access to green crabs and are looking for restaurants to sell them to."

The organization's website lists retailers where green crabs can be purchased—including the Portside Fish Market in Warren—and fishermen and growers who are harvesting them, like Catherine Puckett. While Parks admits that the list is small, she knows there are other retailers or fishermen who are catching and selling green crabs that she hasn't heard about yet.

"Just look at #greencrab on Instagram and you'll find rural fishermen who catch green crabs," she says. "That's how we found a woman in Newfoundland doing the same thing we're doing."

With progress being made toward consuming what Parks calls "one of the top 10 invasive species around the world," Kuzmina at George's of Galilee is ready to experiment with region's next major invader.

"Anything that the fishermen pull up, anything we've never heard of before, we'll be the first to get our hands on it," she says. "We'll give it a shot."



Call Me Climate Refugee

by **Richard J. King**

Illustrations by **Rockwell Kent**

At the end of the novel *Moby-Dick*, the infamous white whale smashes headfirst into the *Pequod*. The whaleship begins to sink. Aloft stands Tashtego, a Native American harpooner from Martha's Vineyard, who accidentally nails the wing of a live frigatebird to the topmast above his head. The *Pequod* continues to sink. Tashtego is the last person drowned with the ship, taking the "bird of heaven" down with him.

In his attempt to harpoon the whale, Captain Ahab enrages the animal and ends up killing himself and his entire crew. The only one with the real legal power on the ship to stop Ahab is Starbuck, the first mate, who is unable, quite literally, to pull the trigger to stop Ahab's mad, relentless pursuit of the whale. So Starbuck drowns with the rest. It is only Ishmael, who, by fate or by chance, is flung out of Ahab's small boat and beyond the sinking *Pequod*. As Tashtego takes his last breath, Ishmael, now a floating castaway, watches in powerless horror from afar. "The unharming sharks, they glided by as if with padlocks on their mouths," writes Melville, and "the savage sea-hawks sailed with sheathed beaks." It is not until the next day that Ishmael is spotted from the masthead of another whaleship and rescued, to serve as the only living witness to the tragic journey.

All Rockwell Kent illustrations taken from the 1930 edition of Moby-Dick by The Lakeside Press.

Melville as Naturalist

In the summer of 2017, having read and taught *Moby-Dick* far too many times over the years, I stood aloft aboard the *Robert C. Seamans*, one of the oceanographic tall ships of the Sea Education Association (SEA) in Woods Hole, Massachusetts. Perched some 100 feet above the deck, gazing down on the equatorial Pacific, I often thought about that closing drama and what a floating Ishmael might look like from a whaleman's masthead view.

I'd begged to teach this particular trip so I could sail in this region of the Pacific where I imagine *Moby-Dick* ends. I stood aloft at least two hours every day to look for whales, just as Melville would've done as a common whaleman during his three years in the Pacific aboard three different whaleships.

I was researching the natural history of *Moby-Dick*, first published in 1851, with the idea to use this iconic American novel of the ocean as a benchmark for historical knowledge of marine biology, environmental history, and our cultural perception of the sea. I dove deep into whalemen's logbooks in libraries and into the vast and seemingly endless research by previous Melville scholars. I read narratives, novels, and journal articles that were published in Melville's day, many of which we know he read himself.

What I found is that Melville, through his narrator Ishmael, tried to be as careful as possible as to the details of the marine environment, accurately representing the knowledge of his time, and even occasionally correcting, if not outright mocking, theories and descriptions put forth by lubberly naturalists who had never been to sea themselves. "A whale-ship was my Yale College and my Harvard," Ishmael famously declares in *Moby-Dick*. He later adds to build on his authority: "I have swam through libraries and sailed through oceans; I have had to do with whales with these visible hands."

The whaleman's authority was earned. I do not believe there has ever been or will ever be another time in the history of the human race that we send so many people out to patiently and quietly observe the deep ocean environment in the way we did in the mid-1800s, when our appetite for light and machinery lubrication compelled tens of thousands of Americans, like Melville, to ship out to kill whales. At one point aboard his whaleship *Acushnet*, Melville spent more than six months meandering across the equatorial Pacific, not stopping in a single port and only anchoring a couple times in the Galápagos. Melville's whaleships had no engine. He heard no generator or fan. He stood for two hours a day aloft, often alone, scanning for a splash, a spout, a fin, or perhaps a hunk of squid or a patch of plankton —because whalemen knew well what their prey ate. Theirs was a hunter's knowledge, largely limited to superficial dissections, but it was careful, highly motivated, and built upon first-hand experience.

I'm not suggesting that ol' Herman didn't spin a fish story every once in a while or twist things here or there for the purpose of telling a mighty yarn, but over the last several years I've interviewed marine biologists and oceanographers to get their opinions on *Moby-Dick,* and I've been surprised to learn how many descriptions in the novel match our 21st century knowledge. For example, I turned to the University of Rhode Island Graduate School of Oceanography's Bob Kenney, a right whale expert, to help me understand the nature of the plankton on which Ishmael's right whales graze through in the Indian Ocean. Ishmael describes these whales feeding in a region where they were known to be common, and he perhaps describes a sound coming from the right whale's baleen while skim-feeding, a "baleen rattle," which was not described by the scientific community until the 1970s. I interviewed URI's Justin Richard, a beluga whale expert, to learn about Ishmael's description of the whale's spout. "Melville gets the spout mostly right," Richard told me. "It's not just mist. Like Melville said, part of it is the seawater that's been sitting in the depression over the blowhole, which combines with this super powerful exhale, filled with carbon dioxide. This condenses with the outside air."

Sperm whale biologists confirmed for me that all of the white whale's behaviors in that final chase had been recorded at the time and have since been confirmed. And I spoke with two separate shark experts who explained to me that Ishmael's gothic and graphic descriptions of sharks are actually surprisingly accurate, despite the authorial drama, right down to the cannibalism, the perfect circular holes the sharks chomp into whale carcasses, and even their disinterest in eating humans on purpose.

One afternoon while I was aboard the *Robert C. Seamans*, only a few days north of American Samoa, I was standing on deck after we conducted a man-overboard drill. We recovered a fender that Captain Chris Nolan threw over the side. Nolan, a former U.S. Coast Guard officer, explained to us just how quickly our little coconut heads would disappear in the waves, particularly if any kind of sea was running.

"Survivability is governed mostly by water temperature," Nolan said. "In

warmer waters, you can sometimes survive up to 48 hours, or even longer. Even in 90-degree waters, like right around here, you're still losing heat and you'll get hypothermia. I've certainly heard of people surviving for days—the will to live is big in that. But if you're in the water, you are going to die."

After the drill, I asked Nolan about predators in the water, thinking about Ishmael's "unharming sharks" at the end of *Moby-Dick*—if that was something for which the Coast Guard plans.

"No. There's no biological discussions in that training," he said. "I think the sharks are more about curiosity. They are scavengers around bodies. I've never heard of any rescue of someone alive in the water where the rescuers had to fend off sharks."

Ishmael as Climate Refugee

When I stood aloft that summer aboard the *Robert C. Seamans*, we sailed toward the equator and into the Phoenix Islands Protected Area, a gargantuan swath of the Pacific that is larger than some 130 Rhode Islands. This area was recently dedicated as a marine preserve by the government of Kiribati, which has been working with the New England Aquarium and SEA to conduct annual baseline oceanography. Kiribati is one of the island nations in the Pacific that is most vulnerable to sea level rise. With about 100,000 citizens, it is on the front lines of climate change, the complex and cataclysmic global problem caused by nations and cultures half the world away.

While I was standing up there, swaying and watching the surface each day, I thought about Ishmael as a symbol of today's climate refugee. The Kiribati people have begun planning for retreat from their islands because of the rapid loss of arable space and the pollution of their groundwater. They will almost certainly represent one of the first, if not *the* first, nations to be without a claim to home soil because of climate change. For the first time in recorded human history, an entire culture will be a stateless republic of climate refugees.

So even though Melville never intended this, I can't help but read the end of *Moby-Dick* with Ishmael, the biblical orphan, representing a victim and a witness to events he had no power to stop. Fittingly, the frigatebird is the national symbol of Kiribati, that same "sky-hawk" or "sea-hawk" (whalemen's common names for this bird) that Tashtego takes down with him at the sinking of the *Pequod*—and the same seabird, along with the sharks, that permits Ishmael safe passage with "sheathed beaks" after Moby-Dick sinks the ship.

I still go aloft whenever I am teaching aboard the SEA ships. I look for whales or anything else, just to try to connect to that quiet, deep-sea observation from aloft that is so difficult to replicate anywhere on Earth. And I remain struck by how accurate Melville was in terms of his marine biology, oceanography, and meteorology in *Moby-Dick*—from albatrosses to Zueglodons—as well as by how prescient he was in the earliest years of the Industrial Revolution. He anticipated our future empathies for marine mammals and our paradoxical perception of the sea, which remains both inspiring and terrifying.

Yet Melville in the 1850s could never have imagined our current goal of "saving the oceans"—our recognition of the need to steward the sea. In *Moby-Dick,* Ahab stands aloft and declares his ocean "The same!—the same!—the same to Noah as to me." How could Melville possibly conceive that humans could alter the global ocean? That we could alter the very height of the surface, shift the very chemistry of the entire sea, and that our actions could render heaven's storms more intense? This was an impact too far beyond even Melville's imagination—and our own.

And so it is goes today that our lack of national imagination results in our inability to collectively slow climate change. Will the climate refugees and our descendants read us as Ahabs? Or more as Starbucks, the chief mate in *Moby-Dick* who has the power, but is unable to act?

Richard J. King is the author of Ahab's Rolling Sea: A Natural History of Moby-Dick, University of Chicago Press, 2019.

GROWING STRONGER

Although the COVID-19 crisis has been stressful for oyster growers, Jennifer Scappatura says, "It has brought us all closer to help each other keep our industry going."

Photograph by Jesse Burke

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Photographer Jesse Burke and his daughter Clover, 14, worked together on the photoshoot for our cover story. Jesse said he often brings Clover to work with him as an assistant. "She loves helping me and seeing what a real photoshoot looks like. Especially when it's as much fun as the Quonnie shoot, where we met other teens working with their parent and all of us doing it together. It was magical."