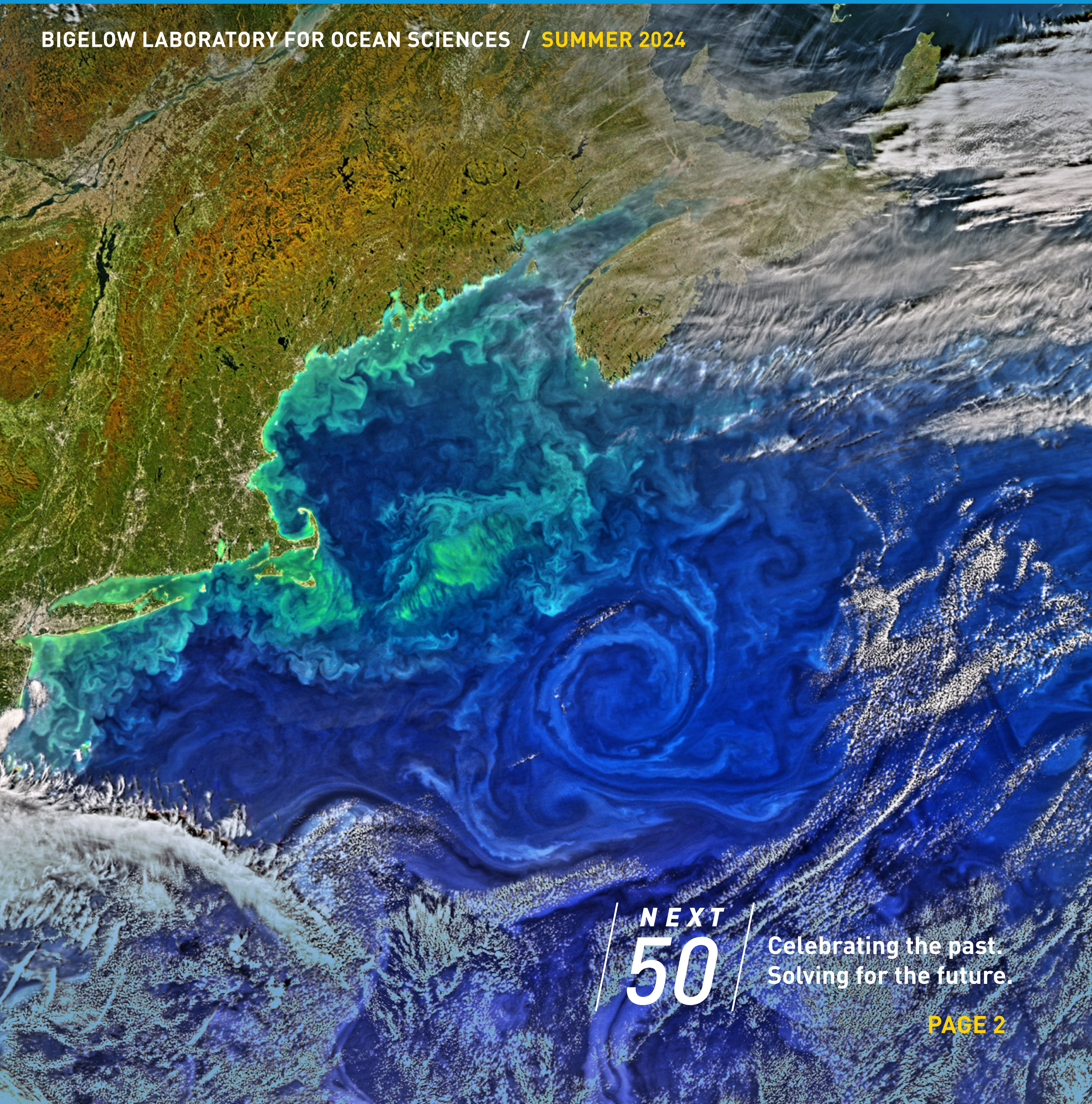
TRANSECT

BIGELOW LABORATORY FOR OCEAN SCIENCES / SUMMER 2024



NEXT 50

Celebrating the past.
Solving for the future.

PAGE 2

What an honor to be at Bigelow Laboratory as we celebrate the incredible legacy of this institute's first 50 years and look ahead to the coming decades!

Bigelow Laboratory was designed from the ground up by scientists to supercharge ocean discoveries, solutions, and inspiration. And what a success it has been! Over the last 50 years, the institute's unique approach has produced exceptional science and impactful innovations — a sliver of which is described on the pages to come (beginning on page 2). From nurturing the birth of satellite oceanography to unlocking the genetic potential of the ocean with single cell genomics, Bigelow Laboratory has had enormous influence on what is known about the ocean and how scientists study it.

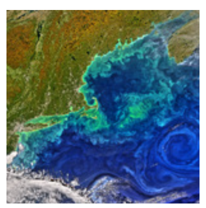
And that influence continues to grow. On page 16, you'll find our latest Impact Report, which shares a glimpse of the recent progress our researchers have made. That work was only possible with the help of supporters like you. Following the Impact Report, you'll find a list of all those who have donated to support our research around the world over the last year. I, and every member of the Bigelow Laboratory staff, are immensely thankful to each person and organization listed for investing in a better future through our science.

With the help of our generous donors, we're working hard each day to understand the foundation of global ocean health, the ways that climate change is challenging it, and the incredible potential of the ocean to support a healthy planet and society. We're applying all we learn to develop urgently needed solutions, and we're inspiring the next generation of scientists by embedding them in our research.

And we are only getting started! As our staff and state-of-the-art laboratory continue to grow, Bigelow Laboratory is headed into its next 50 years poised for even greater success — and we're so glad you'll be part of it.

Deborah A. Bronk

DEBORAH A. BRONK, Ph.D.



ON THE COVER

For almost 50 years, Bigelow Laboratory scientists have pioneered the use of satellites to study the ocean. A NASA image of the Gulf of Maine shows how the presence of phytoplankton shifts the color of seawater, which scientists can use to measure biological productivity. Learn more about recent advances in satellite oceanography on page 8.

Photo: NASA

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CONTENTS

A MICROSCOPY IMAGE shows the complexity of larval lobsters at four different stages of development. Senior Research Scientist David Fields studies how lobster larvae are responding to climate change and ocean acidification at a developmental and genetic level — critical knowledge to support this iconic species and fishery.

Photo: Jesica Waller

Loaded with ambition and science equipment, a small research vessel called the *Bigelow* arrived in Boothbay Harbor 50 years ago. In the decades since, Bigelow Laboratory's bold and creative approach to science has transformed our independent nonprofit from a scrappy startup to a world-renowned hub of ocean science.

While many things have changed, the ideas that guided our founders still shape us today. We hold true to our unique approach to research and our focus on the key marine species that form the foundation of global ocean health. Our guiding beliefs have enabled a rich history of excellence and innovation, and they continue to drive our science and solutions to some of our planet's most pressing challenges.

NEXT 50

Celebrating the Past. Solving for the Future.

Over the next several pages, we'll look back at Bigelow Laboratory's history of innovation and how we're building on those successes to shape a better future. We can only cover a small fraction of the work that's been done, but we hope this historical journey provides you with fresh insights into our mission and the unique approach that continues to power our global impact.

We look forward to celebrating all we've accomplished with your help throughout this year — and looking ahead to the world we're working to create over the next 50!

1970s

A New Era of Ocean Discovery

In the summer of 1974, a small vessel, outfitted for scientific research, docked at McKown Point in West Boothbay Harbor, Maine. It was the beginning of Bigelow Laboratory for Ocean Sciences — founded by Charles and Clarice Yentsch and named for Henry Bryant Bigelow, whose early scientific observations in the Gulf of Maine established him as one of the founders of modern oceanography.

The new institute was envisioned as an independent collaboration of creative researchers. The founders sought to break down traditional barriers to discovery, prioritize research above all else, and foster interdisciplinary collaboration. Scientists were encouraged to study the ocean as a coherent unit and from many different perspectives — in line with the philosophy of Henry Bigelow.

GUIDING BELIEF #1

We believe that independence leads to innovation.

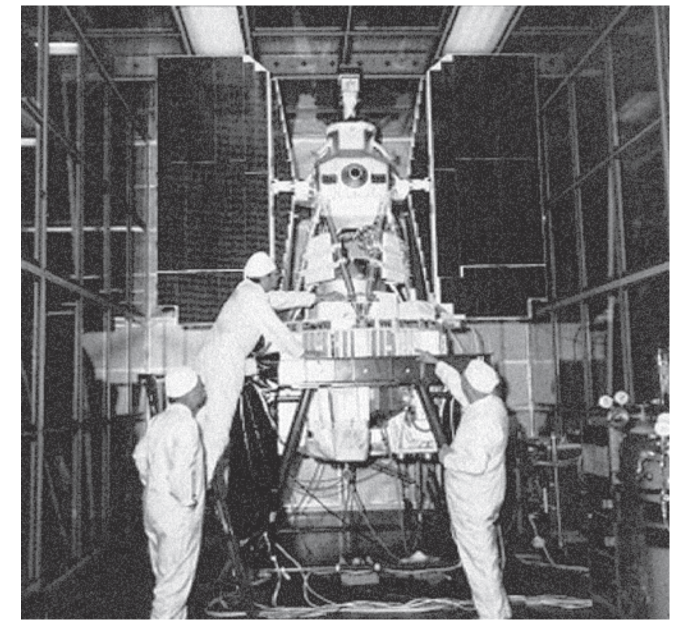
From the beginning, scientists hosted open houses and public lectures to share their work with a broader audience, and they organized a visiting scientist program and an in-house seminar series to share methods and encourage collaboration.

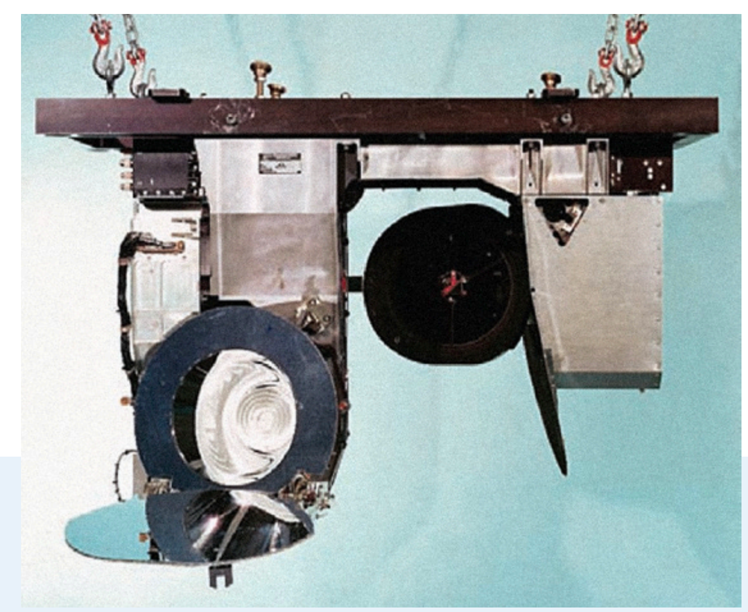
These formative years would shape the laboratory's focus and approach throughout the coming decades, as would the institute's close relationship with the state. Not only did the State of Maine offer an endowment to help the new institute get on its feet, they also leased the land that the institute would occupy for almost 40 years. Until 2012, Bigelow Laboratory adjoined the Department of Marine Resources facilities in West Boothbay Harbor. This facilitated a long-standing collaboration between the two entities on the monitoring of harmful algal blooms and shellfish biotoxins that continues to this day.

In 1974, there were 12 scientists and support staff working at McKown Point. Within just two years, the laboratory was up to 17 scientists, 12 research assistants, and nine administrative and technical staff. By the third year, annual funding exceeded a million dollars, a five-fold increase from the first year.

TOP Charles and Clarice Yentsch, the scientists who founded Bigelow Laboratory in 1974, pose together at a later date. **ABOVE RIGHT** The original Bigelow Laboratory facilities on McKown Point in West Boothbay Harbor (*photo: Robert Mitchell*). **CIRCLE** Jeff Brown works on the old Bigelow Laboratory research vessel.

TOP NASA scientists install early ocean color instruments in 1978 on the *Nimbus-7* satellite, for which Charles Yentsch was on the scientific team (*photo: NASA*).
MIDDLE A model of the Coastal Zone Color Scanner, the first satellite instrument devoted to the measurement of ocean color, which was integrated into the *Nimbus-7* (*photo: NASA*).
BOTTOM Betty and Pat Jackson, the first major donors of Bigelow Laboratory in the 1970s, donated waterfront acreage in Southport when financial insecurity threatened to close the original location in West Boothbay Harbor.





INNOVATION INSIGHT

A MODEL FOR NIMBLE SCIENCE

BY BARNEY BALCH, *Senior Research Scientist Emeritus*

To understand Bigelow Laboratory's first 50 years, one needs to know about the founders, Charles and Clarice Yentsch. I met the Yentsches as a pimply-faced 14-year-old in 1972. I didn't understand much about marine science at that age, but I could appreciate Charlie's and Clarice's can-do attitudes, charisma, and ability to think outside the box.

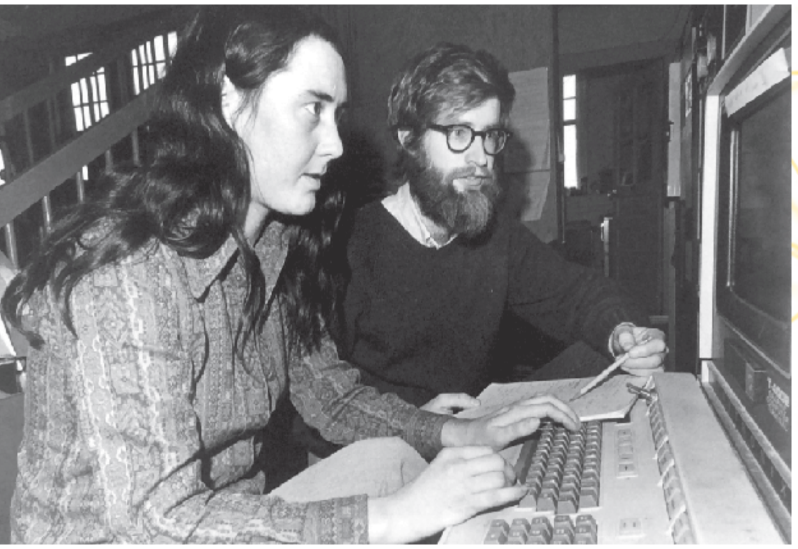
Before Bigelow Laboratory existed, the Yentsches arrived in Gloucester in 1970 to start the University of Massachusetts Marine Station. They landed at a laboratory completely unready for occupancy. But that didn't deter them; they found an unoccupied church and clamped sheets of plywood to the pews to use as lab benches. That spirit of resourcefulness prevailed again a few years later when the Yentsches had the foresight to negotiate one-dollar annual rent on a vacated federal lab in West Boothbay Harbor, Maine. They named their new institute after a pioneering founder of modern oceanography, Henry Bryant Bigelow.

They understood that people are an institution's greatest asset. For subsequent decades, they lured the best minds in the business. From the beginning, Bigelow Laboratory had a laser-like focus, studying the base of the marine food web on which all life in the sea depends, from the scale of single viruses to entire ocean basins. Yes, funding was not always rosy, and there were tough times. But the institute has constantly and nimbly evolved to stay on the cutting edge.

We're now in a time where our research targets topics as diverse as environmental DNA of marine ecosystems to decadal-scale climate change of the global ocean. Some of our scientists are even asking questions about other ocean worlds within our solar system, a truly exciting, expansive, and daunting challenge — and a remarkable transformation from scrappy plywood lab benches a half century ago! Here's to the next 50 years of Bigelow Laboratory for Ocean Sciences! Long may it thrive!

CAFÉ SCI

Learn more from Dr. Balch on July 16. See page 25 for details.



1980s

Global Reputation in Innovation

Throughout the 1980s, the institute's reputation continued to grow. Bigelow Laboratory scientists were active participants in the Joint Global Ocean Flux Study, an international initiative to study the impacts of increased atmospheric carbon dioxide concentrations. They established a new remote sensing facility to expand the use of satellite imagery in oceanography and continued to work with the Department of Marine Resources to monitor the Gulf of Maine. All the while, the institute strengthened its science funding and outreach with its first development and communications director and a new membership-based program to recruit supporters.

One of the most important advancements of the decade, which helped stabilize the institute's funding and secure its position in the field, was the establishment of two Discovery Centers that made research resources available across the institute and to scientists around the world.

In 1980, scientists recommended the creation of a national collection of marine phytoplankton. Initially housed at Woods Hole Oceanographic Institution, it moved to Bigelow Laboratory in 1981. By the end of the decade, the collection — now known as the National Center for Marine Algae and Microbiota — had tripled in size.

Meanwhile, in 1983, the institute launched its new flow cytometry center to apply a laser-based technology, adapted by Bigelow Laboratory scientists from the biomedical field, to study individual single-celled organisms. From the beginning, the center's team organized workshops to educate scientists around the world on the technology and create new applications, such as the FlowCam that combined flow cytometry with image analysis to accelerate breakthrough research.

GUIDING BELIEF #2

We believe there is transformational opportunity hidden at the base of the ocean food web.

LEFT Kim Knowlton collects data aboard the R/V *Cape Henlopen*. **BELOW** Staff work on the Center for Culture of Marine Phytoplankton building, located in the old Bigelow Laboratory dock house. **CIRCLE** Beth Langdon and Peter Williams work at the bench.

TOP Jean Garside and Toby Garfield look over data. **ABOVE** Participants of the first flow cytometry workshop for aquatic sciences hosted by Bigelow Laboratory pose in 1984, including Clarice Yentsch (fourth from left, top row). **LEFT** Elin Haugen runs samples aboard the schooner *Bowdoin*.

INNOVATION INSIGHT

FLOW CYTOMETRY

BY NICOLE POULTON, *Senior Research Scientist, Director of the Center for Aquatic Cytometry*

A drop of seawater can contain a million microscopic organisms. Sorting them all can be a huge obstacle to studying them. Flow cytometry is a method that allows scientists to detect microbes and other small particles in water using laser light. Bigelow Laboratory was one of the first places to examine, count, and study phytoplankton using the tool. Co-founder Clarice Yentsch championed its use and established the first center dedicated to flow cytometry for aquatic sciences, creating a multitude of research directions and opportunities. One early advancement made possible by flow cytometry, for example, was the discovery of a bacterium known as *Prochlorococcus* — the planet's smallest and most abundant photosynthetic organism, which produces about 20 percent of the oxygen we breathe.

Bigelow Laboratory's approach to science has always been exploratory, allowing scientists to think "outside the box" when it comes to these innovative technologies. Prior to the use of flow cytometry, microscopy was the only way of counting and identifying microscopic marine organisms. Scientists here later merged microscopy and flow cytometry into a single instrument, developing one of the first imaging flow cytometers. Known as the FlowCam, this instrument is now produced by a spin-off company and widely used in aquatic laboratories around the world.

Flow cytometry is constantly advancing, and the impact and applications of the field continue to grow. Most recently, I'm working with colleagues in industry and at Bigelow Laboratory to use flow cytometry to image, sort, and isolate aquatic organisms for downstream analysis. I'm also working with partners at other institutions to develop a tool for counting and measuring even the smallest types of microplastics.

As I look ahead to the coming decades, I think the cutting-edge work of Bigelow Laboratory on flow cytometry will continue to accelerate science and the insights it provides about our world.

CAFÉ SCI

Learn more from Dr. Poulton on July 23. **See page 25 for details.**

1990s

Expanded Mission, Renewed Vision

The early 1990s was a time of uncertainty in terms of the future of science — at Bigelow Laboratory and across the country. By the end of the decade, though, as Bigelow Laboratory celebrated its 25th anniversary and the world celebrated the "International Year of the Ocean," the future was looking as bright as ever.

Education became a greater priority in the 1990s. The institute established the BLOOM program for Maine high school students and created scholarships to enable high school and undergraduate students to participate in Bigelow Laboratory research. In 1994, the institute partnered with the University of New England, developing a marine science curriculum that sparked collaborative research and increased mentorship and teaching opportunities.

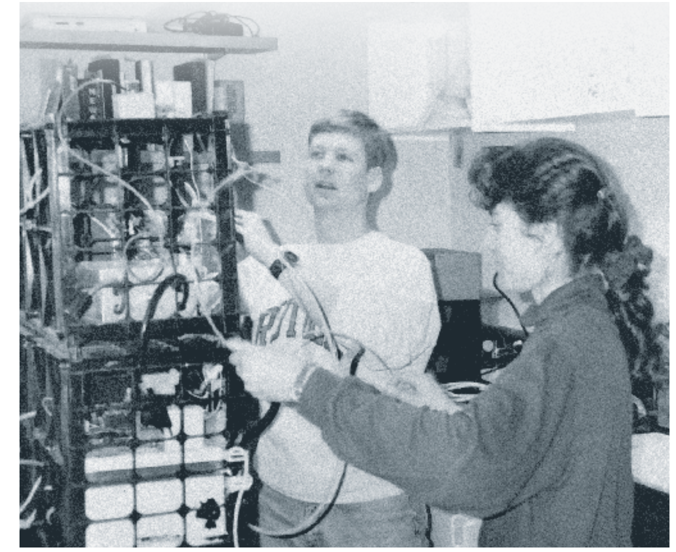
But research continued to be the institute's focus — and to grow. Congress designated Bigelow Laboratory's collection of algae a national center, establishing it as the country's official repository for phytoplankton. Bigelow Laboratory scientists also led a Nature Conservancy-funded ecosystem research project that was the largest privately funded marine research program in Maine's history to that point.

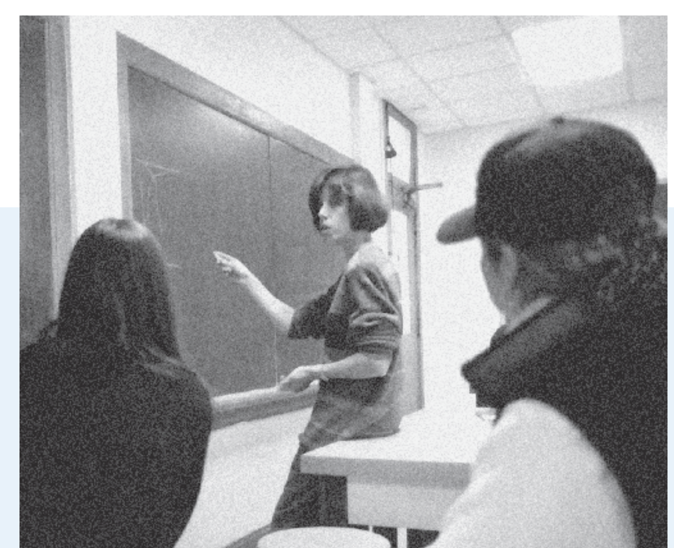
The institute's pioneering work using satellite technology to study the ocean also advanced in leaps and bounds. Scientists led the development of an educational program in schools that used this remote sensing data. They applied satellite imagery to study pollution and track the movement of toxic sediment from the Kennebec River into the Gulf of Maine. And they advised NASA when, in 1997, the agency launched its new SeaWiFS ocean color satellite. The information coming from the satellite, and the need to validate its data with on-the-water measurements, sparked the genesis of the Gulf of Maine North Atlantic Time Series at Bigelow Laboratory, which continues to provide insight on this rapidly changing body of water today.

GUIDING BELIEF #3

We believe in bold research and big thinking.

TOP Staff gather for a celebration of the institute's 25th anniversary. **ABOVE LEFT** The inaugural class of Bigelow Laboratory's high school program, which would later be renamed Keller BLOOM, arrive in 1990. **ABOVE RIGHT** Scientists working with Dave Phinney and Barney Balch, far right, pose on the R/V *Delaware II* in 1999. **CIRCLE** Terri Cucci works in the field with undergraduate students.





TOP Dave Drapeau and Lisa Graziano work on an oceanographic instrument. **MIDDLE** Janet Campbell, who helped develop a program to teach regional high school students using satellite imagery of the Gulf of Maine, works in the lab. **BOTTOM** Paty Matrai teaches University of New England undergraduates.

INNOVATION INSIGHT

SATELLITE OCEANOGRAPHY

BY CATHERINE MITCHELL, *Senior Research Scientist*

A colleague once told me, "You think about the ocean from way up here," indicating with his hand above his head. That may seem like an unusual perspective for someone at an institute focused on some of the smallest lifeforms in the ocean, but he was right. Ocean color satellites have transformed the way we look at our oceans. They can give us a daily view of the whole globe, something unachievable by other methods, and have revealed many surprises about our planet.

The first ocean color satellite was launched in 1978, thanks in part to the pioneering work of Bigelow Laboratory's co-founder, Charles Yentsch, and his colleagues. Microscopic plant and animal life can affect the color of seawater, which they surmised would be visible from space. They convinced NASA this was worth spending money on — and launched a revolution in oceanography.

In 1998, Bigelow Laboratory initiated the Gulf of Maine North Atlantic Time Series, on-the-water fieldwork that has enabled important advances in the field and helped NASA validate their measurements. The program, which I recently took over management of, uses its unparalleled data set to reveal how the base of the food web is changing in the Gulf of Maine.

Building on almost 50 years of satellite oceanography innovation, our research agenda is more ambitious than ever as we find new ways to leverage observations from "way up here." We're developing new algorithms to interpret satellite data and translate it into meaningful biological information. We're using ocean color to track long-term changes across the Gulf of Maine and the whole planet. And scientists at Bigelow Laboratory are using satellites for ocean forecasts.

Just this year, NASA launched a new ocean color satellite, PACE, which will monitor the oceans in more detail than ever before. We'll continue to be out in the Gulf of Maine, collecting data in support of the new satellite and all the exciting insights it will reveal over the coming years.

CAFÉ SCI **Learn more from Dr. Mitchell on August 6.** **See page 25 for details.**

2000s

A Foundation for the Future

At the turn of the century, Bigelow Laboratory was pushing the boundaries of ocean science around the world. Scientists continued to advance fundamental research — studying everything from the role of viruses in global biogeochemical cycles to the evolutionary history of marine organisms — and they began to grapple with the growing challenge of climate change.

Bigelow Laboratory researchers studied ocean acidification in Patagonia and nutrient pollution in the Arctic. They explored ocean "deserts" in the South Atlantic and monitored abrupt climate change impacts in the Arabian Sea. Back on the Maine coast, grants from NASA and the NSF allowed scientists to apply remote sensing to detect harmful algal blooms.

The new millennium was also a time of growth more literally. The institute purchased 67 acres in nearby East Boothbay to begin its most significant physical expansion to date. The summer lecture series expanded into a more regular event, attracting hundreds of attendees each summer to evening science talks. The institute also formed a broad academic partnership with Colby College and, at the end of the decade, officially became a site for the NSF-funded Research Experience for Undergraduate program.

One of the most significant expansions was the creation of a new Single Cell Genomics Center in 2009. Capitalizing on the institute's expertise in flow cytometry and in sharing research capabilities through its Discovery Centers, SCGC became the only center of its kind in the world. Since its founding, SCGC has helped pioneer new technology in genomics and bioinformatics, helping illuminate the diversity and importance of microscopic marine life.

GUIDING BELIEF #4

We believe that the most important discoveries for our planet's future require working at the intersection of disciplines.

TOP David Fields, left, and Steven Shema examine their experimental flume used to understand the relationship between the physical and biological properties of the Gulf of Maine (*photo: Dennis Griggs*). **ABOVE** Ramunas Stepanauskas works on the development of single cell genetics techniques that would lead to the creation of SCGC in 2009. **LEFT** Barney Balch, right, engages with visitors at the annual open house in 2008.

TOP Rick Wahle looks at specimens after diving in the Gulf of Maine. **MIDDLE** Nicole Poulton, center, teaches Keller BLOOM high school students in 2005, the year she took over directorship of the program. **BOTTOM** *Henry*, the autonomous glider named in honor of Henry Bryant Bigelow, launches for its inaugural mission crossing the Gulf of Maine in August 2008 (*photo: Greg Bernard*). **CIRCLE** Joaquim Goés looks at data from a NASA-funded project to measure the effects of climate change on marine life in the Arabian Sea.

INNOVATION INSIGHT

SINGLE CELL GENOMICS

BY RAMUNAS STEPANAUSKAS, *Senior Research Scientist, Director of the Single Cell Genomics Center*

Although invisible to the naked eye, the microbes I study are so numerous and diverse that they play major roles in the uptake of atmospheric carbon dioxide, soil fertility, plant and animal health, and countless aspects of the modern bioeconomy. However, only a tiny fraction of the planet's microbial diversity is amenable to cultivation, a necessity for traditional research techniques. Bigelow Laboratory's Single Cell Genomics Center was founded in 2009, becoming the world's first facility for studying DNA in individual microbial cells. Using technology pioneered by our scientists, SCGC has unlocked the biological blueprints of individual microbes, without the need for cultivation.

One of SCGC's early successes was the recovery of genome sequences from "microbial dark matter" — the major branches on the tree of life that previously lacked any biological information. SCGC has also contributed to the discovery of processes that impact global carbon cycles, chemicals that may have medical applications, and even microbial inhabitants of NASA's spacecrafts. SCGC's services are available to the global scientific community and have been used by over 100 organizations and companies on six continents.

Bigelow Laboratory's collaborative ethos, focus on transformative research, and efficient model have been significant in the success of this unique center. SCGC is constantly evolving, forging new partnerships and pushing the limits of technology to address vexing scientific questions. For example, we're currently developing methods to link microbes' genetic code to their corresponding biological features, such as rates of metabolic activities, at the scale of individual cells. Understanding this essential link has long evaded science, and I'm excited to be a part of this important step.

In the future, we hope to make this technology cheaper and more scalable, so that it can be applied to an even broader range of scientific questions. There's so much it can reveal about Earth's biota, and perhaps even contribute to the search for life on other planets.

CAFÉ SCI

Learn more from Dr. Stepanauskas on July 30. See page 25 for details.

2010s

Transformative Growth in Impact

In 2012, Bigelow Laboratory officially moved from its original location at McKown Point to its new home in East Boothbay. The state-of-the-art laboratory was the first scientific research facility in Maine to achieve LEED Platinum certification for green building construction.

The new laboratory enabled the institute to dramatically expand its portfolio of foundational research and educational programs. Within just a few years, the staff size doubled and grew the breadth and depth of expertise at Bigelow Laboratory. New research began in ecosystems from the deep sea to coral reefs, and focused on marine life from viruses to larval lobsters. This growth also allowed the institute to expand ties with industry and other partners to explore new applications of research through innovative Impact Centers.

In 2014, the FDA approved Bigelow Laboratory as the first in the nation to use an advanced, quantitative testing method to detect algal toxins in shellfish. This greatly enhanced the monitoring work that had been done in collaboration with Maine's Department of Marine Resources for decades, and it made widely accessible a new and more precise approach to biotoxin testing.

The campus expanded further as the decade went on. In 2016, a research greenhouse was built to support the development of sustainable, algae-based products with industrial partners. A new residence hall opened the following year to house up to 32 students, as well as visiting scientists in adjoining apartments. It was named in honor of Graham Shimmield, Bigelow Laboratory's executive director who drove the campus development throughout most of this decade and passed away before the residence hall was complete.

GUIDING BELIEF #5

We believe that science must be nimble and responsive to serve the pressing needs of modern society.

TOP Steve Archer, right, works with fellow researchers to transform scientists' understanding of the changing arctic as part of the MOSAiC expedition, an interdisciplinary project with more than 300 scientists that Archer helped lead (*photo: Esther Horvath*). **ABOVE** The inaugural NSF-funded REU intern class at Bigelow Laboratory pose with their mentors in 2010 (*photo: Dennis Griggs*). **LEFT** Graham Shimmield, left, and Colby College President Bro Adams launch the new partnership between Bigelow Laboratory and Colby College in 2010 (*photo: Dennis Griggs*).

TOP Beth Orcutt presents at the Café Sci series in 2018 about her efforts to study the impacts of deep-sea mining. **MIDDLE** Keller BLOOM students board the *Snowgoose III* for a day of field research in May 2010 (*photo: Greg Bernard*). **BOTTOM** Dash Masland works in the Single Cell Genomics Center studying how deep-sea bacteria get the energy they need (*photo: Dennis Griggs*).

INNOVATION INSIGHT

IMPACT CENTERS

BY NICHOLE PRICE, *Senior Research Scientist, Director of the Center for Seafood Solutions*

Bigelow Laboratory hosted its first Joint Industry Partnership event in May 2015, engaging members of the growing Maine aquaculture industry to share our science capabilities and brainstorm how our resources could help.

It was exciting to see all the opportunities to put our science to work solving problems, but it was also eye opening. There were clearly many data-driven needs but limited financial resources. At the same time, funding agencies were starting to demand more quantifiable metrics of direct impacts to procure research funding. From these two pressures, our Impact Centers were born.

Bigelow Laboratory's Impact Center model weds cutting-edge science capacity with industry, community, or policymaker needs. This unique approach enables us to tackle more applied challenges while expanding Bigelow Laboratory's reach. The Center for Seafood Solutions I direct, for example, engages with industry to identify opportunities and obstacles in need of science-based solutions. It enables us to collaboratively seek funding with an array of partners, bring in new research disciplines, and unite scientists across Bigelow Laboratory to work toward a shared vision.

From rural Maine up to a global scale, our Impact Centers are tackling important issues around food and socioeconomic security, climate change preparedness, water quality, and greenhouse gas emissions reductions and capture. Our research is grounded in pragmatic solutions — including safety and feasibility for the people implementing them, as well as profitability for potential investors.

Leading an Impact Center provides an ever-evolving opportunity to contribute to real-world solutions, which has been a uniquely challenging and rewarding experience in my career. Our Impact Centers have proven to be an essential complement to Bigelow Laboratory's excellence in foundational science and to our efforts to improve the future of our rapidly changing world. I can't wait to see the solutions that emerge from this addition to our scientific model.

2020s and Beyond

Onward Toward the Next 50

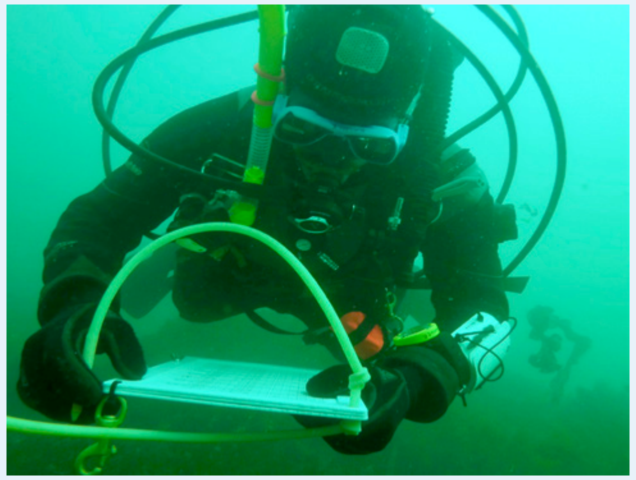
Global challenges driven by the pandemic and climate change brought new obstacles and urgency to Bigelow Laboratory's mission as the institute headed toward its 50th anniversary. But they also served to highlight the resiliency of Bigelow Laboratory's unique approach — and the hope and opportunity its science reveals in the ocean.

The institute's staff of 120, including five recently hired senior research scientists, continue to advance fundamental understanding of the ocean's role in global processes and pursue solutions to pressing challenges. The 2020s have brought rapid acceleration of research around the development of climate mitigation products from algae, the removal of carbon dioxide from the atmosphere, and the understanding of deep-sea ecosystems to inform decision-making on emerging industries.

Researchers also continue to expand the applications of their science to pressing issues through the recently launched Tandy Center for Ocean Forecasting, Center for Algal Innovations, Water Health and Humans Initiative, and testing services for PFAS pollutants. A snapshot of some of the progress made over the last year can be found in our annual Impact Report on page 16.

Currently, Bigelow Laboratory is also undergoing another major physical expansion — made possible through federal support and an ongoing fundraising effort. A new 25,000-square-foot center for ocean education and innovation will increase the laboratory's footprint by more than 40% when it opens in 2025, and it will help transform the institute's inspirational education and solutions-focused science over the next 50 years.

> **"Over the next 50 years, we will unlock the ocean's potential to bring about a better future for all life on our planet."**
>
> — DEBORAH BRONK, PRESIDENT AND CEO



TOP A rendering shows the forthcoming center for ocean education and innovation, which will expand the institute's education and solutions-focused work. **CIRCLE** Carmen Cartisano works on a large, multi-institutional project designing an algae-based feed supplement for cows to address methane emissions (*photo: Colby College*). **ABOVE** The 48-foot R/V *Bowditch* was donated by Middlebury College in 2022 and has enabled new educational and research opportunities. **LEFT** Doug Rasher, whose lab is using environmental DNA to track the movement of species in response to climate change, dives to survey kelp forests off Maine's coast.

TOP The two-story "Majestic Fragility" art installation hangs at Bigelow Laboratory in 2021, expanding the institute's creative approaches to sharing its science. **MIDDLE** David Fields trains students during the Sea Change Semester, an educational program that offers undergraduates a semester-long, immersive experience in ocean science. **BOTTOM** Sunny Pinkham and Dave Drapeau continue to monitor the Gulf of Maine using autonomous gliders during the Covid-19 crisis.

INNOVATION INSIGHT

OCEAN OF OPPORTUNITY

BY DEBORAH BRONK, *President and CEO*

The defining event of the early 2020s was the global pandemic, which sent the world into lockdown and changed how we live and work in fundamental ways. But that crisis also strengthened my belief in the Bigelow Laboratory model as a nimble, independent institute that can turn on a dime — because we did! Throughout it all, we adapted to keep our staff safe and our science moving forward.

With the pandemic behind us, we begin work this summer to build our next strategic plan. Fortunately, the last 50 remarkable years have given us a solid foundation to build on!

We're developing this vision for our future within the context of major global challenges. The U.S. oceanographic community has been losing ground to other countries making huge investments, and the world is grappling with an increasingly apparent climate crisis. The 10 warmest years in the modern record are all in the last decade, and many marine ecosystems and coastal communities are struggling.

However, we find something surprising when we study the ocean closely — hope! The ocean holds incredible unseen potential to feed our planet, regulate our climate, and power our economy. The opportunities are there, and I know our science will unlock them.

Bigelow Laboratory's approach offers insights into how the scientific community can adapt and become more resilient in this changing landscape. We run lean. We move fast. And we work creatively and collaboratively to a degree I've not seen elsewhere throughout my career. While we've grown into a state-of-the-art leader in ocean science, we're still guided by the principles that made our scrappy startup so successful.

As we look ahead to the coming decades, I know we'll continue to do what Bigelow Laboratory does best — generate innovative ways to accelerate the pace of research, answer foundational questions that inspire the next generation, and leverage the ocean as a source of solutions. We may have been around for 50 years, but we are only getting started!

2023 IMPACT REPORT

From rising seas to shifting food webs, our planet has undergone dramatic changes over the last 50 years.

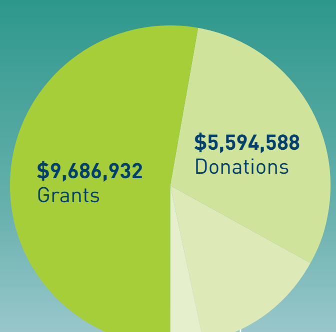
Throughout this time, Bigelow Laboratory has advanced the leading edge of ocean science through our discoveries — and through innovative technologies we've developed and shared with the world.

We hope you enjoy this look back at how our bold science has led the way to a brighter future during the last year.

2023 FINANCIALS

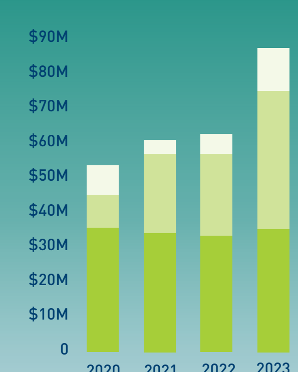
JULY 1, 2022 – JUNE 30, 2023

REVENUE **$18,350,976** Total*



EXPENSES **$18,589,257** Total

ASSETS 2020 – 2023



*Bigelow Laboratory received an additional $24,888,987 in special revenue during fiscal year 2023 that is not reflected here.

View our audited financial report at bigelow.org/financials.

Ocean Health and Function

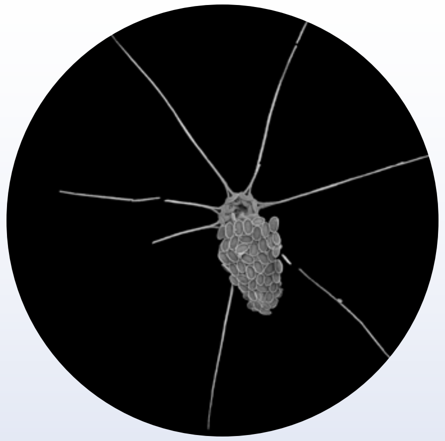
We reveal how the ocean works and how to better care for our planet.

Thousands of PFAS chemicals have been developed, but scientists still don't have a good grasp of how these complex pollutants impact ecosystems. Our researchers recently launched ambitious and collaborative research to understand the prevalence and fate of PFAS in coastal environments and to increase access to testing services in Maine.

bigelow.org/2023-pfas

Phytoplankton form the foundation of a rich marine ecosystem in the North Pacific. Volcanic ash, including "aged" ash that's blown into the ocean even years after an eruption, might provide the nutrients, like iron, phytoplankton need to grow. A team of our scientists explored this connection between ash and phytoplankton blooms this year, drawing on interdisciplinary expertise and student research.

bigelow.org/2023-volcanic-ash



Some organisms can switch between photosynthesis and other methods of getting energy and nutrients, and we now know these mixotrophs are much more common in the ocean than once thought. Several of our scientists published research last year on mixotrophy, illuminating the molecular basis of the phenomenon and how it may make organisms more resilient to changing conditions.

bigelow.org/2023-mixotrophy

Viruses play an essential role in the ecology and evolution of microbial life. Last year, our scientists discovered the first evidence of "giant," double-stranded DNA viruses that may be infecting fungi in the deep ocean crust. Their results open up a whole suite of new questions on the role of viruses in biogeochemical cycling in this extreme environment.

bigelow.org/2023-giant-viruses

Photos, clockwise from bottom left: Colin Fisher, Chris Waythomas, Christoph Aeppli

Our Changing Planet

We focus on key species to predict, combat, and adapt to climate change.

As warming temperatures become the norm across the world's ocean, marine animals are likely to become more vulnerable to disease. Our scientists are using diverse methods, in collaboration with resource managers, to understand the potential impact of different marine pathogens on ecosystems and fisheries, including new work on epizootic shell disease in the Gulf of Maine's lobsters.
bigelow.org/2023-marine-disease

As carbon dioxide continues to increase in the ocean, its waters are becoming more acidic — and many marine species are struggling to adapt. However, new research published by one of our scientists last year showed that ocean acidification may actually support the growth of one species of copepod that's a vital food source in the North Atlantic, highlighting the complex impacts of climate change on ocean health.
bigelow.org/2023-ocean-acidity

Bigelow Laboratory works closely with community groups, tribal organizations, and local government partners to create resilient communities and ecosystems. Last year, our researchers began a collaboration with tribal communities in northern Maine to apply advanced techniques like environmental DNA to monitor the impacts of dam removal in the light of rapidly changing conditions.
bigelow.org/2023-local-science

Climate change and warming ocean temperatures are reshaping the distribution of species in the ocean. Supported by a cohort of student scientists, our researchers are using cutting-edge techniques and developing new tools to track the movements of marine species, like white sharks, in the Gulf of Maine and forecast where they might appear in the future.
bigelow.org/2023-white-sharks

Photos, clockwise from top left: Maya Groner; Rachel Sipler; Kyle Oliveira

The Ocean's Potential

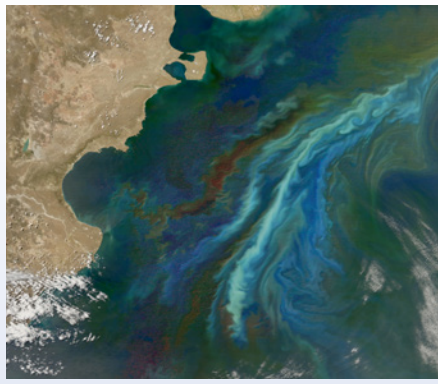
We develop the tools needed to unlock the opportunity of the ocean.

Blue mussels in the Gulf of Maine have declined significantly in recent years, making it difficult for aquaculture farmers to collect the young larvae they need. Our researchers recently began developing innovative technologies to detect and quantify the abundance of blue mussel larvae that will eventually lead to the creation of user-friendly, field-ready toolkits for mussel farmers.
bigelow.org/2023-larval-mussels

Single-celled organisms shape food webs and nutrient cycling in most ecosystems, including the ocean. For 15 years, Bigelow Laboratory's Single Cell Genomics Center has pioneered technology to unlock the DNA of individual cells. That expertise enabled recent scientific advances that include linking genes to the activity rates of microbes and building a genomic atlas of ocean microbial life.
bigelow.org/2023-single-cells

Microplastics are ubiquitous in marine and inland waters around the world. Last year, our scientists created a new analytical method that creatively combines different specialized techniques to characterize and count some of the smallest varieties of microplastics in water. It's a critical step to understanding the persistence and impact of different kinds of plastic in the environment.
bigelow.org/2023-microplastics

Fertilizing the ocean with iron to spur phytoplankton growth is one strategy that's been considered to help remove excess carbon dioxide from the atmosphere. Our scientists published research last year, though, that showed that iron fertilization could negatively affect far off marine ecosystems. These findings highlight the critical need for more research into both the benefits and unintended consequences of marine carbon dioxide removal.
bigelow.org/2023-iron-fertilization



Photos, clockwise from top right: Greta Rybus; NASA Earth Observatory; Rachel Kaplan

GIVING OUR SINCERE THANKS

Bigelow Laboratory is an independent, nonprofit institute. Our impact is only possible with the help of our community of supporters. Their generosity fuels our discoveries, powers our solutions, and enables us to inspire the next generation of ocean leaders.

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Dana Wilson
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from Susan and Bob Corbin
Sadie Woodruff
from Sandra Herndon

GIFTS IN MEMORY OF

Elaine Bennett
from Jim Bennett
Priscilla Hayes
from Maggie and Joe Keohan
Maureen Keller
from Gordon Wolfe
Dick Morrell
from Sandy and Honor Sage
Jack Ritchie
from Kate Ritchie
Cameron Roletter
from Michael H. Kaminski and Linda F. Renshaw
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SCIENCE SNAP

SALPS, LIKE THIS *THALI DEMOCRATICA*, are incredibly efficient at moving through seawater. They're also uniquely adaptive eaters, feeding on an enormous range of particle sizes. With such adaptability, they can grow incredibly fast — reaching maturity in some cases in just 48 hours. Like swarms of vacuum cleaners, large salp populations can deplete a region's standing stock of phytoplankton in a relatively short time period, potentially shifting the ecosystem's food web.

Photo: Nick Record

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