In a Maine Fishing Village, a Microplastics Researcher Reenvisions Aquaculture

By Brian Kevin
Photographed by Greta Rybus
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We open on the rotating globe: some brown, a bit of green, but mostly the mottled blue of a single world ocean. Blooming with phytoplankton in its light-filled reaches and sheltering, in its depths, the bulk of the planet's animal biomass, it covers some 71 percent of Earth's surface. It churns with a confusion of wind-driven currents and deeper, colder ones, moving water along a great, 1,000-year circuit, from the North Atlantic to the southern seas and back, a global conveyor belt distributing nutrients and sweeping past and into the Gulf of Maine. Zooming in on the gulf, we see the tides massaging New England's bedrock coastline, filling and draining its innumerable coves and estuaries and enfolding, in the gulf's middle latitudes, clusters of granite islands, like those of Maine's Deer Isle archipelago. There, near a village called Oceanville, the salt water surges between two forested necks, then presses through a narrow channel to fill a tendrilled cove streaked with strings of oyster floats. And there, tending them over the gunwale of a roughed-up scow, is Abby Barrows.

A 37-year-old Stonington native, tanned and sinewy, Barrows pulls one floating bag at a time, unfastening it from its line and emptying its contents onto a sorting table, where she cleans and culls her oysters by hand. The largest and best she sorts into a few waiting harvest bags, to wash and deliver to customers later on. The rest she returns to their original bag, scrubbing away any fouling and giving it a good shake, to chip away the oysters' brittle edges, before reattaching it to the line, flipped over from its prior orientation. It is a routine she has performed countless times since taking over her nearly 2½-acre aquaculture lease in Deer Isle's Long Cove, in 2015.

Along most of her lines, Barrows's oystering gear is largely indistinguishable from gear found at any other Maine oyster farm that uses the floating-bag method. The rectangular mesh bags enclosing the oysters are made of high-density polyethylene — marine-grade plastic, it's sometimes called — with foam or industrial-plastic floats, attached with plastic zip ties, to keep bags on the water's surface. As long as the mesh is kept clean, water flows through, and the oysters feed by filtering algae particles from it, improving water quality in the process by removing excess nutrients and sediment. As oysters grow, they are transferred into bags with larger mesh, allowing more water, and thus more food, to flow through.

At Long Cove Sea Farm, Barrows relies on a lot of secondhand gear, brushes she found washed ashore, rope picked up at the dump. "I try not to feed the maw of the industry," she says.

But at Long Cove Sea Farm, one line of gear has a section that's different from the others. Barrows is growing many of her pebble-size first-year oysters inside a set of experimental enclosures, cedar boxes with fine stainless-steel mesh on their tops and bottoms, their floats fastened on with stainless-steel ties. Some of the boxes are then enclosed in traditional plastic oyster bags, while others are set inside wire cages known as ranches. It's a setup that eschews much of the plastic materials that oyster farms typically rely on, the first baby steps of a USDA-funded project to identify, test, and compare alternative materials.

For Barrows, the project is an extension of a professional interest and personal fixation that has shaped the last 10 years of her life, one that has sent her around the world, earned her the cooperation of thousands of volunteer researchers, and garnered attention from the World Health Organization, the National Geographic Society, and others. Its focus is microplastics, a class of polymer fragments that includes tiny pellets manufactured for commercial and industrial use (say, exfoliating beads in shower gel), as well as shreds and fibers of degrading plastic-based products: fleece jackets in the washing machine, car tires losing tread, oyster bags and other marine gear corroded by wind and waves.

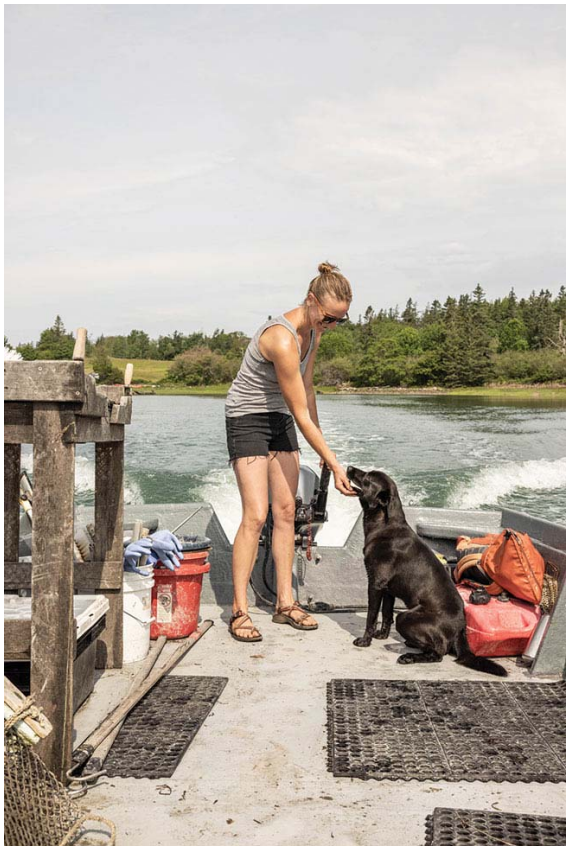
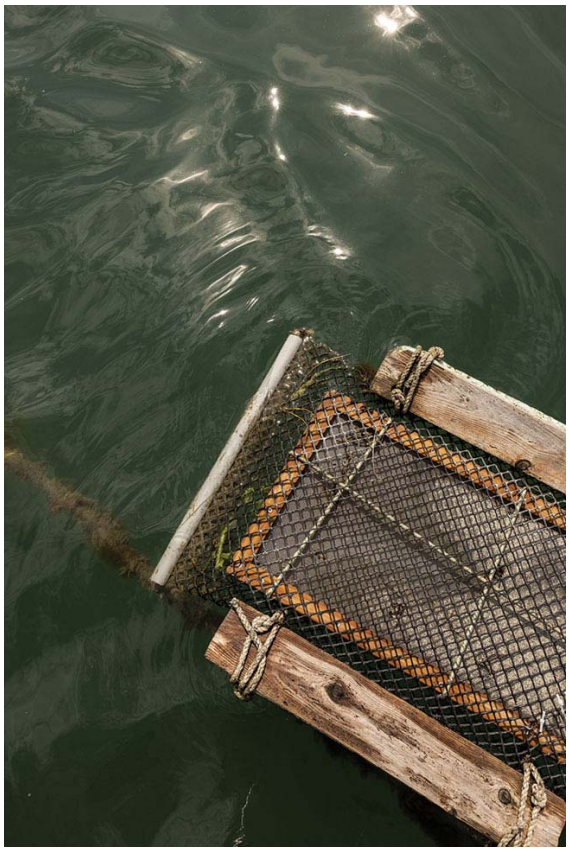
Today, microplastic pollution is a rapidly emerging field of scientific study and increasingly covered in the popular press — sometimes with apocalyptic overtones. But 10 years ago, when Barrows first learned of its existence, there was so little awareness around microplastics that the then-journeyman scientist was captivated by their obscurity. It was like she'd discovered an asteroid hurtling towards Earth before anyone had heard of asteroids.

"I thought, this is a huge issue that no one knows about," she says. "I live in a community that relies on the ocean, and no one is talking about this or aware of this — no one even knows what's happening."

Barrows grew up on the water, but at a remove from the deeply entrenched fishing culture of Deer Isle, the woolly island at the east end of Penobscot Bay where the port town of Stonington has long been the hub. The bridge connecting Deer Isle to the mainland was fewer than 30 years old when Barrows's dad moved from Connecticut to Stonington, in 1968. On an impulse, fresh out of college, Nat Barrows purchased the town's weekly newspaper, and though he later founded an influential commercial-fishing trade publication, he was not a fisherman. Barrows's mother, a nurse and native New Jerseyian, was an inveterate sailor and imparted to her children a love of boating and the ocean. As a kid, Barrows says, "I was always tooling around in little boats."

Her parents had a small farm, and she grew up loving animals. After high school, she and her boyfriend — now husband, Ben Jackson — went to Australia to volunteer on organic farms. Barrows loved Deer Isle, but she had a teenager's angst and itchy feet. Her plane ticket down under was one-way.

In 2003, she enrolled at a public university south of Sydney to study marine biology. A year in, she met a grad student who invited her onto a research team mapping old-growth forests in Tasmania, and she fell in love with her second island. Barrows transferred schools and spent her remaining college years crew-hopping in Tasmania: she trapped Tasmanian devils to study their facial tumors, dissected feral cats to investigate their stomach contents, surveyed endangered parrots on a remote mountainside. "In Tasmania, I realized science is what I really wanted to do," she says. "It reinforced my initial urges: I like getting dirty. I love the fieldwork."

- 
- 

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Tending to her oysters (with help from pooch Fife), Barrows looks in on this season's class of baby oysters, some of which are stored in prototype cedar boxes with screens, rather than more typical bags of fine plastic mesh.

A zoology degree in hand, Barrows took a job managing assistants on a seahorse survey off Papua New Guinea. Her crew worked out of a research station on a roadless island called Motupore. “It was ringed by mangroves on one side,” Barrows remembers, “and you'd just be up to your knees in the mangroves in trash. Any kind of plastic you can imagine — water bottles, whatever.” It was ocean flotsam, not left by locals. “People there are in dugout canoes, still very much subsistence living,” she says. “So seeing all that was pretty wild.”

On another Papuan island, the first thing she saw upon stepping ashore was a large pile of partially burned plastic bags. On a boat trip in West Papua, on which passengers were offered Styrofoam containers of fish heads and rice, she stood on the top deck to look back at the boat's wake. “I remember just seeing trash bag after trash bag full of Styrofoam,” she says. It started dawning on her what a crisis ocean plastics had become.

Following further travels — Nepal, the Middle East, Scotland — Barrows returned to Deer Isle in 2009. “The longer I was away, the more I realized what a unique and special community this is,” she says. She took temporary jobs — thirding on a lobsterboat, substitute teaching — while chasing short-term fieldwork around the globe. Everywhere she went, she saw plastic. Surveying sea turtles in Uruguay and Costa Rica, she found loggerheads with stomachs full of it or fins amputated after being caught in it.

In 2011, Barrows took a job coordinating education programming at Blue Hill's Marine & Environmental Research Institute, a nonprofit focused on environmental health. (Today, it's known as the Shaw Institute, for its founder, Dr. Susan Shaw.) Martha Bell was the institute's education director and remembers hiring Barrows after a phone interview.

“She had gone off and traveled the world, done her independent thing, and was just kind of coming back to the community,” Bell says. “She had that knack for communicating science. From the very beginning, she was able to really read her audience well.”

Barrows played tour guide on eco-cruises and designed curricula for youth programming focused on marine conservation, with occasional guest speakers. One was an undergraduate at Bar Harbor's College of the Atlantic, Marina Garland, whose senior project focused on ocean plastics. During a semester at sea, Garland had learned from a professor to search seawater samples for microplastic particles using a microscope. She showed Barrows and her students, and when Barrows took her turn looking down the ocular, she felt a switch flip.

“The microplastics just got to me,” she says. “I had no clue.”

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Keeping the screens clear is critical to keeping the oysters fed and healthy.

Soon, Bell and Barrows were incorporating microplastics sampling into their youth programming. “The teens were just wowed by it,” Bell recalls. “We had a whole setup at MERI where we were filtering and looking at samples. Anyone who came through, we'd show them the microplastics, and people would say, ‘Oh my god, I can't believe this.’”

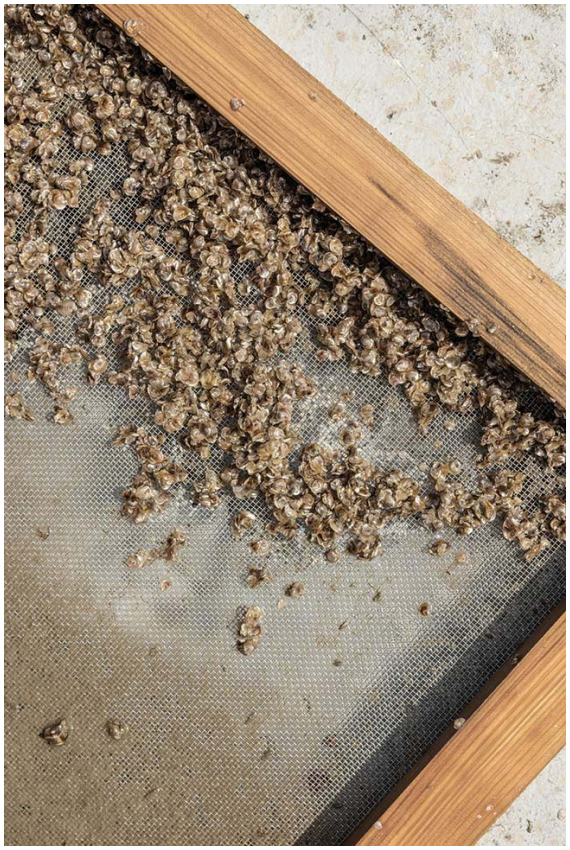
Almost overnight, Barrows found herself preoccupied with determining where the plastic motes were coming from and where in the natural environment they might be found.

“How much plastic we use, how much pollution is going into the water, how much our synthetic clothing has a role — that’s the thing I'd always talk about with people,” Barrows says. “‘My L.L.Bean polar fleece can shed thousands of microfibers that are basically going directly into our waterways?’ And not only when you wash it, but when you dry it and when you wear it, it's shedding.” She laughs. “I was such a shitty person to go to a party with for a few years.”

Now, we're zooming in close, seeing what Barrows saw under the microscope: A confetti of colorful squiggles, some of them tangled, like bits of string in a junk drawer. These, from synthetic fabrics, are known as microfibers. Miniature marbles the color of sea glass, called microbeads when they make your toothpaste abrasive, called “nurdles” when they're to be melted and poured into molds. Indistinct crumbles like chunks of mined ore. These are fragments of Styrofoam and other plastic goods, broken down by entropy and UV light.

Scientists define microplastics as plastic particles smaller than five millimeters across. A British marine biologist coined the term in 2004, but as of a decade ago, when Barrows's interest was piqued, there were only a handful of peer-reviewed papers evaluating their abundance, distribution, or effects on ecosystems. The scholarship is more robust today, though much of the science remains hazy. Lab studies, for example, suggest that marine organisms ingesting microplastics may reproduce less successfully, sustain tissue damage, and suffer nutritionally. But how well those studies mimic the natural environment is an open question. More certain is the fact that many plastics contain additives — pigments, say, or stabilizers — known to be carcinogens or endocrine disruptors.

What most concerns Barrows is that microplastics are known to accumulate persistent organic pollutants. Known as POPs or “forever chemicals,” they're a class of contaminants that includes the pesticide DDT and dioxins from paper mills, and they linger in the environment long after their use. Studies show concentrations of POPs in microplastic pellets many orders of magnitude higher than in the seawater they float in. Researchers disagree over whether those toxins can readily transfer from a plastic particle to an organism that consumes it, but Barrows isn't the only scientist made nervous by the possibility.

- 
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For years, Barrows tended her gear out of a small wooden rowboat, which she now uses to get to and from a larger outboard scow.

In 2013, Barrows transitioned from education to research at MERI, taking over the institute's water-quality monitoring program. Testing water samples from sites across Blue Hill and Penobscot bays, she initiated Maine's first baseline-data map of microplastic pollution. She launched a food-web study analyzing tissue from Maine mackerel and shellfish (including oysters and lobsters), identifying microplastic particles in 96 percent of the samples. Seeking the best way to gather water samples, she led a comparison study and authored a paper illustrating that plankton nets, the most-used method for sampling microplastics, were inferior to simple "grab samples" — that is, jars filled by hand.

When Barrows wanted to take her data collection global, she approached a nascent Montana-based nonprofit called Adventure Scientists. Founded in 2011 by Gregg Treinish, an accomplished backpacker and wilderness educator, the organization aims to recruit and train hardcore outdoorspeople — mountaineers, kayakers, and the like — to collect samples and data from remote, often hairy corners of the globe. Barrows reached out to Treinish, who was hungry for meaningful partnerships and knew MERI by reputation. Together, Barrows and Adventure Scientists launched what would become a five-year effort to gather and analyze samples from all the world's oceans and from freshwater sites as well, creating the world's largest microplastics data set.

Barrows designed a field methodology for thousands of adventurers who would collect some 2,400 samples from Greenland to Antarctica, Maine to Madagascar to Myanmar. She did the lab work through MERI at first; then, when the institute changed its research focus in 2015, Adventure Scientists put her on its payroll. She set up her own lab in a rented space in Stonington and enrolled as a grad student at College of the Atlantic — to the surprise of Treinish, who hadn't realized his principal investigator did not have an advanced degree.

"It goes to show that if you have passion about an issue and a hunger for knowledge, like Abby does, you can have a pretty big impact anyway," Treinish says. "She quickly has become a leader in the field, to the point where her old email address here, I still get requests all the time for her to review papers, to do magazine articles, to be a speaker."

The project picked up media traction, not least because its citizen scientists included Arctic explorers, pro surfers, and other high-profile adventure travelers. When Barrows and her collaborators published their results in a peer-reviewed journal article in 2018, it made a splash, concluding that every major ocean basin on the planet is contaminated with microplastics at substantially higher concentrations than models suggested. Some 74 percent of the project's samples contained microplastic pollution, 90 percent of which were microfibers. The Gulf of Maine was second only to the Caribbean in having the highest amounts of microplastics of any sampled region in the Atlantic.

The Global Microplastics Initiative considerably boosted Adventure Scientists' profile. Barrows was invited to speak at conferences and marine-education events worldwide. Data from the project, free and open-source, continues to aid researchers.

"More than 250 institutions have used the data set, from middle-school students using it for reports up through the World Health Organization and the EPA using it to help create maximum contamination limits," Treinish says. "I do think we helped get microplastics on the map at places like National Geographic and TED. In 2014, nobody was talking about microplastics. The fact that you can now ask probably 70 percent of Americans what a microplastic is and they'll know? That was not the case when we started."

At an outdoor cleaning station behind her childhood home, Barrows sprays grit off oysters from her morning harvest. Her year-old Lab-terrier mix, Fife, prances around her legs ("pandemic puppy," she says). Nearby, she and her husband are building their own house, every step themselves, right down to milling their own lumber. Until it's done, they've alternated house-sitting, living in a trailer, and staying with Barrows's dad in the house she grew up in. (Her mother, Ann, died of breast cancer in 2014.) On a back porch, she's set up a pickup station for customers, with a fridge full of oyster orders, a selection of wine bottles, a basket of oyster knives, and a few Long Cove Sea Farm totes.

One day in 2015, as the Adventure Scientists project was getting started, Barrows called a local grower to ask whether she could buy a few oysters. The grower said she was out, but how would Barrows like to buy the whole farm? She'd never tasted an oyster until she was in her 20s — "not a big thing growing up in Stonington," she says — but she'd nursed an interest in aquaculture because of oysters' water-quality benefits. She bought the farm as a sort of side hustle. "I was a total weekend warrior at first," she says.

But in 2018, with her master's degree and the Global Microplastics Initiative wrapping up, she realized it was time for a change. That March, she was prepping for a trip — a conference in San Diego, then a pollution-education junket in Indonesia — when she learned she was pregnant. "I recognized this was going to be my last hurrah for a while," she says. "It was a great run. I did tons of speaking engagements. I got to go on really cool expeditions. Now, I could just focus on being a mom and trying to run my own business."

Her daughter, Io, was born that November. Come spring, Barrows was setting up a pack-and-play in her oyster scow so the baby could join her parents tending gear.

That summer, Barrows headed down east to speak about microplastics at an event called the Seaweed Symposium. She was invited by Severine von Tscharner Fleming, a farmer, seaweed cultivator, and beginning oyster grower who directs the Pembroke-based Greenhorns, a media and education collective focused on small-scale farming. After Barrows's presentation, von Tscharner Fleming piped up from the audience to ask what Barrows planned to study next. Barrows, sounding a bit pensive, said she hadn't quite figured out how to direct the energy she'd put into microplastics research.

"I would really love to marry the oyster farm with some of the plastics studies," she said, "figuring out some ways to do some gear experimentation."

Afterwards, von Tscharner Fleming approached Barrows about working together on a grant proposal, and this spring, they were awarded $15,000 by the USDA's Northeast Sustainable Agriculture Research and Education Program, to "identify durable, inexpensive, ecologically friendly materials for aquaculture systems, especially oyster cultivation." Barrows's cedar-box setup at Long Cove represents the project's infancy. The plan is for those baby oysters to try out a number of alternative gear arrangements during the two years they're in the water. When they're big enough, Barrows will transfer them into metal-mesh bags. Already ordered is a supply of cork and mycelium, a buoyant fungus, that Barrows and von Tscharner Fleming will fashion into plastic-free floats. Their grant proposes experimenting with a number of biomaterials, including slatted wooden crates in lieu of polyethylene bags, linen and hemp rope to replace zip ties, and pumice and coconuts for floats. Throughout the growing season, Barrows is collecting data — oyster size, water temperature and salinity, levels of fouling, and more — to compare the experimental-gear group with a

conventional-gear control group.

Right now, she says, the amount of plastic that oystering brings to Maine's waters may seem trivial. But that volume could skyrocket as Maine aquaculture continues to boom. From 2010 to 2019, Maine's growers went from harvesting roughly 3 million oysters a year to a bit shy of 14 million. The number of shellfish leases jumped by more than a third during that time. Marine gear accounts for perhaps 20 percent of the eight million tons of plastic that makes its way into the oceans each year. And while pushing alternative gear may be daunting in an established fishery like, say, lobstering, Barrows sees these early days of Maine oystering as a chance to forge a more sustainable path while there's still comparatively little gear in the water.

Deer Isle's Long Cove, where Barrows grows her oysters, has an idyllic feel, though Barrows says the shoreline is more developed than she remembers growing up.

"Aquaculture is going to be a big part of Maine's future," she says. "We have this opportunity to rethink our current systems and materials, so why shouldn't we? There may be bigger fish to fry, but this is an opportunity that's kind of a no-brainer."

Sebastian Belle, executive director of the Maine Aquaculture Association, says Maine's sea farmers tend to have a DIY ethos and a zeal for innovation, not to mention a reverence for water quality. "Cost is always a factor," he says, "but there's no doubt that if there was a product out there that held up, was strong enough to survive wave action and storms, was easy to recycle if it's recyclable, and was better than plastic — I'm sure there would be a great deal of interest."

Barrows hopes that, within a few years, Long Cove Sea Farm can be a model of what plastic-free — or, at least, plastic-reduced — aquaculture might look like.

Von Tscharner Fleming, who's also testing alternative gear, in Pembroke, thinks Barrows can drive the conversation, as she did with microplastics. "Abby is an aqua-babe," she says. "She's somebody who inspires other people, and to the extent that you have inspiring people demonstrating what's viable and explaining best practices, that does put us on a better path."

When her oysters are washed and bagged, Barrows hops in her Mazda minivan to make deliveries. She's still a small operation, moving 1,000 to 1,500 oysters per week, all locally, some through pop-ups at events and some to restaurants like Deer Isle's Aragosta or the Brooklin Inn. Her oysters have their devotees. They're creamy, and because Long Cove has less freshwater input than oyster-growing rivers and a big tidal flush renewing its waters, they taste notably briny and clean. They taste like the ocean.
