



# 2022 Annual Report

ACCELERATING OCEAN SCIENCE FOR THE GLOBAL GOOD



WOODS HOLE  
**OCEANOGRAPHIC**  
INSTITUTION



A large, white iceberg is melting in the deep blue ocean. The water around the base of the iceberg is a vibrant turquoise color, indicating the presence of meltwater. In the background, a range of snow-capped mountains stretches across the horizon under a clear blue sky. The overall scene conveys a sense of environmental impact and climate change.

**OUR OCEAN.  
OUR PLANET.  
OUR FUTURE.**



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Cover: On July 21, 2022, *Alvin* swimmers Molly Smith and Rick Sanger give the thumbs-up signal while preparing to make the deepest dive in the submersible's 58-year history. Learn more on page 5. Photo by Ken Kostel, © Woods Hole Oceanographic Institution

This page: Aerial view of Greenland icebergs. Photo by Croy Carlin, © Woods Hole Oceanographic Institution



# A Message from the President and Director

THE YEAR 2022 WAS ONE OF TRANSFORMATIVE CHANGE and notable momentum at Woods Hole Oceanographic Institution (WHOI). Inspired by Vision 2030 and fueled by an unprecedented level of philanthropic support, WHOI scientists made remarkable strides to advance fundamental research, accelerate innovation, and engage with the world. At the same time, we continued our efforts to make WHOI—and the field of oceanography—a more diverse and welcoming place for all.

The results speak for themselves in the form of achievements in science, engineering, marine operations, and engagement with the public and policymakers. We are grateful to everyone, especially our funders, for supporting so much positive change.

WHOI raised a record-shattering \$95.8 million in new philanthropic commitments in 2022—two-and-a-half times the amount raised in 2021. The 2022 total included three eight-figure gifts and 31 gifts at the principal (seven-figure plus) and major (six-figure) gift levels. The total number of supporters also grew to a record high of more than 7,500.

This outpouring of generosity affirms that Vision 2030 is resonating widely in a world that needs science-based strategies to protect ocean ecosystems and wildlife; fight pollution and climate change; and sustainably meet humanity's growing needs for water, food, energy, and jobs.

While government funding for science at WHOI remains strong at \$215.5 million, our fundraising success helped drive innovation, advance key strategic priorities, and provide greater flexibility for WHOI scientists and

engineers to pursue bigger, high-risk/high-reward ideas. Increasing interest from private-sector investors seeking promising climate solutions was also a key factor. A good example of this is Propeller, an ocean-climate technology impact fund that supports entrepreneurship and blue-tech innovation at WHOI and elsewhere. Launched in 2022, Propeller closed its inaugural \$100 million fund and is already investing in exciting new technologies in the ocean-climate space. WHOI is pleased to be a science partner.

On the research front, solutions-focused research in areas such as ocean alkalinity enhancement and efforts to save coral reefs complemented WHOI's core commitment to fundamental discovery science.

Deep in the ocean, the human-operated submersible *Alvin* made history when it dove to a new depth of nearly 4 miles deep in the Puerto Rico Trench, achieving U.S. Navy certification for a depth of 6,500 meters and putting roughly 99 percent of the sea floor within reach of scientists.

In Sharm El-Sheikh, Egypt, WHOI made its mark in international policy engagement through its leadership—along with Scripps Institute of Oceanography—of the Ocean Pavilion at the UN Climate Conference (COP27). This was the first-ever ocean-themed pavilion in the official blue zone of a United Nations climate conference. It brought together 20 partner organizations from around the globe, attracting 15,000 visitors and providing unique engagement opportunities for graduate students in the MIT-WHOI Joint Program.

WHOI scientists made remarkable strides to advance fundamental research, accelerate innovation, and engage with the world.





Paul Salem, newly appointed WHOI Board Chair

Here in Woods Hole, we welcomed Yessica Cancel as WHOI’s new Chief People Officer. Yessica and her team, together with WHOI’s Chief Diversity, Equity, and Inclusion (DEI) Officer, made strides in attracting 28 new employees from diverse backgrounds and laid important groundwork for continued progress in strengthening WHOI’s already remarkable pool of talent. DEI efforts also progressed in WHOI’s education programs and through new scholarships that are engaging diverse students and postdocs and helping to evolve the face of oceanography.

In the following pages, you will meet some of our generous funders and read about many additional 2022 highlights that underscore how Vision 2030 is making us stronger, more secure, more relevant, and more impactful.

As the planet undergoes unprecedented change, WHOI is stepping up to expand the frontiers of knowledge and accelerate the search for solutions to many of our generation’s most pressing problems. The critical role each of our supporters plays in this mission cannot be overstated.

This is our time,

Peter de Menocal  
President and Director



## A LEADERSHIP TRANSITION

In December of 2022, WHOI said goodbye to board chair David Scully and welcomed Paul Salem, who will chair the board from 2023 to 2030.

David served as board chair from 2015 to 2022. Accomplishments during his term included championing the construction and launch of the research vessel *Neil Armstrong*, the launch of the Ocean Twilight Zone Project with support from the TED Audacious Program, as well as the launch of WHOI’s game-changing Advancement Initiative.

“I cherish the time I spent steering the board of the Oceanographic. WHOI is a global leader in ocean science because of its world-class team including our scientists, engineers, and technical staff. I am grateful for the opportunity to work with our board and other supporters, who give so selflessly to advance this important work. I know WHOI’s greatest discoveries are still ahead,” says David. “I wish Paul Salem all success as he assumes this important role. I can’t wait to see what this team will accomplish.”

Paul is a senior managing director emeritus at Providence Equity Partners, a global private equity firm specializing in the media and communication industries. “I am humbled by the opportunity to serve with the leadership of WHOI and the Board of Trustees. This role combines my passion for the ocean with the opportunity to work with the amazing scientists and engineers at WHOI to advance the Institution as a world leader in protecting and saving our oceans,” says Paul.

According to WHOI President and Director, Peter de Menocal, trustee leadership speaks to a special connection to the institution and its mission. “We are grateful to David for his service, and we welcome Paul to our community and thank him for his commitment to leading us toward the fulfillment of WHOI’s Vision 2030,” says Peter.





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# RESEARCH HIGHLIGHTS



## HUMAN-OCCUPIED SUBMERSIBLE ALVIN MAKES HISTORIC DIVE

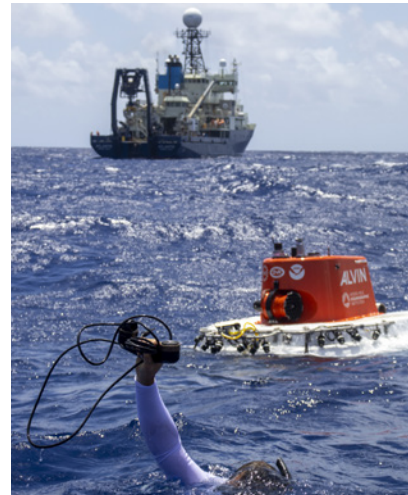
WHOI's iconic *Alvin* sub successfully reached a depth of 6,453 meters (nearly 4 miles) in the Puerto Rico Trench, north of San Juan, P.R. on July 21, 2022. This is the deepest dive in the 58-year history of the submersible. The dive was a critical step in achieving certification from the U.S. Navy to resume operations after an 18-month overhaul and upgrade that extended the sub's maximum dive rating from 4,500 meters (14,800 feet) to its new limit of 6,500 meters (21,325 feet). Naval Sea Systems Command (NAVSEA) requirements stipulate the certification dive be between 6,200 and 6,500 meters. The added range puts roughly 99 percent of the seafloor within reach of the world's longest-operating, most active, and, by many measures, most successful human-occupied submersible program in the world.

## RAPID WARMING IN THE GULF OF MAINE REVERSES 900 YEARS OF COOLING

Rapid 20th-century warming in the Gulf of Maine has reversed long-term cooling that occurred there during the previous 900 years, according to new research that combines an examination of shells from long-lived ocean quahogs and climate model simulations. The warming is “likely due to increased atmospheric greenhouse gas concentrations and changes in western North Atlantic circulation,” according to a paper published in *Communications Earth & Environment*, an open-access journal from Nature Portfolio.

“Given future projections of atmospheric greenhouse gas concentrations and Atlantic Meridional Overturning Circulation strength, this warming trend in the Gulf of Maine is likely to continue, leading to continued and potentially worsening ecologically and economically devastating temperature increases in the region in the future,” the paper states.

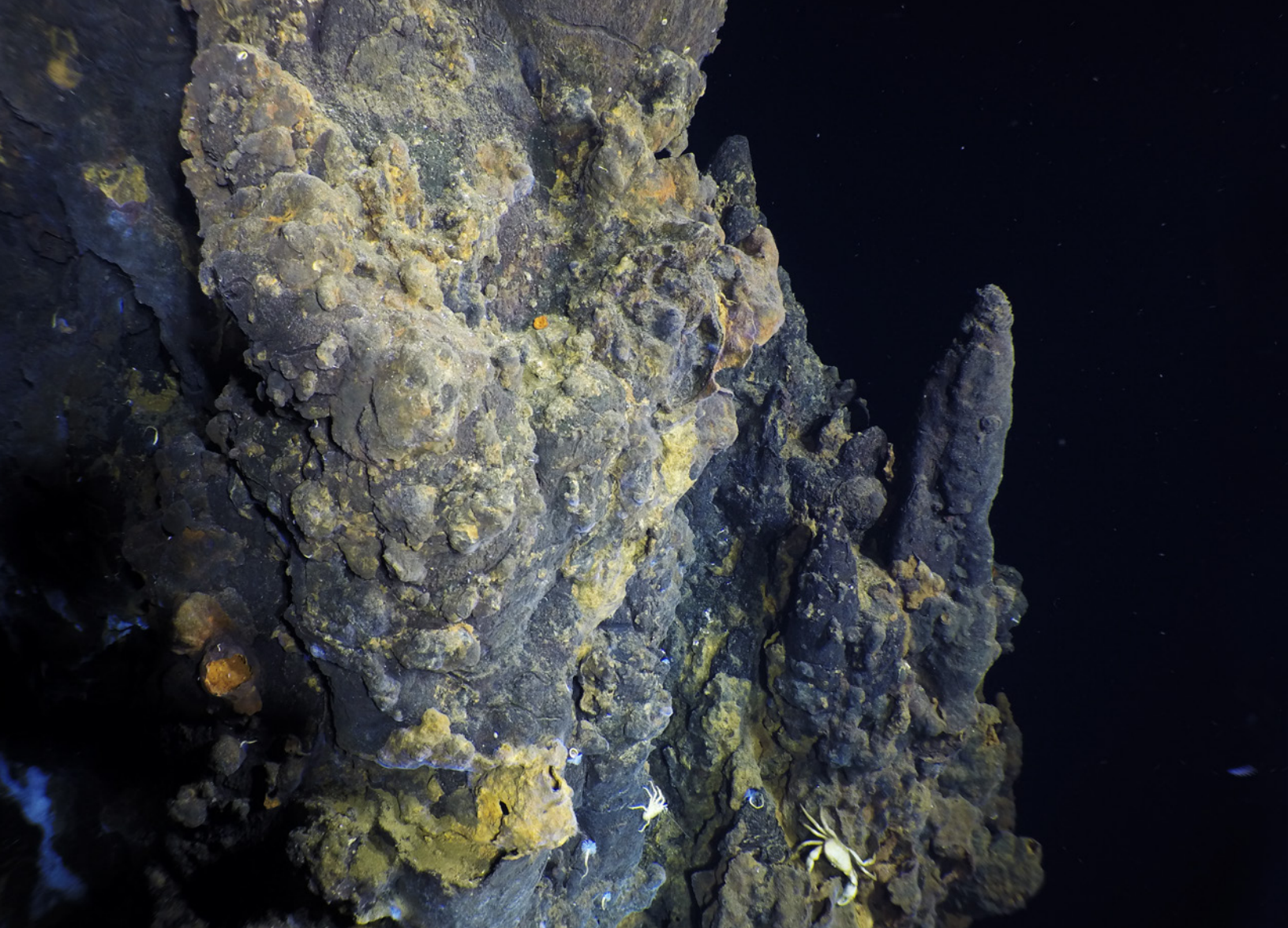
“This paper shows—both from the clams and also from the climate model simulations—that in the late 1800s there were some pretty dramatic changes and the Gulf of Maine began to warm, reversing 900 years of cooling that had been primarily driven by volcanoes,” said Nina Whitney, lead author of the paper. Whitney is a NOAA Climate and Global Change Postdoctoral Fellow in the Physical Oceanography department at WHOI and earned her Ph.D. at Iowa State University, where the research presented in this paper began.



*Alvin* engineer Fran Elder swims away from *Alvin* during launch of one of the sub's certification preparation dives. Photo by Hannah Piecuch, © Woods Hole Oceanographic Institution.

The striped marlin (*Kajikia audax*) is a species of billfish that is overfished in the North Pacific. A new study, co-led by WHOI, finds that marine predators, like the striped marlin, find food hotspots in open ocean deserts by aggregating in clockwise-rotating ocean eddies to feed. Image credit: Pat Ford (Pat Ford Photography).





Sulfide structures at the recently discovered YBW-Sentry vent field have yellow iron staining, and host white Bythograeid crabs. Image credit © Woods Hole Oceanographic Institution, National Deep Submergence Facility, remotely operated vehicle *Jason* team, WHOI-MISO Facility, National Science Foundation.

## CLIMATE CHANGE COULD LEAD TO A DRAMATIC DECREASE IN ESSENTIAL OMEGA-3 FATTY ACIDS

The first-ever survey of planktonic lipids in the global ocean predicts a temperature-linked decrease in the production of essential fatty acids, such as omega-3 fatty acids, which are linked to numerous health benefits in humans. A significant implication of the survey is that as global warming proceeds, there may be fewer omega-3 fatty acids produced by plankton at the base of the food web, which will mean less omega-3 fatty acids available for fish and for people. Omega-3 fatty acid is an essential fat that the human body cannot produce on its own.

The survey, published in the journal *Science*, analyzed 930 lipid samples across the global ocean, revealing previously unknown characteristics of ocean planktonic lipidomes. The research “is another example of how human activities are perturbing the oceans in ways that we never expected, and of the uncertainty of how the ocean is going to respond to warming,” says journal article co-author Benjamin Van Mooy, of WHOI.

The research was funded by grants from the National Science Foundation, the Marine Microbiology Initiative Division of the Gordon and Betty Moore Foundation, and the Simons Foundation.



## **HYDROTHERMAL FIELD DISCOVERED AT THE EAST PACIFIC RISE 9°54'N**

A 2022 paper in the *Proceedings of the National Academy of Sciences* (PNAS) documented the discovery of a new high-temperature, off-axis hydrothermal vent field on Pacific seafloor at 2,550 meters (8366 feet) depth. The discovery—made in 2021 by researchers from Lehigh University, Scripps Institution of Oceanography, the University of Bergen Norway, and WHOI—could change scientists’ understanding of the impact that seafloor vent systems have on the life and chemistry of Earth’s oceans.

The team discovered the hydrothermal field along a portion of the global mid-ocean ridge known as the East Pacific Rise about 200 miles off the coast of western Mexico. The new site is roughly twice as large as the nearest active hydrothermal vent fields in the region and its fluids originate at hotter temperatures than other nearby vents. The size and location of the site underscores the likelihood that there are more hydrothermal vents in the deep sea than previously thought, emphasizing the need for more high-resolution mapping to locate them.

“The discovery of a new hydrothermal vent could change scientists’ understanding of the impact that seafloor vent systems have on the life and chemistry of Earth’s oceans.”

## **WHOI-LED TEAM AWARDED \$7.6M TO SUPPORT GULF OF MEXICO LOOP CURRENT RESEARCH**

A WHOI research team received \$7.6 million from the Gulf Research Program (GRP) of the National Academies of Sciences, Engineering, and Medicine (NASEM) for “An Operational System Using Real-time Subsurface Observations to Improve Loop Current Forecasts,” one of three consortia that will undertake phase 3 of the Understanding Gulf Ocean Systems (UGOS) program (UGOS-3). The program is helping address forecasts of important currents of the Gulf of Mexico. All told, \$22 million was committed to this research phase. Other awarded institutions include Texas A&M and Florida State University.

The research is focused on improving Loop Current system forecasts. Deep and fast-moving, the Loop Current is of interest to industry, weather forecasters, and scientists due to sometimes unpredictable changes in its velocity, temperature, and position. Its deep, warm eddies can supply heat to tropical storms moving over them, allowing the storms to rapidly intensify. Enhanced predictions of these currents and eddies will help avoid risky conditions for oil drilling and production, reducing risks to offshore workers, and will also help improve oil spill response, weather forecasting, and the sustainable management of the Gulf’s rich fisheries.



## A SCIENCE/INDUSTRY PARTNERSHIP INCREASES MARINE MAMMAL PROTECTIONS

North Atlantic right whales are one of the most endangered species on the planet. Deaths from fishing gear entanglements and ship strikes continue to outpace births, and the number of reproductive females is declining. A new collaboration between WHOI and the CMA CGM Group, a world leader in shipping and logistics, aims to increase whale detection efforts along the U.S. East Coast and reduce the potential for ship strikes along critical shipping routes. With funding from CMA CGM, long committed to protecting the environment and preserving biodiversity through multiple initiatives in the U.S. and worldwide, WHOI researchers have deployed two, near-real-time passive acoustic monitoring buoys off the coast of Norfolk, Va., and Savannah, Ga., this year. In addition to construction and deployment of the new buoys, WHOI and CMA CGM are leading and supporting the continued operation of the WHOI-developed digital acoustic monitoring (DMON) buoys.

Acoustic buoys play a vital role in protecting marine animals. Each whale species creates its own unique calls, and these new buoys are equipped with a digital acoustic monitoring (DMON) instrument that transmits information about detected sounds to shore every two hours. This WHOI technology can detect, classify, and report the sounds of marine mammals in near real-time from a variety of autonomous platforms, including moored buoys. The whale detections are displayed publicly on the Robots4Whales website and shared in near real-time with mariners and other stakeholders. This enables dynamic protections, including NOAA's Slow Zones for Right Whales, through voluntary vessel-speed restrictions along the eastern seaboard that are activated when right whales are detected.

## WHOI LEADS MULTI-SHIP OCEAN TWILIGHT ZONE STUDY IN THE NORTHWEST ATLANTIC

WHOI scientists, with partners from National Oceanic and Atmospheric Administration (NOAA) and the University of Rhode Island (URI), completed an unprecedented four-ship expedition in the Northwest Atlantic to study the under-explored, highly important Ocean Twilight Zone (OTZ). The expedition examined the inner workings of Diel Vertical Migration (DVM), the largest migration on Earth in which trillions of organisms move from the twilight zone to the surface each night and return to the deep at sunrise. The vertical migration massively impacts marine food webs and may also help regulate the amount of atmospheric carbon the ocean sequesters each year. The mission is the most comprehensive study yet of the OTZ, and included scientists aboard the NOAA ship *Bigelow*, the research vessel *Endeavor* (operated by URI), the commercial fishing vessel *Monica*, and an autonomous, AI-driven surface ship called the USV *Mayflower 400*. WHOI robots, tags, floats, and other technologies were used with the new Ocean Twilight Zone Network.

The study collected data on sharks and other large predators that dive into the OTZ to feed, used acoustics to characterize migrating fish and other organisms, measured the movement of carbon through the twilight zone, gathered environmental DNA for analysis, and captured video footage, still images, light data, and acoustic data.



## EVIDENCE BOLSTERS CLASSIFICATION OF A MAJOR SPAWNING GROUND FOR ATLANTIC BLUEFIN TUNA OFF THE NORTHEAST U.S.

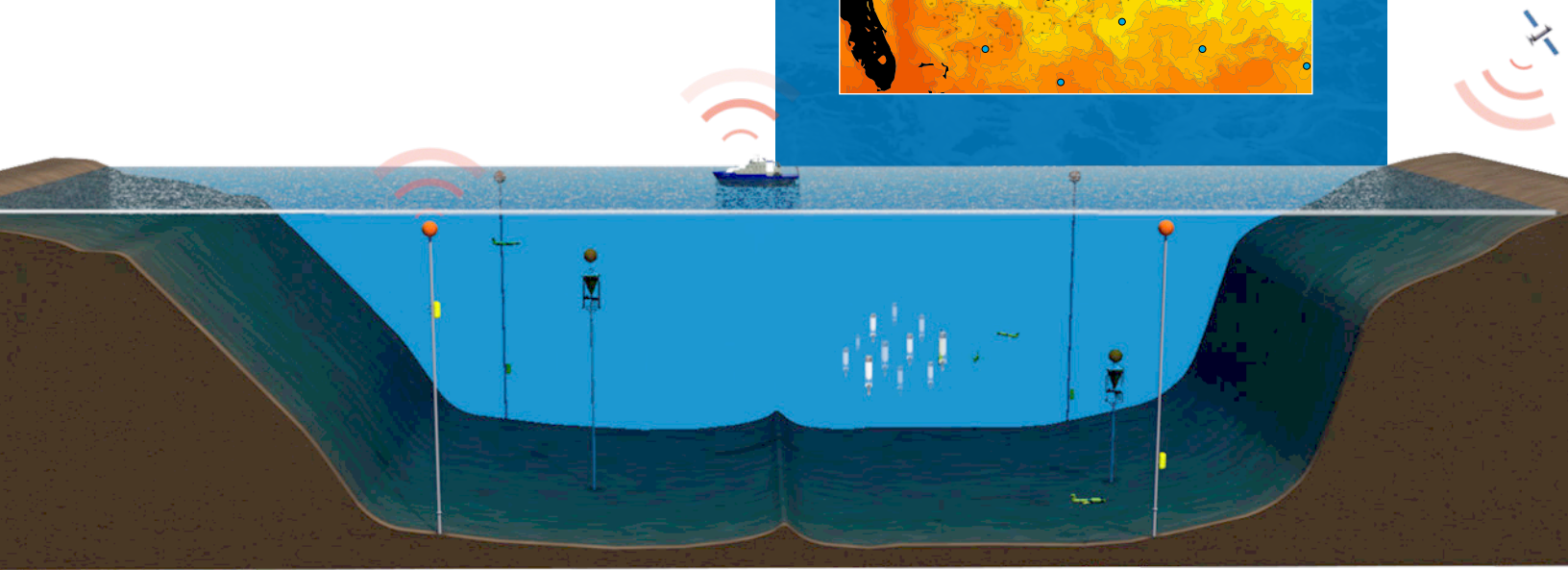
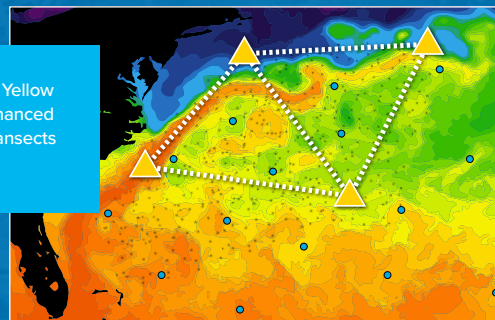
The Slope Sea off the northeast United States is a major spawning ground for Atlantic bluefin tuna (*Thunnus thynnus*), a 2022 paper in the *Canadian Journal of Fisheries and Aquatic Sciences* affirms. This finding likely has important implications for population dynamics and the survival of this fish, according to the paper, which cites evidence from larval abundance, growth rates, and particle-tracking simulations. The science also suggests that spawning in the Slope Sea “may offer the species additional resilience in the face of both harvesting and climate change.”

“In comparison to everything else we know about this species, the Slope Sea is a perfectly good place to be born as a larva,” said lead author Christina Hernández, a doctoral student in the MIT-WHOI Joint Program in Oceanography/Applied Ocean Science and Engineering, at the time of the study.

## OCEAN VITAL SIGNS NETWORK ANNOUNCED TO THE UNITED NATIONS

At a June 2022 United Nations meeting in Lisbon, Portugal, member countries discussed the critical importance of the ocean and the need for more science and knowledge about it. Against that backdrop, WHOI President and Director Peter de Menocal announced the launch of the Ocean Vital Signs Network (OVSN), an international effort to study ocean data in an area twice the size of France—1 million square kilometers—where an always-connected “internet” of devices using the Starlink Network will sense carbon and nutrient flows. He described the devices as “curious robots” that talk with each other to understand the ocean’s floor. They will be deployed in the northwest Atlantic to reduce uncertainties about carbon flow by an order of magnitude. “It will do for science what the Hubble [telescope] did for the cosmos,” he said. He also called for an inclusive code of conduct to frame carbon removal research whereby participants commit to open, collaborative research, and perform independent assessments of strategies.

Overhead map of a regional OVSN network in the North Atlantic. Yellow triangles represent OVSN “supersites,” the mesh represents enhanced broadscale observing, and dotted lines are repeated sampling transects by autonomous underwater vehicles or ships.







A microscope image of biological specimens shown alongside similarly sized microplastic beads. The organisms pictured here are all crustaceans. The size ranges were matched to show that a WHOI-designed sensor could tell plastics and organisms apart independently of their size. Photo by Beckett Colson, ©Woods Hole Oceanographic Institution

### **WHOI CO-LEADING DEEP-OCEAN GENOME PROJECT AS PART OF EARTH BIOGENOME PROJECT**

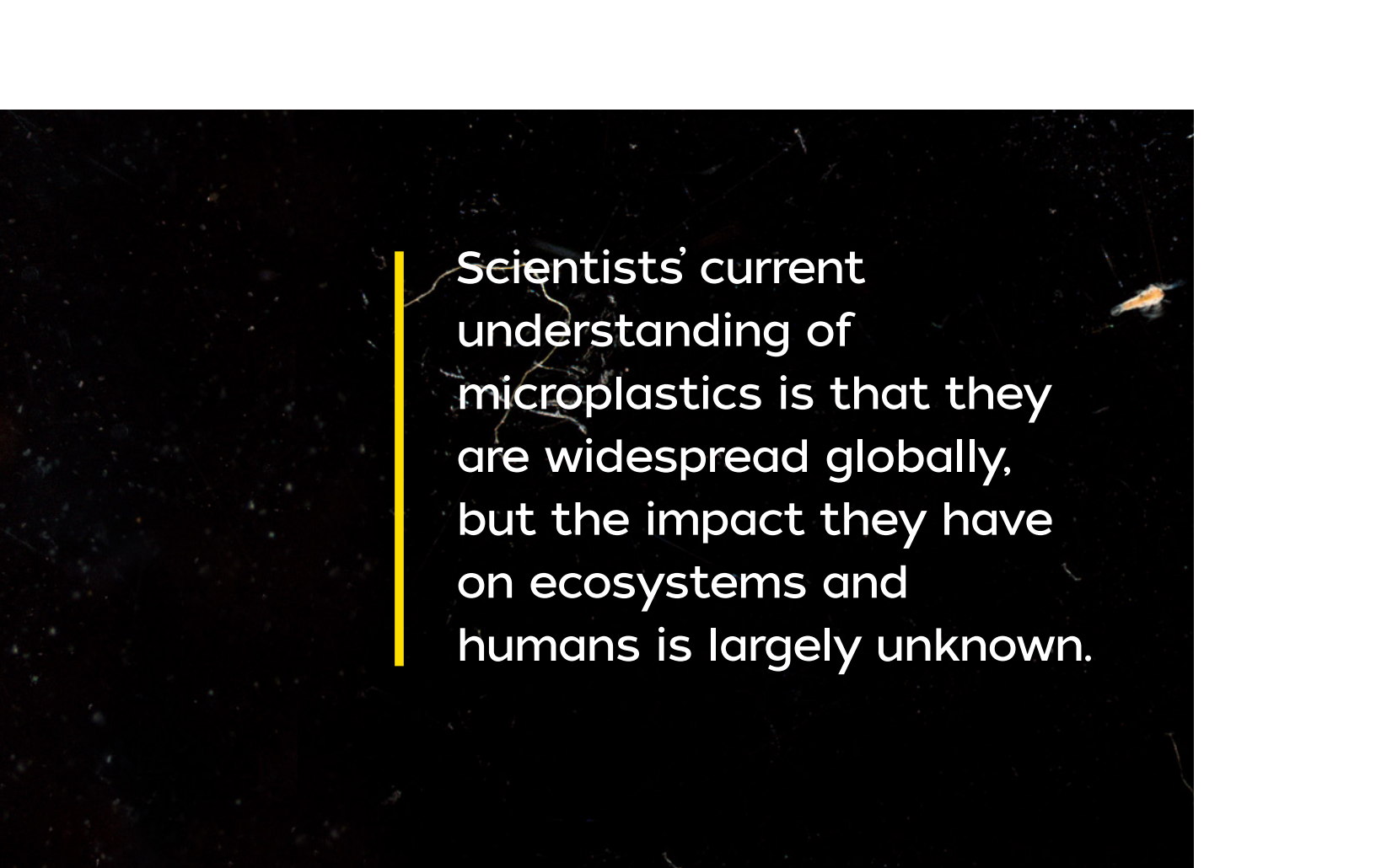
A global effort to map the genomes of all plants, animals, fungi, and other eukaryotic life (organisms whose cells have a nucleus) on Earth entered a new phase, moving from pilot projects to full-scale production sequencing. A key part of this ambitious effort is sequencing the deep-ocean genome, a project co-led by WHOI and the University of Connecticut to obtain fundamental new knowledge of the organization, evolution, functions, and interactions of life in one of Earth's least-understood regions: the deep ocean.

### **A SENSOR TO DETECT MICROPLASTICS**

A project led by WHOI's Chemical Sensors Lab is advancing an in-field microplastics sensor that measures the number of plastic particles in water. WHOI joined co-development technology company Triple Ring Technologies to design and engineer the fieldable sensor. The sensor's technology was developed in the lab of Anna Michel, WHOI associate scientist and National Deep Submergence Facility chief scientist with MIT-WHOI Joint Program student Beckett Colson. An Environmental Protection Agency grant to Triple Ring Technologies is supporting this technological innovation.

"We're confident that this fieldable sensor will offer a widespread assessment of microplastic pollution in waterways, wastewater, storm water, and other areas where microplastics could be a concern," explained Michel.





Scientists' current understanding of microplastics is that they are widespread globally, but the impact they have on ecosystems and humans is largely unknown.

#### **EXAMINING THE IMPACT OF CORAL CHEMICAL COMPOUNDS ON REEF COMPOSITION AND HEALTH**

With coral reefs on the brink of extinction, understanding every aspect of these complex ecosystems is urgent. A 2022 study revealed that organic chemical compounds produced through metabolism—known as “metabolites” or “exudates”—vary significantly by coral species and that the compounds impact the abundances and compositions of reef microorganisms differently. This knowledge is especially important in the Caribbean where coral dominance is shifting from hard stony coral to soft octocoral in response to human-caused stressors such as eutrophication, overfishing, and global climate change.

“As the species composition of these reefs shifts, it is likely changing the chemicals that are

released on the reef that then will have impacts on the microbial community,” said lead author Laura Weber, a former postdoc and current information systems associate in WHOI’s Marine Chemistry & Geochemistry Department. “We need to pay more attention to how changes in reef structure and species composition might influence the microbes that live on the reef, leading to more feedbacks in terms of reef health.”

The research was published in *ISME Communications* and supported by the National Oceanic and Atmospheric Administration and the National Science Foundation.



# EDUCATION PROGRAMS



WHOI's educational programs were fully in-person in 2022, offering opportunities for undergraduates, graduate students, and postdoctoral researchers. Recruitment efforts focused on continuing success in increasing diversity as a pathway to broadening participation in the ocean sciences and engineering. In October, WHOI staffed a virtual booth at the National Diversity in STEM Conference of the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science. Associate Dean Ann Tarrant and Graduate Admissions and Student Affairs Officer Lea Fraser held two virtual MIT-WHOI Joint Program in Oceanography/Applied Ocean Science and Engineering recruiting sessions in early November, and recruitment materials were provided to many students and postdocs who attended the Fall AGU Meeting for distribution. A new program was also initiated to bring local college students to WHOI to learn about Blue Economy careers.

Nadège Aoki, Konrad Hughen, and Colleen Hansel working on a coral reef.  
Photo by Austin Greene, © Woods Hole Oceanographic Institution

## THE MIT-WHOI JOINT PROGRAM (JP) IN OCEANOGRAPHY/APPLIED OCEAN SCIENCE AND ENGINEERING

**PROGRAM DESCRIPTION:** A five-year doctoral degree program, or, for U.S. Navy officers, a 27-month master's degree program, that combines the strengths of WHOI and MIT to provide research and education opportunities in ocean science and engineering disciplines.

Enrollment grew from 108 in 2017 to 153 in 2022, and percentages of minority and underrepresented minority (URM) students in the JP have grown from 11 percent to 27 percent and 5 percent to 10.5 percent, respectively, since 2010. Ten MIT-WHOI JP graduate students went to COP27 in Sharm El-Sheikh, Egypt, as part of their MIT-WHOI JP course "Climate Change Science: Oceans, Cryosphere, and Climate." JP students caught up on fieldwork and research cruises in 2022. Fieldwork sites included both McMurdo and Palmer stations and the German base station (Antarctica); St. John, U.S. Virgin Islands; Duck, North Carolina; McCullough Mountains in Nevada; Hawaii; Simpson Lagoon in Alaska; and the Canadian High Arctic Research Station in Cambridge Bay, Nunavut. Students also participated in numerous research cruises. These included the

OSNAP AR69-03 cruise onboard the R/V *Neil Armstrong* from Iceland to Greenland; cruises to study hydrothermal vents on Axial Seamount (North Pacific), the Mariana forearc (Southwest Pacific), and the Kane Fracture Zone on the Mid-Atlantic Ridge; as well as the GEOTRACES GP17-OCE cruise from Tahiti, French Polynesia to Punta Arenas, Chile; an Arctic research cruise near Svalbard on the Norwegian icebreaker R/V *Kronprins Haakon*; an Ocean Twilight Zone research cruise on the *Armstrong* (part of a simultaneous multi-ship effort); and multiple small boat shark-tagging day trips. Two new non-credit courses for incoming students were introduced: 1) A Foundational Calculus Course to build student confidence, appreciation for the beauty and unreasonable effectiveness of calculus in science, to ensure that students grasp the basic concepts





and mechanics of calculus; and 2) A Network Course to prepare incoming JP students for graduate study and integrate them into the JP support network with a focus on mentoring, inclusion, access, and opportunity. Current and incoming JP students were recognized with competitive fellowships from agencies including the National Science Foundation, the Department of Defense, NASA, NOAA, and the Natural Sciences and Engineering Research Council of Canada. Additionally, WHOI held its first in-person celebration for graduates since spring 2019 on May 25, 2022.



Many of the 45 alums who graduated between September 2019 and June 2021 joined many of the 27 who graduated between September 2021 and June 2022 at a Fenno Lawn celebration.

## THE 2022 WHOI SUMMER STUDENT FELLOWSHIP (SSF) PROGRAM

**PROGRAM DESCRIPTION:** A 10- to 12-week ocean science and engineering research experience for a diverse group of rising college seniors majoring in science, technology, engineering, or mathematics.

The 2022 SSF undergraduate program was fully in-person, with 23 students engaged with WHOI and the Woods Hole science community. The students participated in activities, including a welcome barbecue, *Tioga* cruise, and summer lecture series; carried out research, gave mid-term oral presentations of their projects, and presented their final projects at a well-attended, in-person poster session. Fifteen of the 23 Summer Fellows have or will be attending scientific conferences to present their research. The SSF Program continues its success in increasing diversity, with minority participation between 46 percent and 65 percent since 2019; and underrepresented minority participation between 24 percent and 50 percent since 2019.





Blue Economy Interns exploring Harmful Algal Blooms at WHOI. Left to right: Patrick Bent (CCCC), Kaleb Riggie (CCCC), Kyle Hegg (CCCC), Ericson Bonilla (CCCC), McCaela Acord (CCCC), instructors Mrunmayee Pathare and Evie Fachon, and program coordinator Kama Thielier. Standing on stairs, left to right: Liberty DeAngelo (UMD), Viktoriya Balabanova (UMD), and Shayla Flaherty (CCCC). Photo by Jayne Doucette © Woods Hole Oceanographic Institution

## **NEW WHOI, CAPE COD COMMUNITY COLLEGE (CCCC), AND UMASS DARTMOUTH (UMD) BLUE ECONOMY INTERNSHIP PROGRAM**

**PROGRAM DESCRIPTION:** *Initiated in 2022, this spring semester program allows CCCC and UMD undergraduates to explore the fields of ocean science and engineering through a two-week January short course and a semester-long internship.*

The Blue Economy Program brings local underserved students to WHOI to introduce them to possible local Blue Economy careers. This pilot program engaged eight students—four from CCCC, and four from UMD. Two of the UMD interns continued as WHOI guest students for summer 2022 and will complete master's degrees at UMD in the 4+1 program; a third had a summer internship at the U.S. Naval Research Laboratory. Two of the four CCCC students spent the summer at WHOI (one will transfer to UMass Amherst for a BS in Biology, the other is now planning to continue for an AA, then transfer to a four-year college for a BS in Chemistry). Another CCCC participant was a WHOI guest student for summer 2022 and will transfer to UMaine, Orono for a BS in Engineering. This new program fills an important niche, and significantly impacts career trajectories.



## THE GEOPHYSICAL FLUID DYNAMICS (GFD) PROGRAM

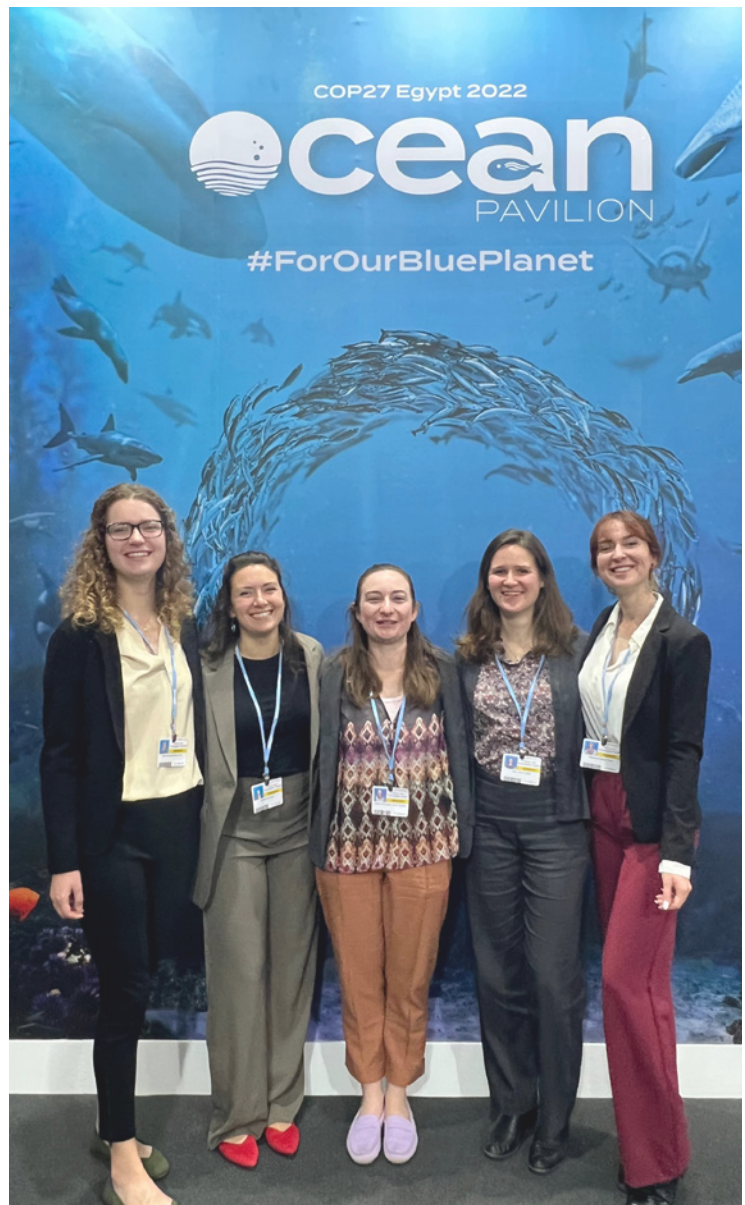
**PROGRAM DESCRIPTION:** Initiated in 1959, the GFD Program introduces geophysical fluid dynamics to physical sciences graduate students and promotes an exchange of ideas among the many fields that share a common interest in the nonlinear dynamics of rotating, stratified fluids.

In 2022, eight fellows were selected to participate in the GFD Program. The program theme was “Data-Driven GFD” and the principal lectures were given by Peter Schmid (KAUST), who concentrated on recent theoretical development of data-driven analysis techniques for fluid dynamics, and Laure Zanna (New York University), who concentrated on the connections of these techniques to geophysically relevant flow systems. There was also a Sears Public Lecture on “Coastal Vegetation and Coastal Flows: Restoration, Climate Mitigation & Adaptation” given by Professor Heidi Nepf of MIT.

### POSTDOCTORAL RESEARCHERS

**PROGRAM DESCRIPTION:** Thirty-six postdoctoral scholars, 14 postdoctoral fellows, and 78 postdoctoral investigators engaged in WHOI research for some portion of the year.\*

In addition to the U.S. Geological Survey funding to promote diversity within our scholar program, we welcomed the addition of the two-year Carawan Postdoctoral Scholarship to support members of underrepresented groups and socioeconomic backgrounds in the ocean sciences and engineering fields. Nearly 12 percent of the postdocs at WHOI met the federal definition of an underrepresented minority. The National Science Foundation’s Division of Ocean Science has added a postdoctoral fellowship that allows the fellow to be hired as a postdoctoral fellow/postdoctoral investigator, an employment position that allows the fellows full employee benefits, and several of these fellows/investigators are now at WHOI.



The ocean took center stage in the Blue Zone at the 2022 United Nations climate conference (COP27) in Sharm El-Sheikh, Egypt. The Ocean Pavilion, organized by WHOI and Scripps Institution of Oceanography in partnership with 18 other oceanographic organizations around the world, raised awareness about the ocean’s role in climate, the potential it holds to help shape a sustainable future, and the need for science to lead the development of solutions. Left to right: Ciara Willis, Brenna Boehman, Helena Cheslack, Cora Hersh, Shawnee Traylor. Photo by Danielle Fino, © Woods Hole Oceanographic Institution

*\*Scholarships were awarded competitively and funded through the endowment and other sources; fellows were funded through competitive awards from external agencies, foundations, and foreign countries; and investigators were funded with grants from external sources that are part of each department’s research base.*

# IN MEMORIAM

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*WHOI lost one beloved friend, leader, and supporter in 2022. She will be deeply missed. Please join us in remembering her fondly for her extraordinary generosity and service to WHOI and the ocean.*



## **NANCY MILBURN, PH.D.**

*Trustee, Life Trustee, Corporation  
Member, Biology Visiting Committee*

**Philanthropic focus:** Unrestricted  
Giving, Education

“Nancy’s wise counsel and friendship were valued by both male and female colleagues in academia. She was a role model and mentor to many young faculty members at Tufts University, and to both scientists and graduate students at WHOI. As a member of WHOI’s Board of Trustees, she played an important role in providing advice to the Academic Program Office, especially in enhancing new opportunities for interdisciplinary research and student enrichment.”

— *Judith McDowell, WHOI Scientist Emeritus,  
Biology Department*

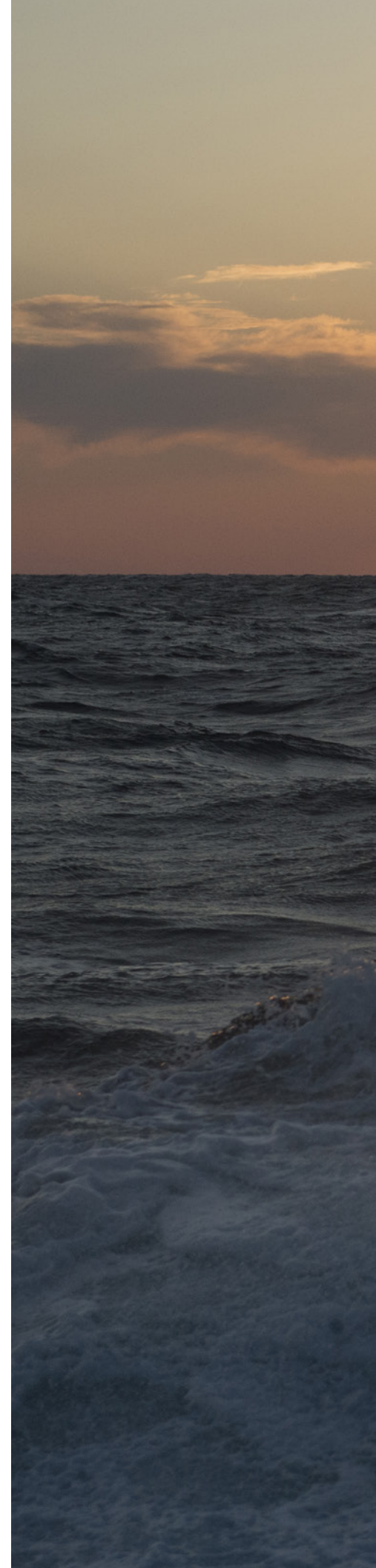






Photo by Chris Linder, © Woods Hole Oceanographic Institution



# THE POWER OF GIVING

PRIVATE PHILANTHROPY KEEPS WHOI ON THE LEADING EDGE OF SCIENCE AND INNOVATION THAT ACCELERATES THE SEARCH FOR SOLUTIONS. WE ARE GRATEFUL TO THE NUMEROUS INDIVIDUALS AND FOUNDATIONS WHO MADE CONSIDERABLE INVESTMENTS IN WHOI IN 2022. HERE ARE SOME OF THEIR STORIES.



Nadège Aoki adjusts a hydrophone installed on a coral reef. Photo by Austin Greene, © Woods Hole Oceanographic Institution

## FAREWELL to an Extraordinary Ocean Science Champion

When the Deerbrook Charitable Trust closed its doors in 2022, its Trustees left WHOI a \$10 million parting gift to further the Deerbrook Ocean Research Accelerator (DOSA), one of the most impactful gifts WHOI has ever received.

“When Deerbrook established the DOSA endowed fund in 2019, they created a novel way to support research while unlocking matching funds from other organizations,” says WHOI President and Director, Peter de Menocal. “This extraordinary gift provides WHOI with a war chest to go after strategic funding opportunities that require WHOI to have a stake in the results.”

The Deerbrook Charitable Trust was established in 2006 “to provide individuals with the opportunities to have a better education, stronger family, healthier life, and more secure future.” Their mission aligned with WHOI’s and between 2011 and 2022 the Deerbrook Trustees provided more

than \$24 million in funding and established a singular legacy for ocean science at WHOI. In addition to creating DOSA, they generously funded numerous initiatives, including the analysis of the aftermath of the Fukushima nuclear reactor spill, the Center for Marine Robotics, essential upgrades to the *Alvin* submersible, Vision 2030, the Ocean Vital Signs Network, and CWATER (Complex for Waterfront Access to Exploration and Research). The Trust also provided countless gifts to be used at WHOI’s discretion.

Larry Clark, president of the Deerbrook Charitable Trust, stated that “it has been an honor and a privilege to be able to continue the Clark family’s legacy of supporting the world-class ocean research and ocean engineering enterprise at WHOI. We hope that Deerbrook’s investments will provide long-term benefits to the institution.”

“Deerbrook’s longtime strategic support for WHOI has left an indelible mark,” says Peter de Menocal. “We thank the Trustees deeply for their vision, their dedication to the ocean, and for the example they have set for others to follow.”

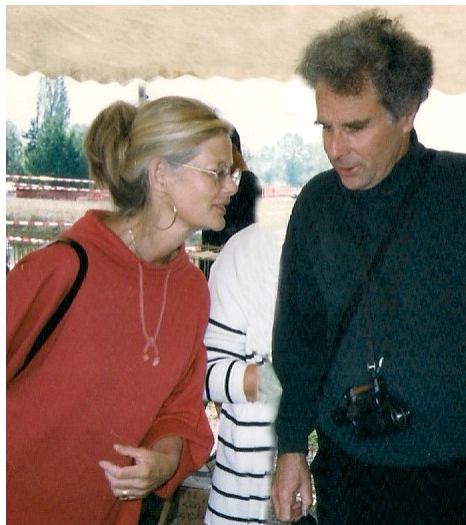


## MOVING THE NEEDLE and Safeguarding the Ocean with Unrestricted Giving

*Elsbeth Zurcher and Jamie Austin put their trust in WHOI by including us in their estate planning and by making their gifts unrestricted. This type of giving is one of the most helpful ways to support WHOI.*

### ELSBETH ZURCHER ON SAFEGUARDING THE OCEAN

Swiss-born Elsbeth Zurcher—who lives in a farmhouse in the village of Feigères, France—is one of a growing number of international WHOI supporters. A WHOI Eye Society Member who has included WHOI in her will, she fondly remembers visiting WHOI with her late husband, Peter Patzig, an American engineer with a passion for science. Though the couple did not visit the states often, they took “an epic road trip to the U.S. East Coast” in the early 90s. “We visited WHOI’s campus, laboratories, harbor, all of it, and were impressed,” says Elsbeth. “Finally, something dedicated to our concerns for safeguarding the oceans that cover so much of our planet, and it was obviously a serious organization.” Both Peter and Elsbeth grew up near the water; Peter on the Great Lakes, the Chesapeake Bay, and the Potomac River, and Elsbeth on the Indian Ocean. So, after their WHOI visit, they decided to channel their mutual love of nature and the ocean into annual fund gifts to WHOI. Peter gave until his death in 2017 and since then Elsbeth has carried forward their giving with funds from Peter’s estate.



Elsbeth Zurcher and her late husband Peter Patzig are devoted WHOI supporters from overseas. Photo courtesy of Elsbeth Zurcher.

“It is important to deepen our knowledge of what makes up 70 percent of our planet—the oceans—and their complex global influences.”

—Elsbeth Zurcher

“It is important to deepen our knowledge of what makes up 70 percent of our planet—the oceans—and their complex global influences,” says Elsbeth. “Their role is often underestimated and poorly understood, even though it is crucial to the survival of most living things on Earth.”

## JAMIE AUSTIN ON MOVING THE NEEDLE

When Jamie grew up spending summers at his family's Massachusetts home on Martha's Vineyard, Woods Hole was a popular sailing destination. On occasion, WHOI scientists would come over to test instruments on the front lawn, delighting the young rock collector with stories of research at sea. When his father, James, was invited to join the inaugural voyage of WHOI's former research vessel, R/V *Knorr*, it sparked Jamie's nearly 50-year relationship with the Institution.

Now an oceanographic geophysicist, Jamie arrived at WHOI in 1973 as a doctoral student in the MIT-WHOI Joint Program, graduating in 1979. Though he spent his academic career at the University of Texas at Austin, he returned as chief scientist on numerous WHOI-operated research cruises. In 1998, Jamie became a WHOI Member of the Corporation, and since 2007 he has served as a Trustee. In these roles, Jamie is dedicated to ensuring WHOI's long-term financial sustainability. That's why, as part of his estate planning in 2022, he increased his bequest intention and made a combined commitment of \$5 million in unrestricted support for WHOI's strategic goals.

"I trust Peter de Menocal's leadership, that's why I gave this money unrestricted," says Jamie. "Estate giving makes you feel like you're moving the needle. Everyone who can do it, should."



Jamie Austin on the R/V *Knorr*. Photo by Tom Kleindinst, © Woods Hole Oceanographic Institution

## The new Carawan Postdoctoral Scholars Program will help develop a diverse next generation of leaders in ocean research

Carawan Postdoctoral Scholar Sara Gonzalez gives an Aquaculture Overview Session at WHOI's AVAST Innovation Hub. Photo by Jayne Doucette, © Woods Hole Oceanographic Institution

## INVESTING in a More Diverse Equitable, and Inclusive WHOI

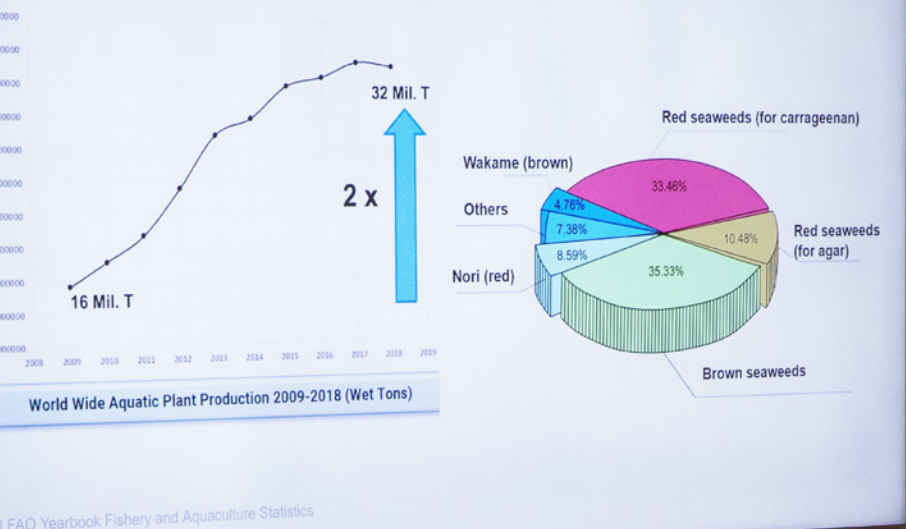
Mark and Rosemary Carawan and Dr. Yuki Honjo are WHOI supporters dedicated to diversifying ocean science. To ensure that this happens, they have made significant investments in increased diversity, equity, and inclusion (DEI) at WHOI.

## THE CARAWAN POSTDOCTORAL SCHOLARS PROGRAM

A new scholarship program is jumpstarting WHOI diversity at the postdoctoral level. Thanks to Mark and Rosemary Carawan's vision and planning, the new Carawan Postdoctoral Scholars Program will help develop a diverse next generation of leaders in ocean research, where racial and ethnic diversity are extremely low. In 2022, the Carawans launched the program with a gift that currently supports one postdoctoral student over a two-year period.



## Global Perspective of Seaweed Farming



Carawan Scholars are members of underrepresented groups and socioeconomic backgrounds and are selected based on their individual circumstances. Awardees can pursue their own research interests while working with a WHOI sponsor and advisor. They have access to lab and office space close to their sponsor and receive a stipend, allowances for relocation and health and welfare, and travel expenses, as well as equipment, supplies, and special services. Carawan Scholars also have the opportunity for continued mentorship and professional support through their alumni network.

Sara Gonzalez—an expert in seaweed ecology, aquaculture, and its uses in society—is the first Carawan Scholar. “This program has enabled me to pursue multiple projects to

advance seaweed aquaculture in the U.S. and attend national and international conferences that expanded my professional network,” says Sara. “The postdoc position is also buoying my enthusiasm and sharpening my skillset for the career in sustainable aquaculture research that I aim to achieve, and I look forward to building relationships with future Carawan Scholars as we pursue our passions in oceanography.”

Looking ahead, the Carawans also have assured the program’s longevity with a planned substantial gift that will establish a Carawan Scholar Endowment. “We wanted to make a tangible difference for diversity in oceanography,” says Mark Carawan. “And Woods Hole Oceanographic was clearly the best place to do that.”



## THE SUSUMU AND KAZUKO HONJO MEMORIAL DEI FUND



Susumu and Kazuko Honjo.  
Photo courtesy of Yuki Honjo.

How do you honor the parents who helped inspire you every day of your life? For Yuki Honjo, CEO of Falmouth-based McLane Research Laboratories, a WHOI Corporation member and the DEI liaison to the Corporation, the answer was easy. After her parents, Kazuko “Kay” and Dr. Susumu “Sus” Honjo passed in 2019 and 2020 respectively, Yuki established the Susumu and Kazuko Honjo Memorial DEI Fund, an endowment that supports diversity,

equity, and inclusion initiatives within the WHOI community in their memory. The fund will support training, fellowships, seminars, and other initiatives which further the work of making WHOI a more inclusive and diverse community.

The Honjos have a long history with WHOI. Susumu was an esteemed WHOI oceanographer (1970-2004), whose pioneering work contributed to the understanding and observations of marine particle compositions and fluxes and of the oceanic biological pump. He later founded McLane Laboratories, a WHOI partner that provides advanced time-series samplers and engineering design services to the international oceanographic community, and in 2019 was awarded the first WHOI Distinguished Emeritus Award for his lifetime achievements. Kazuko, who married Susumu in 1957, did what many women of that era did, passing up a botany career to support her husband’s science. “My father was the first to credit my mom for his success,” says Yuki, adding that her mother also supported Yuki’s academic career.

Today, Susumu and Kazuko’s work lives on in the endowment named for them. “I wanted to continue their legacy and impact in ocean science,” says Yuki. “A diverse environment, whether in the ocean, in society, or at WHOI, is a stronger, more resilient, dynamic, and, ultimately, a more interesting habitat. Diversity brings new ideas and viewpoints to the table, and that kind of fresh creativity is essential. I think my parents would love the idea of a fund that would help people who are not the majority smooth their paths so they can thrive and contribute to science.”





Associate scientist Alan Condrion is the first Harris Early Career Scientist Fellow. Photo by Daniel J. Hentz, © Woods Hole Oceanographic Institution  
Inset: Clint and Meg Harris helped launch an endowment program to support early career scientists with a generous gift to WHOI. Photo courtesy of Clint Harris

## UNLEASHING Early Career Talent

How do you tackle the world's biggest challenges? At WHOI, the goal is to unleash the best and brightest early career talent on key ocean issues and provide them with the resources they need to flourish.

WHOI scientists must typically spend a significant fraction of their time pursuing federal grant funding to support their labs—a model that can hamper their ability to pursue higher-risk/higher-reward ideas, which can be more difficult to fund through federal agencies such as NSF. To change this, WHOI is prioritizing a new paradigm: endowed chairs for early career scientists.

Meg and Clint Harris, a WHOI Trustee, helped launch this ambitious program of support for pre-tenure scientists at WHOI with a generous gift of \$3.2 million to establish two early career scientist chairs. The chairs are being awarded as fellowships until WHOI reaches its goal of establishing

30 early career scientist chairs. Once the full amount has been raised, the fellowship program will convert to endowed chairs.

WHOI scientist Alan Condrion is the first Harris Fellow. “The fellowship has been invaluable. I cannot state that enough,” says Alan. “It provided me the freedom to pursue new ideas and focus on projects that I’ve aspired to but had to keep on the back burner.” Alan credits the Harris Fellowship with enabling his study of the climate impacts of the Missoula Floods. The floods, which occurred at the end of the last ice age, were some of the largest known floods on Earth. “The fellowship allowed me to attend a week-long field camp to study the geological evidence of the floods; I couldn’t have done that if I didn’t have salary funding,” says Alan. “Attending the meeting and interacting with a new research community was very beneficial in

moving my work forward on a largely unexplored topic.” Alan’s other research interests include why the Earth’s climate abruptly changes and how likely it is to suddenly change in the future, as well as the role of melting ice sheets in controlling the Atlantic Meridional Overturning Circulation, sea ice, icebergs, and rates of future sea-level rise.

“Early career scientists like Alan are the future of oceanography and innovation,” says Clint, a venture capital investor who also served as a naval officer on nuclear submarines in the 1970s.

“Meg and I feel that establishing the Harris Family Associate Scientist Chairs is a solid investment, not only in WHOI’s budding scientists, but also in a society that needs to rely on great scientific minds both today and tomorrow.”

# 2022 GIVING

IT IS A PRIVILEGE TO ACKNOWLEDGE THE MANY INDIVIDUALS, FOUNDATIONS, CORPORATIONS AND ORGANIZATIONS THAT MADE GIFTS OR PLEDGES IN 2022

## \$25,000,000 OR MORE

The Edna McConnell Clark Foundation

## \$10,000,000-\$24,999,999

Deerbrook Charitable Trust<sup>°</sup> Propeller Ocean Climate Tech, LLC

## \$5,000,000-\$9,999,999

Dr. James A. Austin, Jr.<sup>#°</sup> Anonymous (1)  
Simons Foundation<sup>°</sup>

## \$1,000,000-\$4,999,999

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George and Wendy David Margaret and Clinton Harris<sup>°</sup>  
Mr. and Mrs. Michael E. Esposito<sup>°</sup> NI  
Francis E. Fowler IV Anonymous (4)

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Photo by Paul Walczak, Oregon State University, © Woods Hole Oceanographic Institution

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WHOI computer scientist Yogesh Girdhar chaperones autonomous underwater vehicle CUREE, as it explores a reef along St. John in the U.S. Virgin Islands. CUREE, short for "curious robot," was built with a learning "brain" that seeks out unique sights or sounds on a coral reef, and then changes its mission directive to study them. By adopting the very human traits of curiosity and decision-making, next-generation ocean robots like CUREE are helping scientists expand their ability to monitor changes to the world's most vulnerable ocean ecosystems. Photo by D. Mele, © Woods Hole Oceanographic Institution



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Associate Scientist Amy Apprill giving a presentation about coral reefs at the WHOI "Ocean of Opportunity" event at at WBUR Radio's CitySpace venue in Greater Boston. Photo by Daniel Hentz, © Woods Hole Oceanographic Institution

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A close-up of *Mesobot*, an underwater robot capable of tracking and recording high-resolution images of animals in the mid-ocean region known as the twilight zone.  
Photo by Evan Kovacs, © Woods Hole Oceanographic Institution



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California Polytechnic State University student Ryan Galusha showing instructor Taylor Crockford his ratchet strap work on WHOI's coastal research vessel *Tioga*. Photo by Jayne Doucette, © Woods Hole Oceanographic Institution





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*The Society is named for former Director Paul M. Fye, whose leadership and vision helped build the foundation that will support ocean science and education well into the future. For information on gifts that provide income and tax benefits, contact Jim Flynn, Director of Major Gifts and Planned Giving, (508) 289-2018 or jflynn@whoi.edu.*

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Matt Long (seated) and MIT-WHOI Joint Program student Solomon Chen review plans for the Continuous Reconnaissance In-situ Twilight zone Tiny Respirometer (CRITTR). Photo by Daniel John Hentz, © Woods Hole Oceanographic Institution

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On October 25, 2022, the U.S. Fish and Wildlife Service announced the inclusion of the Emperor Penguin as a threatened species under the Endangered Species Act based on evidence that the animal's sea ice habitat is shrinking and will likely do so for decades. Photo by Dan Zitterbart, © Woods Hole Oceanographic Institution

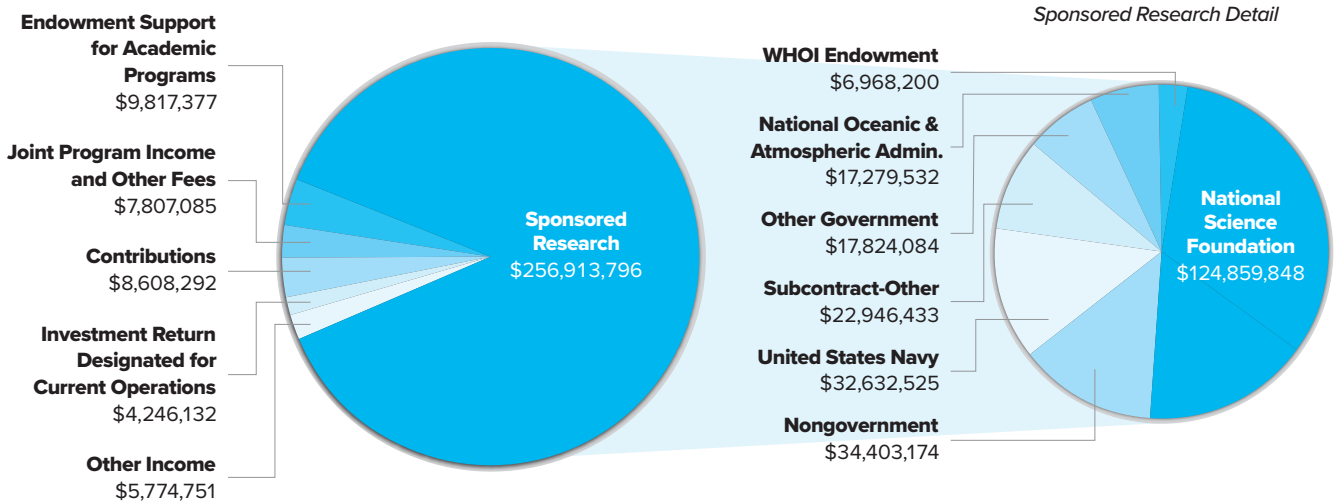
# 2022 FINANCIAL STATEMENTS

WE ARE PLEASED TO PRESENT THE 2022 AUDITED FINANCIAL STATEMENTS OF THE WOODS HOLE OCEANOGRAPHIC INSTITUTION (WHOI). WE ARE GRATEFUL TO OUR MANY FUNDERS, BOTH PRIVATE AND PUBLIC, FOR THEIR SUPPORT OF WHO'S MISSION OF OCEAN RESEARCH, EXPLORATION, AND EDUCATION.

The Institution continued to deliver its mission in the face of ongoing political and economic turbulence due to climate change, the pandemic, the invasion of Ukraine, and the threat of a government shut down. Our scientists, engineers, and technical and support staff remained fully employed and productive, but even so, the Institution experienced a small decrease of 0.7 percent to our total funded sponsored research portfolio. Funding increases from the National Science Foundation were offset by decreases from the United States Navy and the Ocean Observatories Initiative cooperative agreement.

We continued to make significant investments in our fundraising activities and finished the year with a small profit of unrestricted funds. Ship operations increased by 48 percent as both vessels were fully operational in 2022. Our investment portfolio experienced challenging returns battered by inflationary pressures and rising interest rates, ending 2022 with a market value of \$442.9 million. With rising interest rates, the defined benefit obligations of the Institution decreased from \$110.7 million to approximately \$57.6 million. We are grateful to our trustees for their generosity and fiduciary guidance.

REVENUES: **\$293,167,433**





## STATEMENT OF FINANCIAL POSITION

As of December 31, 2022, WHOI's total assets were \$724.7 million, total liabilities were \$175.5 million, and total net assets were \$549.2 million. Net assets represent the accumulated financial strength of a not-for-profit organization and are an important gauge of its ability to carry out its mission. As noted in our 2022 report, the Institution issued \$75.5 million in MassDevelopment Fixed Rate Revenue Bonds Series 2018, during 2018.

The Institution received net proceeds of \$85.7 million; of this amount \$50.7 million was used to retire the Series 2008 Bonds, with the remainder used to build the new research facility and for renovations and maintenance projects throughout the Institution. The federal government allows interest and depreciation for real property and equipment in the Institution's indirect cost rates for reimbursement. Principal payments on the Series 2018 Bonds began in 2019. The investment portfolio, \$442.9 million, represents 61 percent of the total assets as of December 31, 2022.

## STATEMENT OF ACTIVITIES

WHOI's total revenues without donor restrictions decreased by \$2.1 million; from \$295.3 million in 2021 to just under \$293.2 million in 2022; and the

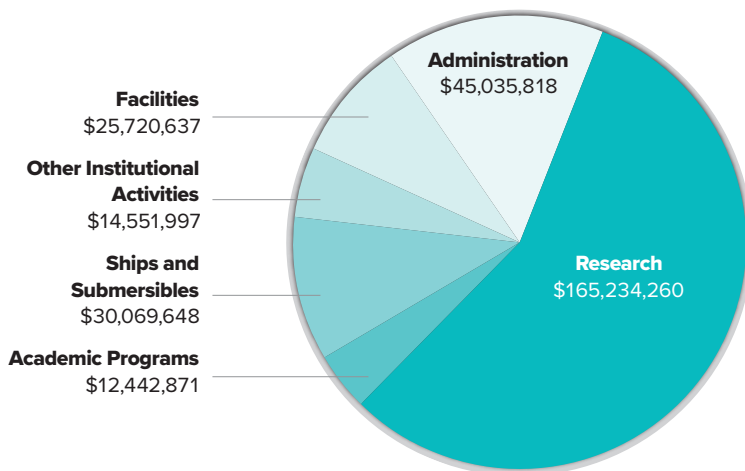
Institution's change in net assets from operating activities was a small profit of \$0.1 million. Our \$21.2 million of endowment income and appreciation was distributed to operations as follows:

- Education: \$9.4 million
- Research: \$7.6 million
- Unrestricted: \$4.2 million

The Institution had facilities and administration costs of \$70.8 million, and approximately 80 percent of that amount, \$58.3 million, was recovered from government and nongovernment research. This included \$3.8 million of interest associated with the Series 2018 Bonds. The remainder was institutional expenses.

Philanthropy continues to play a major role in meeting both research and educational programming obligations. Current-use giving and endowment income accounted for 21.3 percent of the Institution's revenue in 2022. In total, 7,566 supporters invested a record-shattering \$95.8 million in WHOI's mission—more than double the amount raised in 2021. The continued expansion of the supporter base at all levels is essential to achieving WHOI's bold Vision 2030 with its overarching goal of advancing ocean science for the global good.

EXPENSES: **\$293,055,231**





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