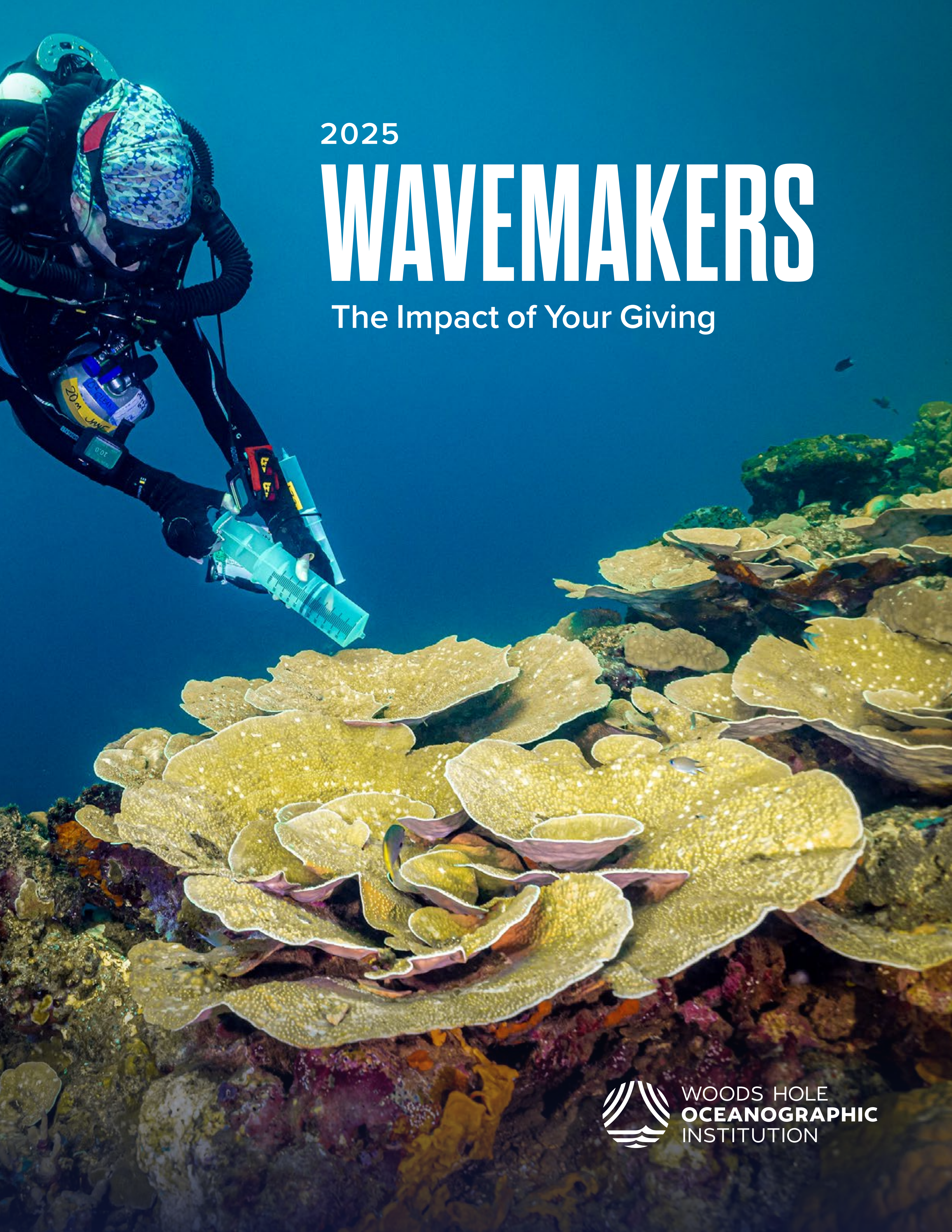


2025

WAVEMAKERS

The Impact of Your Giving

WOODS HOLE OCEANOGRAPHIC INSTITUTION

A Message from WHOI President and Director Peter de Menocal

One of WHOI's greatest strengths is our ability to adapt—to pursue the most promising science, respond swiftly to emerging opportunities, and stay at the forefront of ocean discovery. That agility is made possible by the steadfast support of our generous donors. You are our Wavemakers!

This fall, we launched the public phase of the Campaign for Our Ocean Planet with an ambitious goal of raising $500 million by 2027. As the largest campaign ever undertaken for ocean science, it comes at a pivotal moment as the sea faces unprecedented pressures.

Our blue planet supports a remarkable abundance of life, from the tiniest plankton to the largest whale. To protect this life—and the people who depend on it—WHOI's scientists are developing solutions to restore ecosystems, safeguard seafood supplies, and build climate resilience.

At the heart of the campaign, your investments strengthen WHOI's ability to attract top talent and support scientists at every career stage. By ensuring WHOI's team remains a leader in marine science, we can deploy cutting-edge research, technology, and innovation precisely when the world needs them most.

We are profoundly grateful to the thousands of donors who are stepping forward, reflecting an extraordinary vote of confidence in WHOI's mission. Your giving is the ballast that steadies us through changing currents in science, policy, and funding. It enables our scientists and engineers to tackle global challenges that might otherwise remain out of reach.

On behalf of our entire community—scientists, engineers, students, and staff—thank you for your enduring support. Together, we are building the knowledge and capabilities needed to sustain our living ocean now and into the future.

Sincerely,

Peter de Menocal
President & Director

On the cover:
A technical diver collects a water sample near corals living on a Potentially Polluting Wreck (PPW) in the Solomon Islands. Water samples like this one will show how PPWs across the Pacific impact biodiversity of microbes and corals—and how those species in turn contribute to corrosion or stability of the wreck. Photo by Adam Beard.

RESEARCH HIGHLIGHTS

A Mooring Deep Under Antarctica

Antarctica holds enough water frozen in its ice sheets to raise global sea levels by an estimated 200 feet (60 meters), but it's difficult to accurately measure how much of this ice is melting over time. Currently, most long-term measurements of Antarctic ice melt are taken by satellites, which have a significant margin of error and can only collect data when the skies are clear and the sun is up.

WHOI scientists Catherine Walker and Weifeng (Gordon) Zhang are leading a project to collect more consistent, precise data on ice melt in Antarctica. Seed funding from The W. M. Keck Foundation is supporting this pioneering work, allowing WHOI engineers and scientists to design a system capable of operating for years in this extreme environment.

"There have been underwater vehicles in ice shelf cavities before, but not consistently for much more than a few days and not doing full water column tests or measurements," Walker said. "It will be really exciting to collect data over months and seasons and see how things change."

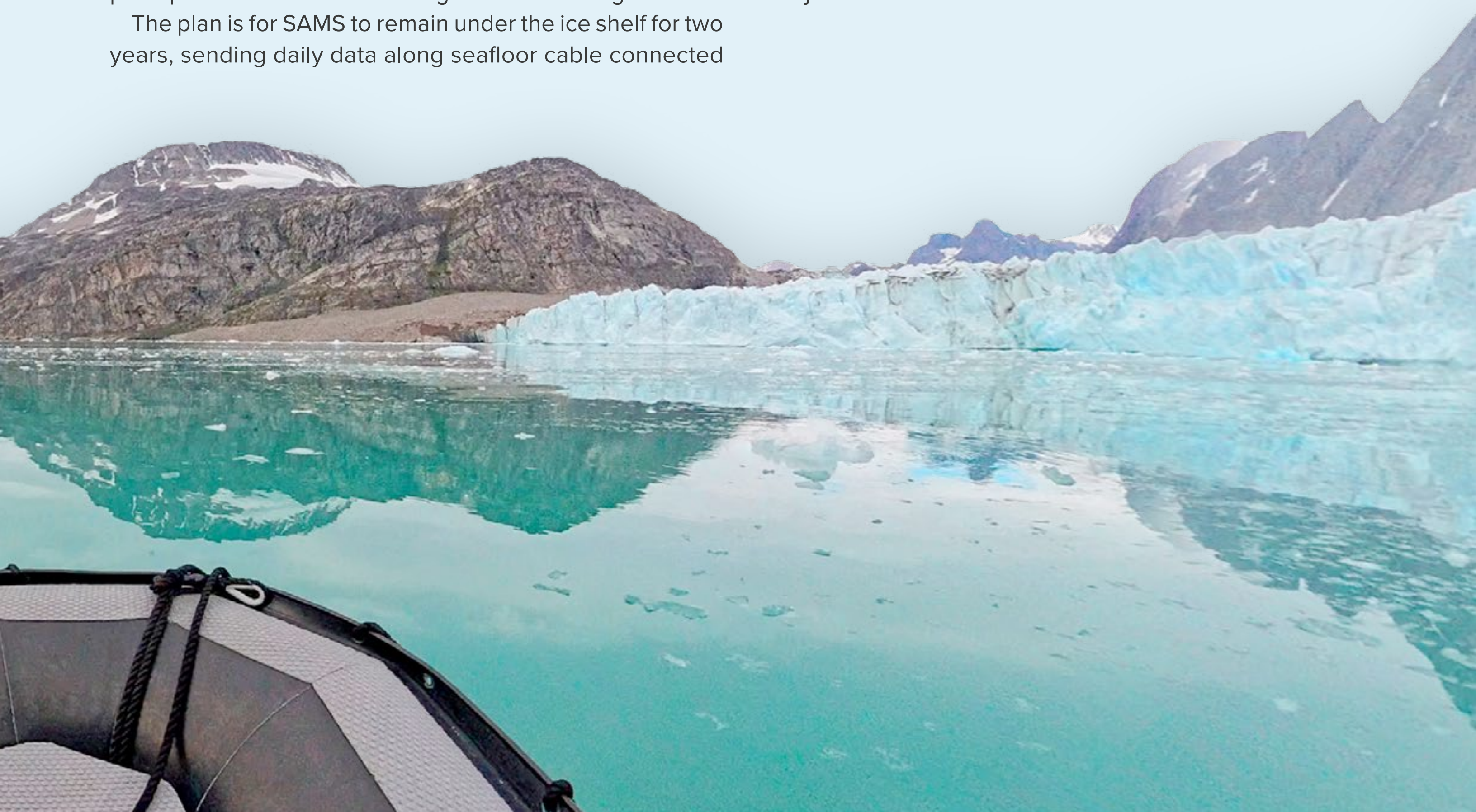
Antarctica's massive floating ice shelves, which can be up to 60 miles (100 km) wide and thousands of feet thick, cover almost two-thirds of its perimeter, extending for miles around the continent and helping to prevent the grounded ice sheet from melting and sliding into the ocean. Working underneath these shelves is extremely challenging: there is no sunlight to provide solar power, the undersides of the ice are full of

jagged crevasses, and there is often a layer of supercooled water that will instantly freeze any metal instrument that touches it.

Self-deploying Autonomous Mooring System (SAMS) is designed to be deployed from a ship and autonomously navigate through this hazardous environment for miles. Once it is deep under the ice shelf, the vehicle will drop an anchor and deploy a mooring to float up to the underside of the ice. Sensors on the mooring and along the anchor line will be able to measure temperature, salinity, the depth of the ice, and the velocity of any nearby currents. A hydrophone will pick up the sounds of ice cracking or bubbles being released.

The plan is for SAMS to remain under the ice shelf for two years, sending daily data along seafloor cable connected to a mooring outside the ice, which will be able to relay it to researchers via satellite. Walker and her colleagues hope the information they collect will provide new insight into the changes in Antarctica's ice shelves and help them either confirm or correct past assumptions made from satellite records.

"The largest source of uncertainty in sea level rise projections is the rate of ice loss from the Antarctic ice sheet," Walker said. "There are a lot of theories about what may or may not be happening, but if we can actually measure some of these processes, then we can do more than just theorize about it." ■



Protecting Billfish from Becoming Bycatch

Longline vessels in the Pacific Ocean put out tens of miles of fishing line, loaded with thousands of baited hooks dangling in the water to catch swordfish and tuna. But these hooks often catch unintended species as well, such as striped marlin, blue marlin, and shortbill spearfish.

"Striped marlin in the western and central North Pacific is the most immediate concern," said Martin Arostegui, a research associate at WHOI. "That particular stock has been assessed as overfished and experiencing overfishing for well over a decade." The blue marlin stock is considered healthier, but it is showing signs of decline, and the shortbill spearfish population hasn't been assessed—researchers don't have enough information to determine how the stock is doing.

Accidental bycatch by longline fishing accounts for more than 90% of the striped marlin, blue marlin, and shortbill spearfish taken from the North Pacific. Arostegui and WHOI assistant scientist Camrin Braun are leading an international collaboration to understand where and when these three species of billfish are at the highest risk of being caught accidentally by fishing fleets. Their work will help guide fishing efforts and inform fishery management decisions about where, when, and how commercial fishing should occur to keep bycatch at sustainable levels.

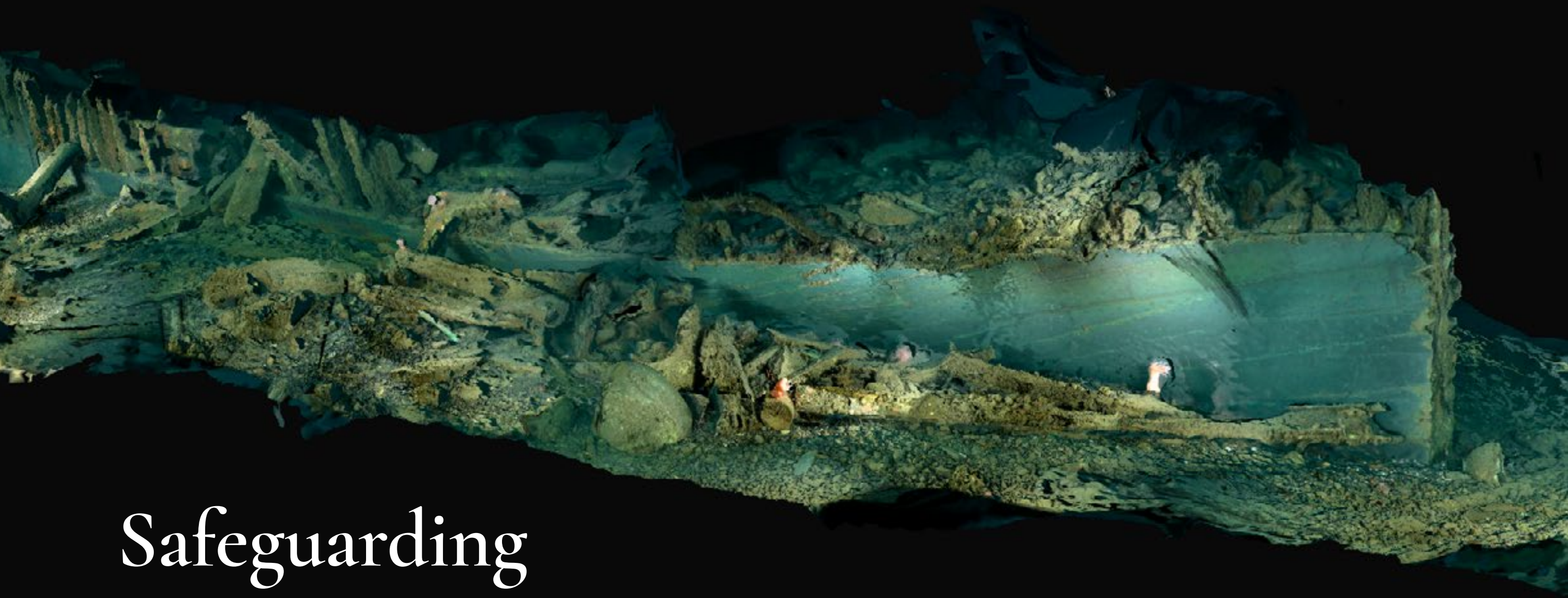
Billfish are fast and highly migratory. They can travel thousands of kilometers, and where they head depends on both the time of year and the particular oceanic conditions. To understand where these species occur, researchers are analyzing bycatch reports from commercial fishing logs and notes from fisheries observers. Collaborations with the sport fishing community have also provided decades of data from tagging programs, which place numbered tags on billfish so they can be identified when caught again. By combining this with 30 years of environmental data in the North Pacific, they hope to identify the ocean conditions that each species prefers and build predictive models of where the fish are likely to occur.

On the fishing industry side, the situation is equally complex. Thousands of vessels from a variety of countries fish in the North Pacific at different times of year, using different methods, and targeting different species. The researchers are gathering publicly available data about the movements and methods of various fishing fleets to predict where they are likely to overlap with different species of billfish.

Arostegui and Braun intend to combine these massive datasets on these billfish species and the fishing effort to identify critical areas where there is a particularly high and persistent risk of bycatch for each species, either over the whole year or in certain seasons. The project is currently limited to the North Pacific, but future plans call for expanding to the South Pacific to inform billfish management worldwide.

"You can't really understand the big picture without understanding what all of those vessels are doing relative to each species," Arostegui said. "This can provide managers with new options to consider in making decisions about managing the risk that these animals experience as they swim through the myriad national jurisdictions and international waters of the open ocean." ■

"YOU CAN'T REALLY UNDERSTAND THE BIG PICTURE WITHOUT UNDERSTANDING WHAT ALL OF THOSE VESSELS ARE DOING."*–Martin Arostegui, WHOI Research Associate*



Safeguarding Shipwrecks in Stellwagen Bank

In late November of 1898, heading north toward Maine, the passenger steamship Portland sank in a massive storm. None of the roughly 200 people on board survived.

The wreck of the Portland lies in what is now Stellwagen Bank National Marine Sanctuary, home to anemones, sponges, schools of fish, and other marine creatures. Sonar images from 2009 showed the ship's iconic fantail stern still intact. But by 2019, new scans revealed it had been torn away—likely by fishing gear—and a net was entangled on the port bow.

"Shipwrecks are underwater heritage, but unlike artifacts in a museum, they aren't roped off," said Kirstin Meyer-Kaiser, an associate scientist at WHOI. "They're a part of the environment—they have a cultural heritage value and a biological value."

When fishing nets snag on shipwrecks, they can destroy both important habitat and pieces of human history. Meyer-Kaiser and her colleagues are working to prevent further damage to these sites by raising awareness of the problem, designing a remotely operated vehicle capable of removing entangled nets, and working with local fishermen to figure out strategies to limit future entanglements.

"Fishing nets do incredible damage to shipwrecks," Meyer-Kaiser said. "There is a direct connection between what happens to the structure of a ship and the organisms living on that part of the ship."

In collaboration with WHOI Sea Grant, the researchers are designing school programming that encourages students to try to figure out how to prevent fishing gear from entangling on a shipwreck. Meyer-Kaiser and her colleagues are also working with a nonprofit called Sound Explorations to develop a traveling exhibit with a 3D model of the Portland's bow with and without the entangled net. The exhibit will use sound and music to guide interactions and have a net-removal video game.

As another part of the project, WHOI senior engineer Robin Littlefield is designing a new remotely operated vehicle that will be able to cut entangled nets free. The streamlined vehicle will be able to attach floats to lift nets and then slice through any snagged areas without causing further damage to the shipwrecks.

The project also involves ongoing conversations with fishermen about when and why they choose to fish near wrecks. The researchers are hoping to constructively and collaboratively develop policies that will help prevent future entanglements in Stellwagen Bank.

"Cultural heritage involves fishing in Massachusetts. It is an important part of our identity as a region," Meyer-Kaiser said. "So if you want to protect heritage, that means allowing fishing. The key is to find solutions where our history is intact, our biodiversity is sustained, our fisheries are sustainable both now and in the future." ■

Coastal Connections in the Gulf of Guinea

The Gulf of Guinea, a section of the Atlantic Ocean tucked into the curve between central and west Africa, is a remarkably productive area that supports the lives and livelihoods of millions of people in the region. Every summer, cold, nutrient-rich water from the deep ocean rises to the surface, fueling phytoplankton growth along the continental shelf, which in turn provides a bounty of food for fish and other marine life.

But in recent decades, the fish stock in the Gulf of Guinea has been declining, and the reasons for this decline are unclear.

"Is it because the rates of upwelling are changing? Is it because the nutrient distribution has changed? Is it because different kinds of phytoplankton are blooming? Is it overfishing or pollution? There are just so many possibilities and very little data right now," said Amala Mahadevan, a senior scientist at WHOI.

Mahadevan is collaborating with researchers in the U.S. and Ghana to lead the Ocean Margins Initiative, which will be the first comprehensive study of the northern Gulf of Guinea. The goal of the project is to better understand this unique area and its impacts on both coastal communities and the global ocean.

Despite its importance, the Gulf of Guinea hasn't been the focus of much scientific study. Countries in the region haven't had the resources to invest in oceanographic research and concerns about piracy have deterred research vessels from the U.S. and Europe from collecting data in the gulf.

Mahadevan is working with the scientists and students at the University of Ghana, with the support of the Ghana Navy and the local fishing community, to start measuring ocean currents, salinity, temperature, nutrients, plankton, microplastics, and anything else that could clue researchers in to what is happening in the coastal ocean. She hopes the

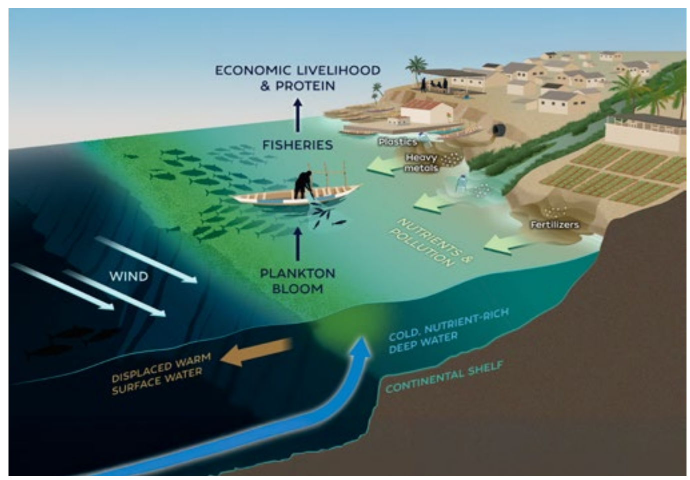
"CURRENT OCEAN MODELS ARE VERY COARSE AND DON'T TAKE INTO ACCOUNT ALL THE FINE-SCALE PROCESSES NEAR THE COAST. WE'RE TRYING TO PIECE ALL OF THIS TOGETHER." *–Amala Mahadevan, WHOI Senior Scientist*

answers they find will be able to help the local fisheries in Ghana, which provide 60% of the country's animal protein.

"If we can predict when there's going to be upwelling or when the fish will be spawning, if we can measure these processes and share that with people on the ground, we could have better strategies to inform the planning and annual closures of the fisheries," Mahadevan said.

The data collected by Mahadevan and her colleagues will also contribute to a better understanding of how processes in coastal areas are affecting the global ocean. The impacts of coastal upwelling are often overlooked in larger ocean models, but they likely play an important role in the large-scale distribution of carbon, oxygen, and nitrogen.

"Current ocean models are very coarse and don't take into account all the fine-scale processes near the coast," Mahadevan said. "We're trying to piece all of this together to get an idea of both seasonal and long-term changes, to understand what happens when there's upwelling, and to set up an infrastructure to make recurring observations and develop models for the region." ■



Discovering Ancient Diets Through Fossilized Fish Teeth

The ocean floor is full of tiny fossilized fish teeth. Because of the durable materials they're made of, fish and shark teeth are far more likely to be preserved than other parts of the animal. Over hundreds of millions of years, these teeth have settled on the sea floor, mixing into the sediment.

"You can find tens to hundreds of these tiny fossils in just a little bit of sediment, and that gives us this absolutely incredible record of fish and shark evolution and ecology going back through time," said Elizabeth Sibert, an assistant scientist at WHOI. "To me, this is a treasure trove."

Sibert has embarked on a project to use these fossilized teeth to understand how deep sea fish and the ecosystems they are part of have changed over time. She hopes to use the size and shape of fish teeth to reveal their main food sources, which are less likely to be preserved in the fossil record. If most of the teeth from a certain era are built for eating jellies, salps, and other gelatinous zooplankton, for example, then it likely means that those creatures were more prevalent than copepods or other zooplankton with harder shells.

But fish teeth aren't quite as intuitive as the teeth of land mammals. The long, thin, curving teeth of an anglerfish look like they are for stabbing into meat, but it turns out they act more like jail bars, folding up to keep prey from escaping after it has been engulfed. Before Sibert can analyze the shape and structure of ancient fish teeth, she needs a reference database for understanding how the shape of modern fish teeth relate to their diet.

Sibert has put together a catalog of fish teeth with high resolution photographs and detailed measurements from 500 modern fish, paired with what researchers know each animal typically consumes. Now, with a seed grant from the Hypothesis Fund she is starting to look for correlations between shape and diet that she can use to analyze ancient teeth.

"We have hundreds of thousands of fossil fish teeth from all sorts of different time and places and we want to be able to make sense of them," Sibert said. "That's where this modern catalog comes in."

The first time period she wants to examine is the Eocene-Oligocene transition, roughly 34 million years ago. During this time, Antarctica went from having a relatively temperate climate to being perpetually encased in ice, so Sibert wants to see how fish in that region evolved to cope with the rapid environmental changes.

"I spent my PhD figuring out different ways to get these microfossil teeth out of sediments in an effective and efficient way," Sibert said. "Now that I've got them, I want to be able to use them to answer these bigger questions about marine ecosystem dynamics and evolution through time." ■

"WE HAVE HUNDREDS OF THOUSANDS OF FOSSIL FISH TEETH FROM ALL SORTS OF DIFFERENT TIME AND PLACES AND WE WANT TO BE ABLE TO MAKE SENSE OF THEM."

–Elizabeth Sibert, WHOI Assistant Scientist

Early Diagnosis for Coral Stress

Coral reefs are vital ecosystems, providing a habitat for a quarter of the ocean's species, protecting coastlines from storm surges, and supporting economies through tourism and fishing. But they are vulnerable to environmental stress from many sources, including warming waters, pollutants, and disease.

The most visible sign of coral stress is bleaching—when the colorful algae that live symbiotically with coral polyps are expelled, leaving the coral white. But before corals reach that point, they exhibit less obvious signs of stress. Konrad Hughen, a senior scientist at WHOI, is developing a system to spot coral stress early and identify the underlying cause.

"We wanted to see if we could develop a way of quantifying coral health without having to wait until they're bleaching and dying," Hughen said. "This is like an MRI for corals."

Hughen and his colleagues have found that when a coral is stressed, the combination of lipid molecules that make up the algae's cell membranes starts to change. Using a technique called Raman spectroscopy, the researchers can detect this change by shining a laser into the corals and watching how the wavelengths of light shift as they interact with the lipids.

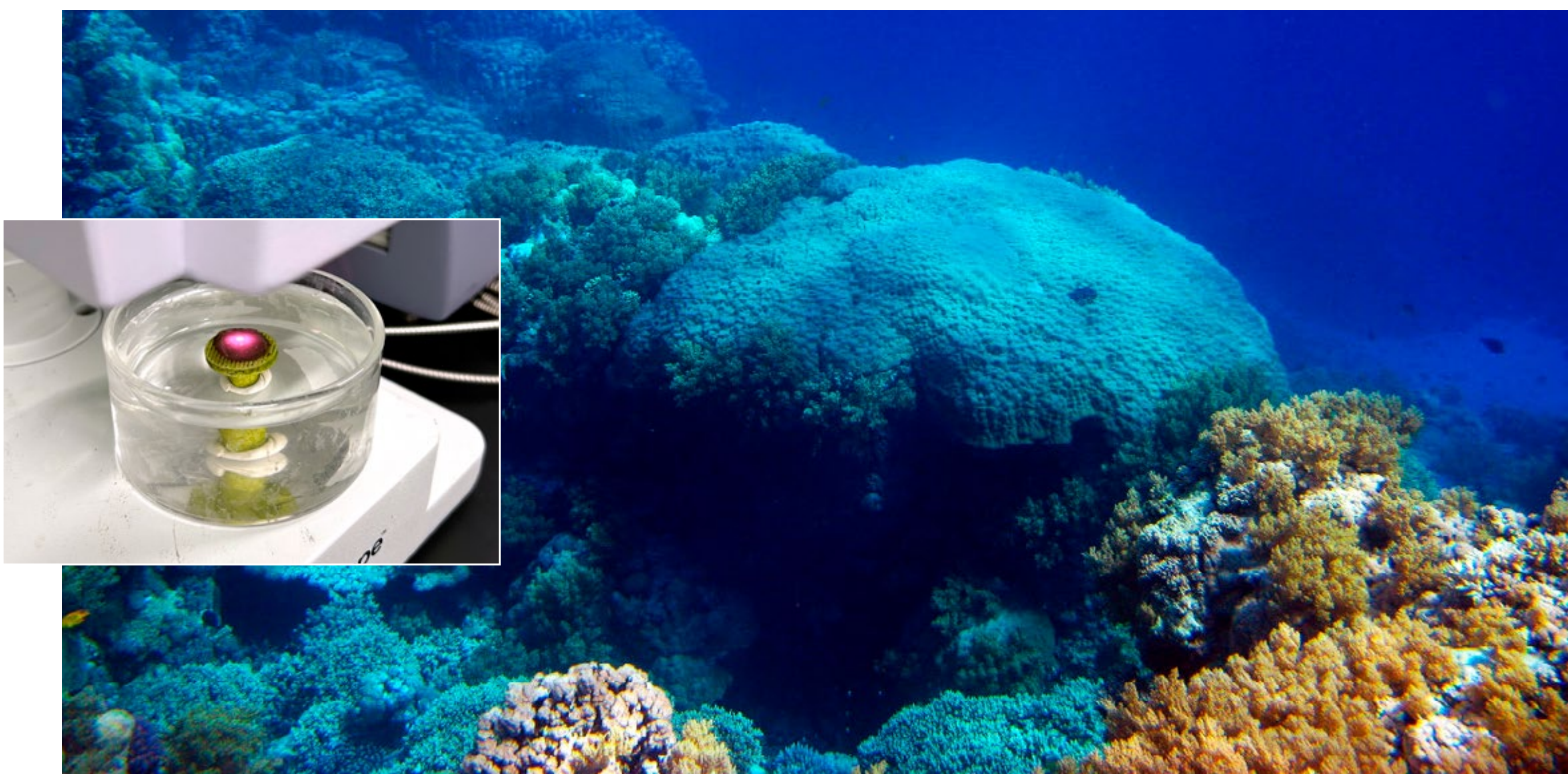
Different types of stress appear to cause the lipids to change in different ways. Hughen and his colleagues are currently trying to identify the unique signatures associated with different stressors.

"Temperature stress has a very specific signature, and we have that one down," Hughen said. "When it comes to things like herbicide stress, we know it's going to be different than temperature, but we're still looking at the data."

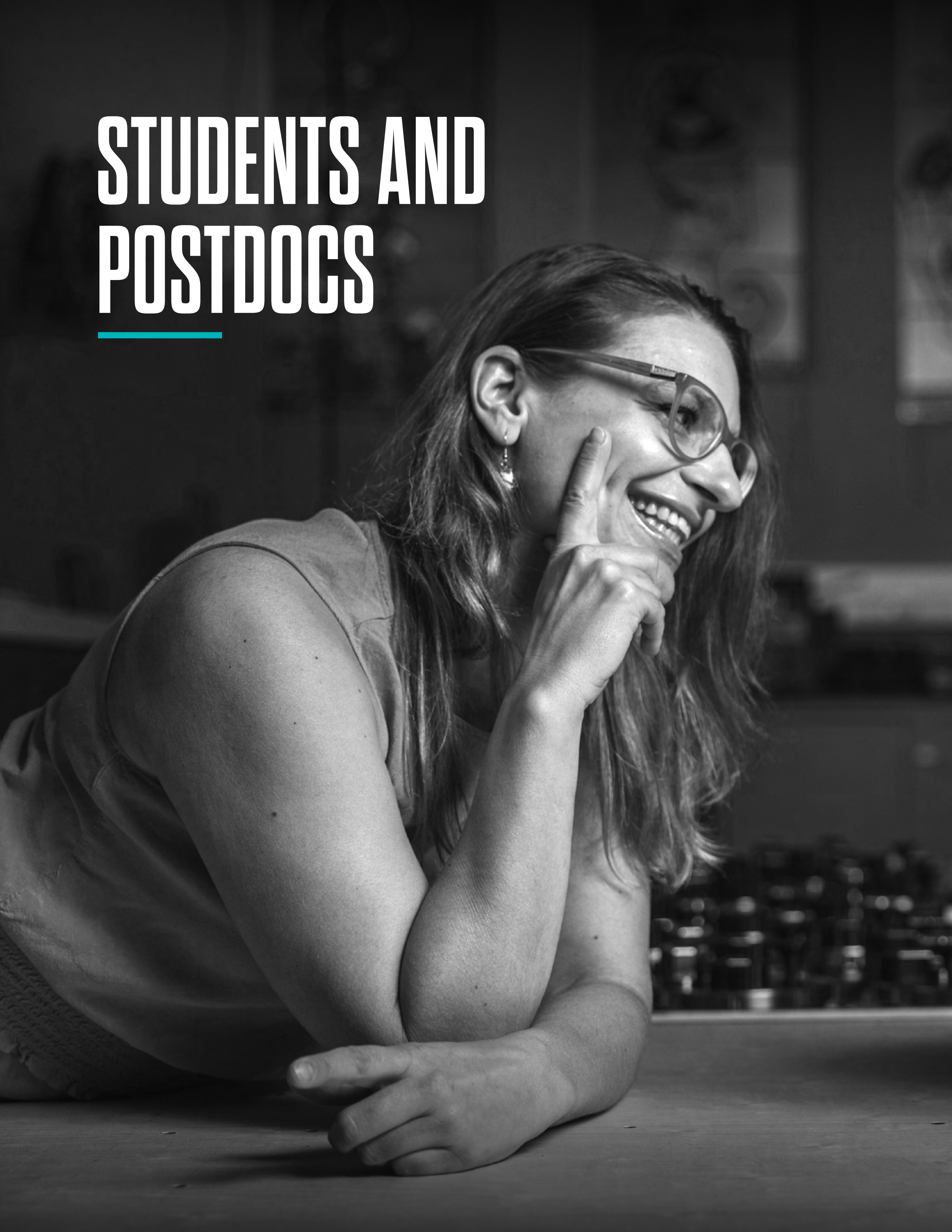
Typically, scientists must collect coral samples and take them back to the lab to analyze them. Hughen and his colleagues are developing a portable, noninvasive laser system that would allow researchers to take stress measurements from live corals underwater. Even on a single coral head, different sections may respond to stress differently—researchers have seen parts of coral heads bleach while other parts retain their colorful algae—so being able to take multiple readings would provide a more complete picture of coral health.

The researchers hope to be able to catch coral stress early, identify hotspots on a reef, and communicate what is causing that stress to local stakeholders so that action can be taken before the reef hits critical stress levels. The work is part of WHOI's Reef Solutions initiative, which is advancing solutions to protect, restore, and preserve reefs around the world.

"I'm trying to get to a place where we can measure stress at a reef scale," Hughen said. ■



STUDENTS AND POSTDOCS



Impacts of Man-Made Sounds on Ocean Life

For years, scientists assumed sharks were silent predators of the sea. But new research suggests some species may be capable of making sounds, and that both sharks and corals are sensitive to the noises humans introduce into the ocean.

WHOI postdoctoral investigator Carolin Nieder studies how marine species hear and respond to sound. As a Ph.D. student at the University of Auckland, she discovered that rig sharks in New Zealand waters produced a mysterious clicking noise. It remains unclear whether the sharks can hear these sounds themselves or if they serve a communicative purpose. "We are creating new knowledge about animals that are incredibly hard to study," said Nieder. "Learning what frequencies sharks can detect, and how man-made sounds affect them, could help us understand the effects of certain human activities on marine life."

Now at WHOI, Nieder works in the lab of associate scientist Aran Mooney, who uses bioacoustics to study how animals detect their environment. She is investigating how corals respond to underwater sound, particularly the natural sounds of a healthy reef. In field experiments in Maui, she found that some coral species move their tentacles in response to certain sounds, while others retract or even change color. "Corals are sensory beings, and they respond to various stimuli," Nieder explained. "We want to determine if sounds can induce stress."

Scientists believe corals detect sound through vibrations known as particle motion, the same physical cue sharks use to hear. This overlap highlights how diverse marine organisms share common mechanisms of sound perception.

Both sharks and corals are vital to ocean health and marine ecosystems. Sharks regulate prey and contribute to a balanced food web, a key contribution to helping fisheries function. Coral reefs provide food, habitat, and shelter to a variety of marine life and provide coastal protection by serving as natural barriers. Yet both are under increasing strain from human activity and environmental change, making it critical to safeguard the habitats that support them.

Nieder hopes her research will inform how society balances human development with the needs of ocean ecosystems. "Humans want to do reasonable things, such as building ports, factories, and housing along coasts," she said. "But, if the sounds we create are harming species like sharks and corals, we have an opportunity to do things responsibly." ■

"WE ARE CREATING NEW KNOWLEDGE ABOUT ANIMALS THAT ARE INCREDIBLY HARD TO STUDY."

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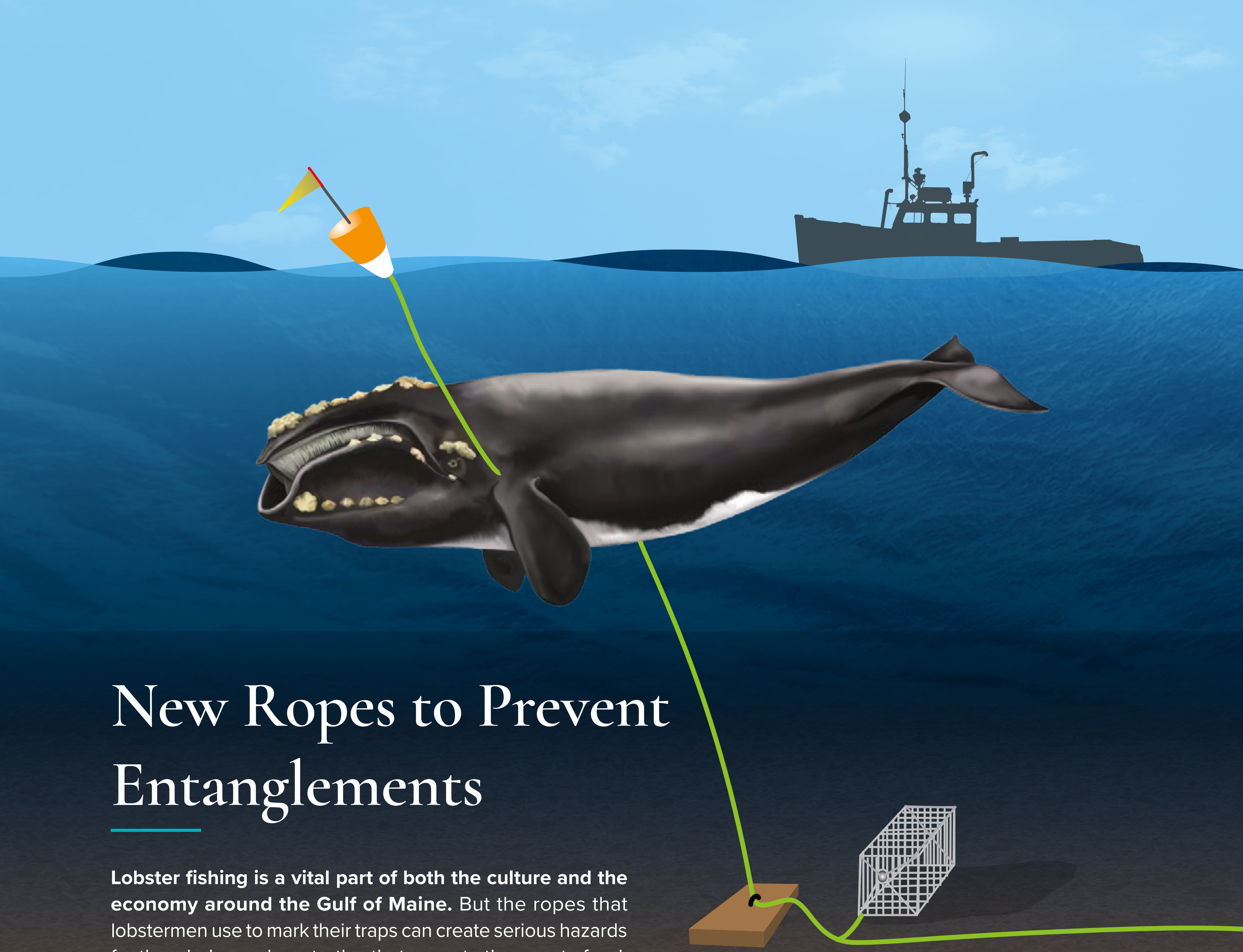


New Ropes to Prevent Entanglements

Lobster fishing is a vital part of both the culture and the economy around the Gulf of Maine. But the ropes that lobstermen use to mark their traps can create serious hazards for the whales and sea turtles that come to the area to feed. Entanglement in fishing gear is the primary cause of death for the North Atlantic right whale, a critically endangered species with only about 370 individuals remaining.

"About 80% of North Atlantic right whales will be entangled at least one time in their life," said Joshua Brandt, a graduate student in the MIT-WHOI Joint Program. "They aren't able to feed as well; it costs extra energy to fight against the entanglement, and the rope can cut into their skin and cause infections. Even if they get untangled, they can still end up dying."

Brandt is working with MIT associate professor Mathias Kolle, as well as colleagues at the Stellwagen Bank Marine Sanctuary, to design ropes for fishermen that would be less likely to entangle marine animals. The goal is to have a rope that becomes rigid in the water, so it can't easily wrap around a fin or fluke, but returns to a flexible state out of the water, so that fishermen can continue to haul up their traps easily.

"We don't want the fishermen to need more complicated equipment," Brandt said. He has met with a representative of the Massachusetts Lobstermen Association to better understand the challenges lobstermen face and the types of solutions that would meet their needs.

Brandt's current approach is to create a rope with a central core filled with hydrogels—the same type of absorbent material used in diapers. When the rope gets wet, the hydrogels swell up, causing the rope to become stiff and inflexible. But restoring the rope to a more pliable state is challenging because commercial hydrogels tend to break apart and ooze out when the rope is squeezed. Brandt is working to engineer materials that have the same absorbent abilities, but will release liquid quickly and easily when hauled out of the water.

"Right now, large areas have to be closed to lobster fishing when the whales are there," Brandt said. "If there's a way to keep these ropes from posing a problem to whales, it's a win-win: the whales won't get entangled and the fishermen could potentially access these areas and not face so many restrictions."

Meteorites Provide Clues to the Earth's Formation

Our solar system, like others throughout the galaxy, started out as a loose cloud of gas, dust, and ice called a protosolar cloud. At some point more than 4.5 billion years ago, this giant cloud started to collapse. The majority of the material collapsed together to form the young Sun. The rest of the material formed a disc that orbited the Sun—this nebular disc was ultimately the birthplace of the Earth and other planets in our solar system.

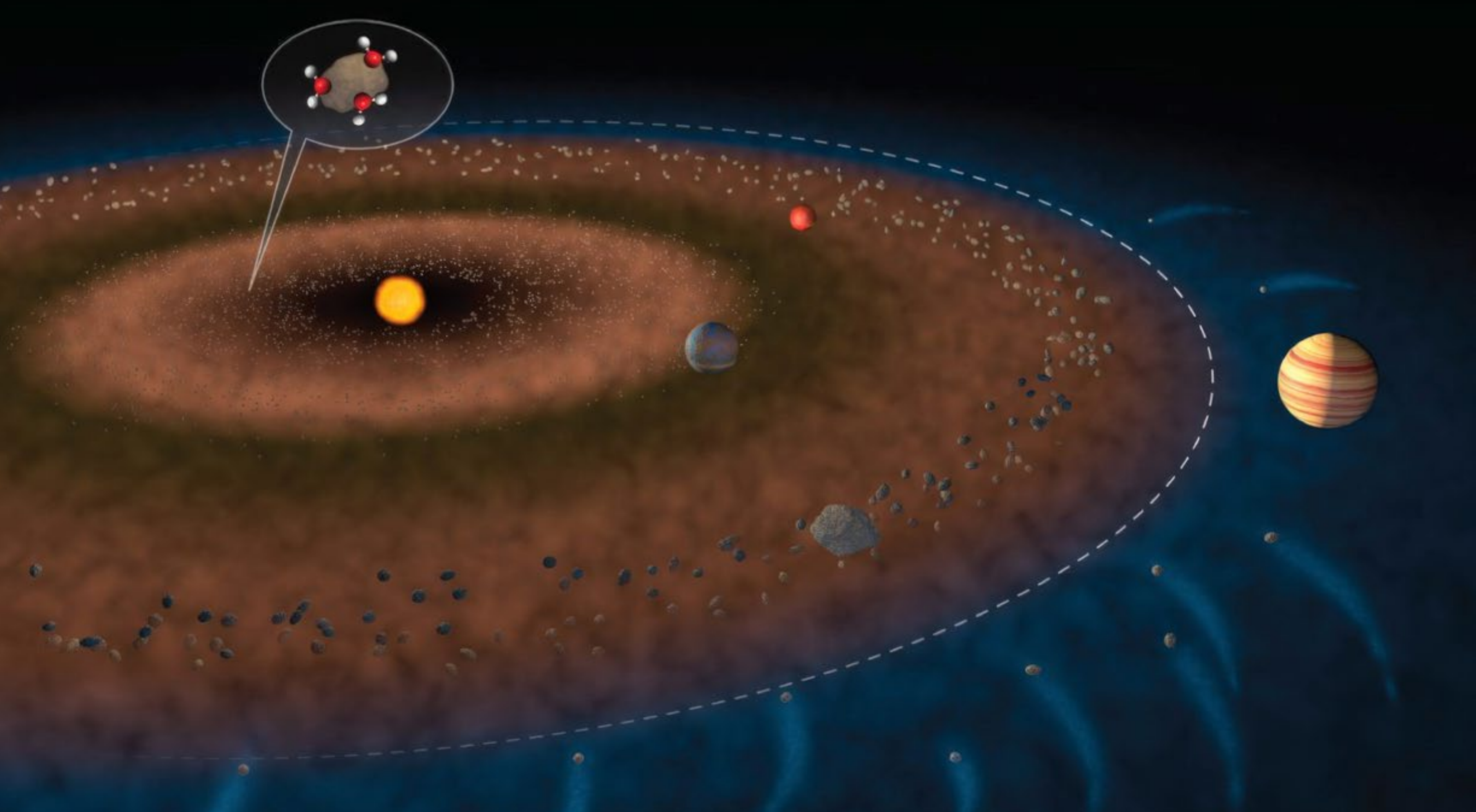
This is the period in time that Liam Peterson, a postdoctoral investigator in geology and geophysics at WHOI, is focused on. Peterson studies meteorites, some of which contain the first materials to form in the nebular disc. By studying the compositions of these early-formed materials, he hopes to gain a deeper understanding of the Earth's origin and its evolution into the planet we have today.

"Meteorites are little time capsules that allow us to understand what things looked like over four and a half billion years ago," Peterson said. "They contain bits of the first materials that formed in our solar system."

Meteorites, many of which are around the size of a pebble or golf ball, crash land all over the Earth. But they are best preserved in places where there is not much precipitation. The majority of the meteorites that Peterson studies come from deserts in northwest Africa and from Antarctica, two locations where they are less likely to have been eroded or contaminated. It's important that they are well preserved because their chemical makeup and structure provide clues to where, when, and how they were formed.

Peterson is interested in meteorites containing calcium-aluminum-rich inclusions—small beads of material that crystallize at temperatures around 1500° Celsius (2730° Fahrenheit), when almost everything else would still be a gas. The early solar system was incredibly hot, and as it began to cool, these would have been some of the very first materials to form. By studying their chemical makeup, Peterson can start to determine the temperature, pressure, and other conditions that were needed to create them.

"These materials condensed out of the nebula in the first one million years of solar system history—they give us a window back in time to right before the planets started to form," Peterson said. "The analyses and experiments I'm doing can help us understand the conditions at the beginning of the formation of the Earth and other bodies."



Improving Predictions for Coastal Flooding and Sea Level Rise

Global sea levels are predicted to rise more than 1.4 feet by 2100, damaging infrastructure, displacing people, and increasing flood risks in many coastal communities. But the seas do not rise uniformly around the globe. There are many different factors that contribute to how ocean heights change in local areas.

Carolina Camargo, a postdoctoral investigator in Christopher Piecuch's lab at WHOI, is using regional observations from satellites, tide gauges, and buoys to study the forces that impact sea level rise and flood risks at the local level. Her work will help improve predictions in different coastal areas, so that those communities have a better understanding of what they may face in the future.

"No place in the ocean is the same—you have so many different dynamics," Camargo said. "Global models lack the resolution to capture all the little things that come together to raise or lower sea level along a specific coast. They're missing processes that are important for local projections."

In New England, Camargo has been studying the Shelfbreak Jet Current, which originates in the cold Labrador Sea. Melting snow and ice create a chilly, less-salty current that travels south, hugging the coast of eastern Canada and the U.S. all the way to the Carolinas.

The introduction of this cold, relatively fresh water has a notable impact on sea levels and regional flood risks, Camargo said. She is using data collected as part of the Ocean Observatories Initiative to examine how different factors, such as density differences between cold and warm water, wind velocities, and the movement of water masses, may be impacting sea level height across New England.

Camargo is also embarking on a project to examine how fluctuations in the Gulf Stream Current are impacting the sea levels around Florida. The Gulf Stream originates in the Florida Straits, sweeping out of the Gulf of Mexico between Florida and Cuba and curling north. NASA's Surface Water and Ocean Topography (SWOT) satellite system has been collecting detailed records of sea surface heights in this area (and around the world) since 2023, and Camargo intends to leverage this unprecedented data set to examine how the Gulf Stream has, and will continue to, impact flood risks in Florida.

"Sea levels are not going to rise equally everywhere," Camargo said. "Hopefully, what we are finding can be used to improve models and projections so that people will have the information they need to protect the coastlines where they live." ■

Glass Sponges: From Deep Sea to Biotechnology

Glass sponges are among the ocean's most unusual creatures, with skeletons made of silica, a glass-like substance that presents in the form of small, needle-like structures called spicules. Dominating Earth's prehistoric oceans, glass sponges have been present in the fossil record for 600 million years. They cycle carbon, sulfur, and nitrogen in the ocean, yet remain some of the least studied marine organisms, largely because they are mostly restricted to the deep ocean.

MIT-WHOI Joint Program student Kate Lane is working to change that. Her research focuses on how these sponges process nutrients and their impact on the ecosystems they inhabit. By studying these animals in the field, researchers are uncovering the potential role of their microbiome in chemical cycling in the deep sea.

Lane collected glass sponges from mesophotic and deep-sea sites off Puerto Rico using the ROV SuBastian aboard Schmidt Ocean Institute's research vessel Falkor (too). By applying advanced techniques such as genetic sequencing, she uncovered microbial communities previously unknown in these rare organisms.

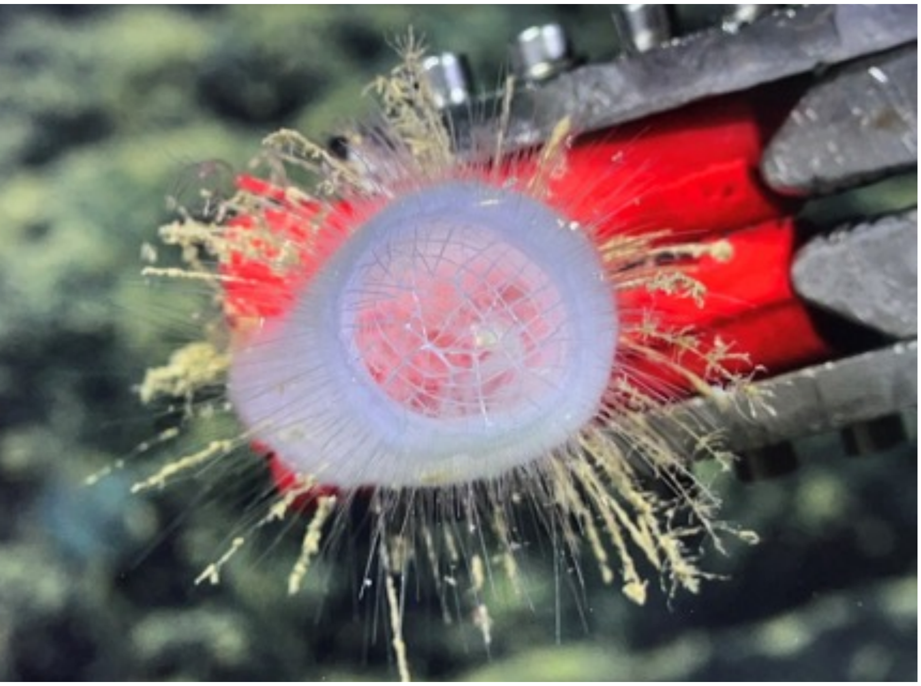
"Glass sponges filter seawater to acquire food, and through that process, they recycle nutrients in the seawater," Lane explains.

To capture those processes, Lane examines the genetic potential of the sponge microbiome, sequencing the DNA of the sponge host and microbes. These genetic clues help reveal how the animals adapt to conditions of the deep ocean: light, temperature, nurtrients, and oxygen. These insights are crucial for developing a clearer understanding of how life adapts in extreme environments.

This work has already produced a dataset that will serve as a lasting resource for future discoveries. Lane's specimens, together with preserved tissue, will be part of the Smithsonian Institution's permanent natural history collection, where taxonomic experts are collaborating to analyze their diversity and ensure the sponges can be studied for years to come.

The genetic sequences Lane generated have created a unique resource for future research. When these datasets become publicly available, researchers and companies may mine them for bioactive molecules, as sponges and their microbiome are known sources of novel compounds that could lead to applications in medicine and industry.

"Studying something as enigmatic as glass sponges truly captures my imagination," Lane says. "I'll be curious to see what scientists do with the data and how this research could lead to future applications in science and biotechnology." ■



BUILDING ON EXCELLENCE

BEN VAN MOOY, DEPUTY DIRECTOR AND VICE PRESIDENT FOR SCIENCE & ENGINEERING

Ben Van Mooy, a longtime WHOI scientist in the Marine Chemistry and Geochemistry Department, has been promoted to Deputy Director and Vice President for Science & Engineering. His research examines how plankton biochemistry influences carbon and nutrient cycling across diverse ocean environments, ranging from the tropics to Antarctica. A 2024 MacArthur "Genius" Fellow, Ben brings scientific distinction and institutional perspective to his new leadership role, where he will help guide the future of WHOI science.

DENNIS MCGILLICUDDY, CHIEF SCIENCE OFFICER FOR OCEAN AND GOVERNMENT AFFAIRS

Dennis McGillicuddy, a longtime WHOI scientist known for his pioneering work on the interplay between ocean circulation and marine ecosystems, was recently appointed Chief Science Officer for Ocean and Government Affairs. Over his three decades at WHOI, he has led interdisciplinary programs, chaired major initiatives, and authored more than 150 publications. In this new role, Dennis will help strengthen the connection between WHOI science and national policy priorities, ensuring that discoveries at sea inform decisions that shape the future of the ocean.

RECENT HIRES

DIANE FOSTER, VICE PRESIDENT FOR ACADEMIC PROGRAMS AND DEAN

Diane Foster joined WHOI in January 2025 as Vice President for Academic Programs and Dean. She previously led the University of New Hampshire's School of Marine Science and Ocean Engineering, where she was a professor of Mechanical and Ocean Engineering. Foster holds degrees in mechanical and civil engineering from UMass Amherst, the University of Maine, and Oregon State University, and completed postdoctoral work in physical oceanography at Dalhousie University. She has also served nationally in executive roles with the U.S. Coastal Research Program. At WHOI, Foster is focused on advancing research, education, and public engagement while creating a thriving environment for students and postdoctoral researchers.

JOHN "CHIP" BREIER, APPLIED OCEAN PHYSICS & ENGINEERING – DEEP SUBMERGENCE LABORATORY

John "Chip" Breier is an oceanographer and engineer who develops robotic tools to study how ocean mixing, chemistry, and life processes interact. His work spans deep-sea volcanoes, the open ocean, and the coastal ocean, using chemical tracers to follow water through the hydrologic cycle. Breier's lab has created instruments deployed on ROVs Jason, Hercules, and Nereus, as well as AUVs Sentry and Remus. He also led the development of AUV Clio. He earned a degree in mechanical engineering from Texas A&M, served as a U.S. Navy engineer, and received his Ph.D. from the University of Texas at Austin in 2006. After completing postdoctoral research at Stanford and WHOI, he joined WHOI's staff in 2008, then served as a faculty member at the University of Texas Rio Grande Valley from 2015 to 2025, before returning to WHOI in 2025 as a tenured Associate Scientist in AOPE.

JOHN COLOSI, APPLIED OCEAN PHYSICS & ENGINEERING

John Colosi is a physical oceanographer who studies ocean acoustics and their connection to multi-scale ocean processes, including turbulent mixing, internal gravity waves, and heat content. His work develops acoustic sensing techniques that provide integral measurements of ocean properties, with applications ranging from climate science to national security. Colosi earned his B.A. and Ph.D. in physics at UC San Diego and UC Santa Cruz, respectively, and previously served on the faculty at the Naval Postgraduate School. He first joined WHOI in 1996, later returned as an adjunct professor at UCSC, and rejoined WHOI in April 2025 as a Senior Scientist in AOPE.

SAMANTHA COY, BIOLOGY

Samantha Coy is a microbiologist whose research focuses on the impact of viruses on ocean ecosystems. Her work examines virus-host interactions at the cellular level and scales up to understand impacts across populations, communities, and biogeochemical cycles. Coy's lab combines biomarkers, omics-based surveys, and physiology-to-ecology approaches to trace infections through time and space. She earned a B.A. in Environmental Science from Drury University, a Ph.D. in Microbiology from the University of Tennessee, and completed postdoctoral work at Rice University and Texas A&M. Coy joined WHOI in January 2025 as an Assistant Scientist in the Biology Department.

ANDY HEARD, GEOLOGY & GEOPHYSICS

Andy Heard is an isotope geochemist who investigates metal cycling in the ocean and its imprint on the geologic record. His current work involves developing new stable isotope tools to study how hydrothermal vents supply metals to the ocean, with research sites ranging from Hawaii's Kama'ehuakanaloa seamount to the Mid-Atlantic Ridge. Heard also uses isotopes of redox-sensitive metals such as iron, vanadium, and thallium to understand how oxygen rose in Earth's early surface environments more than two billion years ago. He earned his M.Sci. in Earth Sciences from the University of Oxford in 2016 and a Ph.D. in Geochemistry from the University of Chicago in 2021. After postdoctoral research at WHOI as both a Postdoctoral Scholar and an Agouron Geobiology Fellow, he joined the Geology & Geophysics Department as an Assistant Scientist in January 2025.

MOMME CLAUS HELL, PHYSICAL OCEANOGRAPHY

Momme Hell has joined WHOI's Physical Oceanography Department from the National Center for Atmospheric Research, where he was a Postdoctoral Fellow in the Advanced Study Program. His research examines how air–sea interactions influence climate-relevant processes, using high-resolution models and remote sensing to better capture small-scale dynamics. Momme earned his Ph.D. at Scripps Institution of Oceanography, his M.Sc. at ETH Zurich, and his B.Sc. at GEOMAR in Kiel.

JAMES MCELWAINE, GEOLOGY AND GEOPHYSICS

James McElwaine is an applied mathematician who studies complex geophysical processes on Earth and other planetary bodies, with recent applications in oceanography. His work spans climate science, astrophysics, planetary science, physics, and environmental fluid mechanics, using models and experiments to understand natural phenomena. He earned his BA and PhD in applied mathematics at the University of Cambridge and held research fellowships at Cambridge and the University of Hokkaido, where he studied avalanches and particle transport. He later served as a Senior Scientist at the Planetary Science Institute and as Professor of Geohazards at Durham University before joining WHOI as an Associate Scientist II in 2024.

XAVIER MOUY, APPLIED OCEAN PHYSICS & ENGINEERING

Xavier Mouy has joined WHOI's Applied Ocean Physics and Engineering Department as a bioacoustician specializing in passive acoustic methods to monitor marine life and the impacts of climate change. His work combines signal processing, machine learning, and the development of low-cost instruments to support conservation and fisheries management. He holds a Ph.D. in Earth and Ocean Sciences from the University of Victoria, with earlier degrees from the University of Quebec in Rimouski and Le Mans University.

YOUNGSUNG PARK, APPLIED OCEAN PHYSICS & ENGINEERING

Yongsung Park is an ocean acoustician who develops methods to detect and locate underwater sound sources, from ships to marine mammals, and to probe ocean environments using acoustic signals. His work integrates physics, signal processing, and machine learning to advance the analysis of underwater sounds. Park earned his B.S. and Ph.D. in Naval Architecture and Ocean Engineering from Seoul National University and worked as a project scientist at Scripps Institution of Oceanography, contributing to ONR-funded studies. He joined WHOI in January 2025 as an Assistant Scientist in AOPE.

STEPHEN TURNER, GEOLOGY & GEOPHYSICS

Stephen Turner is a geochemist and petrologist who studies how volcanism and tectonics at convergent margins shape Earth's crust and influence global cycles. His research utilizes high-precision trace element analysis and microanalytical techniques to investigate processes such as subduction, continental formation, and the cycling of elements between the ocean, mantle, and atmosphere. Turner earned his undergraduate degree from Rice University in 2007 and his Ph.D. in Earth and Planetary Sciences from Harvard University in 2015. He has held postdoctoral positions at Oxford University and Washington University in St. Louis, and faculty roles at the University of Massachusetts Amherst and the University of Houston. Turner joined WHOI in 2025 as an Associate Scientist in the Geology & Geophysics Department.

JAMES WAINAINA, BIOLOGY

James Wainaina is a viral ecologist and computational biologist whose research uncovers the roles of viruses in ocean ecosystems. He integrates genomics, eco-evolutionary biology, and computational tools to study the contributions of viruses to metabolism, biogeochemical cycles, and ecosystem resilience. Wainaina earned a B.Sc. in Biochemistry from the University of Nairobi, an M.Sc. in Biotechnology from Jomo Kenyatta University of Agriculture and Technology, and a Ph.D. in Biochemistry and Computational Biology from the University of Western Australia. He completed postdoctoral work at The Ohio State University before joining WHOI's Biology Department in August 2024 as an Assistant Scientist.

XIAOTING YANG, PHYSICAL OCEANOGRAPHY

Xiaoting Yang has joined WHOI's Physical Oceanography Department following a postdoctoral appointment at Scripps Institution of Oceanography. Her research focuses on large-scale ocean circulation, particularly the meridional overturning circulation and its role in transporting heat, carbon, oxygen, and nutrients throughout the climate system. Xiaoting earned her Ph.D. in Earth and Planetary Sciences from Harvard University and her B.Sc. in Physics from Peking University.

RESEARCH ACCELERATOR

Rapid changes in our ocean are reshaping coastal communities and influencing global climate, food security, and national security. The Research Accelerator Funds fuel high-impact research, innovative technologies, and bold exploration, enabling our scientists to respond quickly to emerging needs. The following highlights showcase just a few of the projects made possible through this vital support.

Can the Ocean Pull Down Carbon?

The ocean may hold one of the most powerful climate solutions left on Earth.

For decades, the ocean has quietly protected us, absorbing heat and carbon from the atmosphere. But to successfully meet the goals of the Paris Agreement and limit global warming to 2°C, we must remove carbon dioxide (CO_2) from the atmosphere at a scale never attempted before, in parallel with rapid reductions in CO_2 emissions.

"Even if we could stop carbon emissions today, we would still need carbon dioxide removal because of all of the greenhouse gas CO_2 that is already in the atmosphere," said WHOI senior scientist Ken Buesseler.

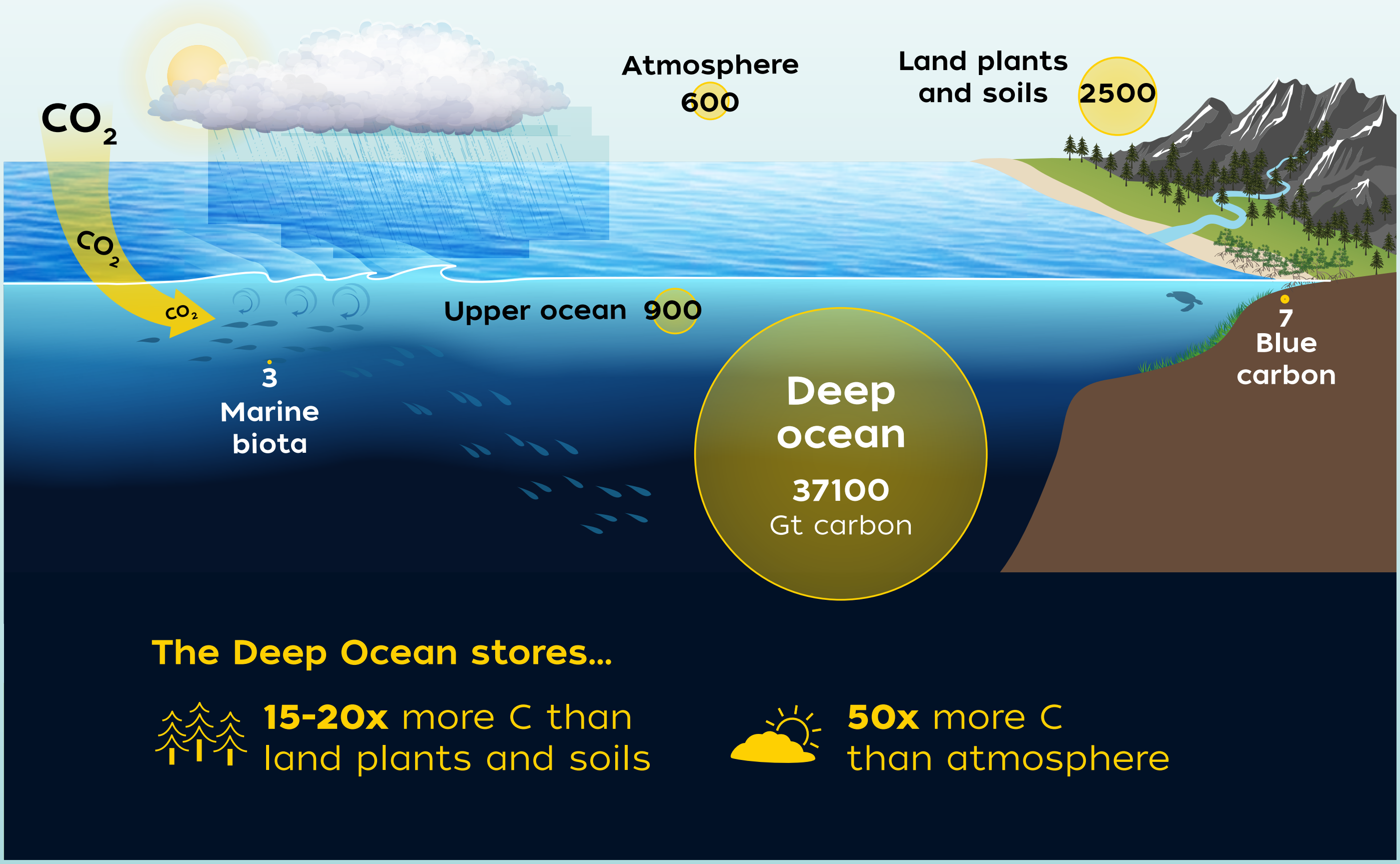
Marine carbon dioxide removal (mCDR) is still an emerging field, but its potential scale is unmatched. If proven viable, it could remove gigaton-level quantities of CO_2 and help reach climate targets that land-based approaches alone cannot meet.

"Given the ocean's large capacity for carbon storage—more than 50 times larger than the atmosphere and 15-20 times larger than all land-based plants and soils—enhancing the ocean's natural ability to store carbon should be considered," according to Paul Morris, project manager for Exploring Ocean Iron Solutions (ExOIS), an independent program hosted at WHOI.

ExOIS is an international nonprofit consortium of 35 institutions that are collaborating to evaluate the potential efficiency of ocean iron fertilization (OIF) for atmospheric mCDR. They are investigating whether OIF can enhance the ocean's natural biological carbon pump to sequester atmospheric CO_2.

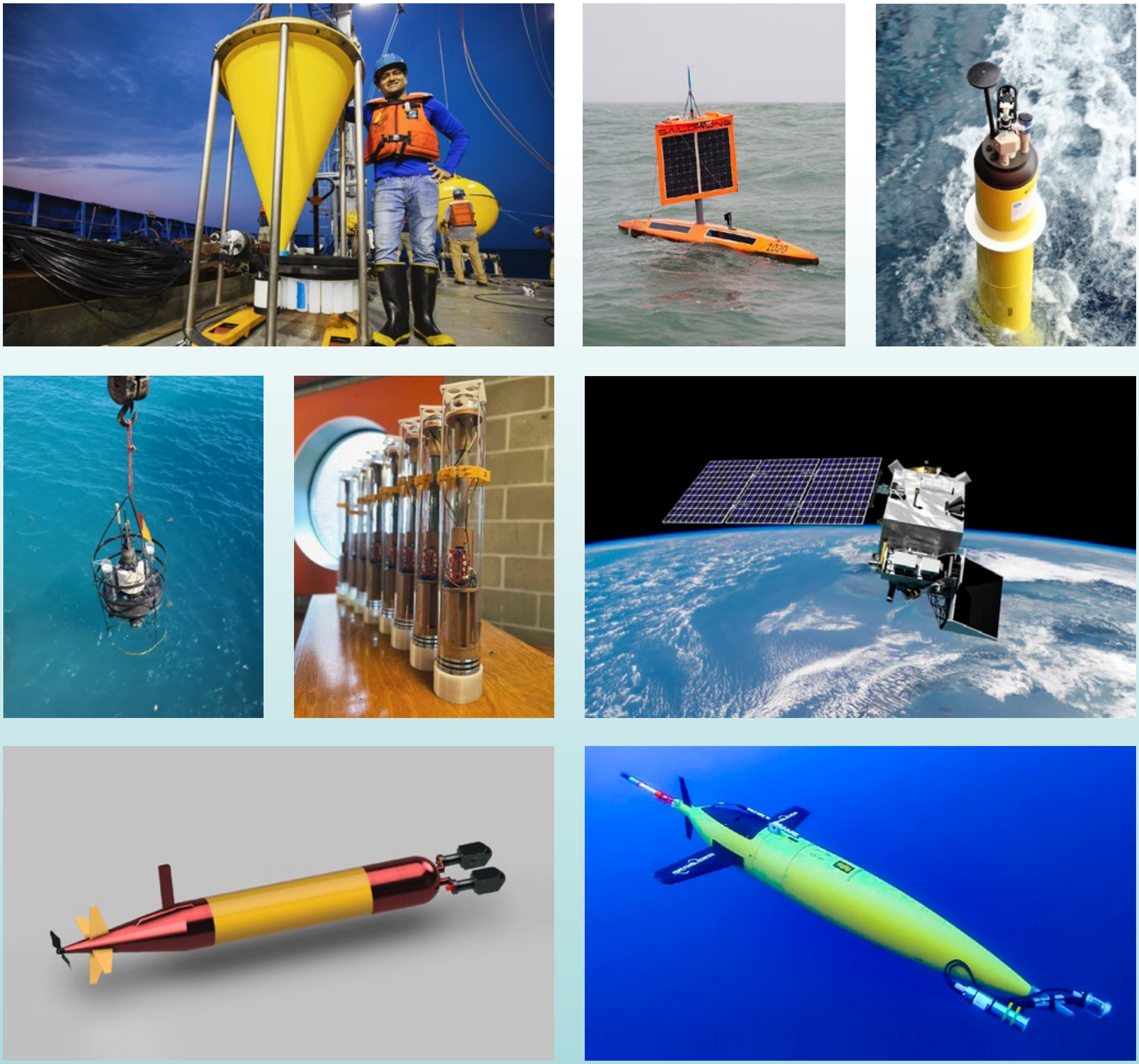
OIF mimics the natural process that occurs when iron in the form of dust from the Sahara, or ash from volcanic eruptions, blows onto the ocean's surface and creates massive phytoplankton blooms. When scientists artificially add iron to the ocean's surface, it similarly stimulates phytoplankton growth—microscopic plants that absorb CO_2 as they photosynthesize. When these organisms die and sink, they can transfer carbon to the deep ocean for long-term sequestration.

Early OIF experiments in the 1990's and 2000's showed consistent biological and geochemical consequences, including phytoplankton bloom formation, nutrient

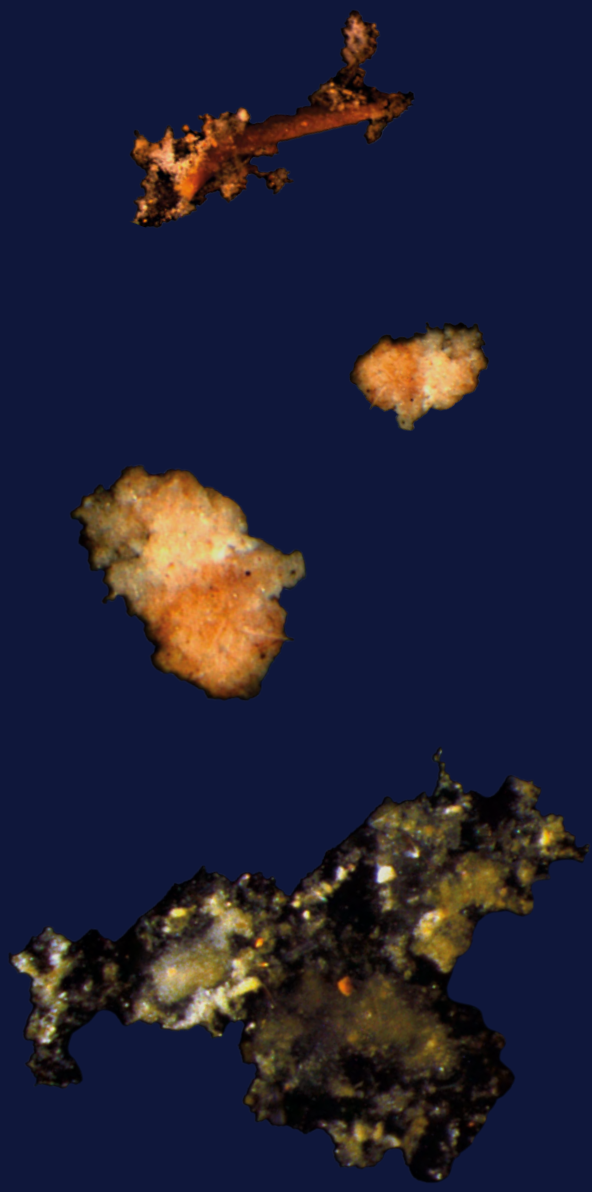


drawdown, and carbon sinking from the ocean's surface to its deeper layers. After the initial effects of these early OIF experiments, the ocean ecosystems naturally reset to ambient conditions. ExOIS is now developing a research program in collaboration with social scientists and governance experts to further our understanding of OIF.

Yet the ExOIS team is clear-eyed: they must approach this strategy with scientific rigor and deep ethical consideration. The next generation of OIF experiments will need to be developed in consultation with those who have a cultural, economic, or geographic connection to the ocean to ensure the work is carried out transparently and equitably. The program is systematically evaluating ecological consequences, the longevity of carbon storage, and the actual climatic benefits of enhanced sequestration. With a team of interdisciplinary experts, ExOIS is building governance for mCDR responsibly, collaboratively, and with global benefit in mind. ■



Examples of potential autonomous platforms that could be used for monitoring OIF field studies.



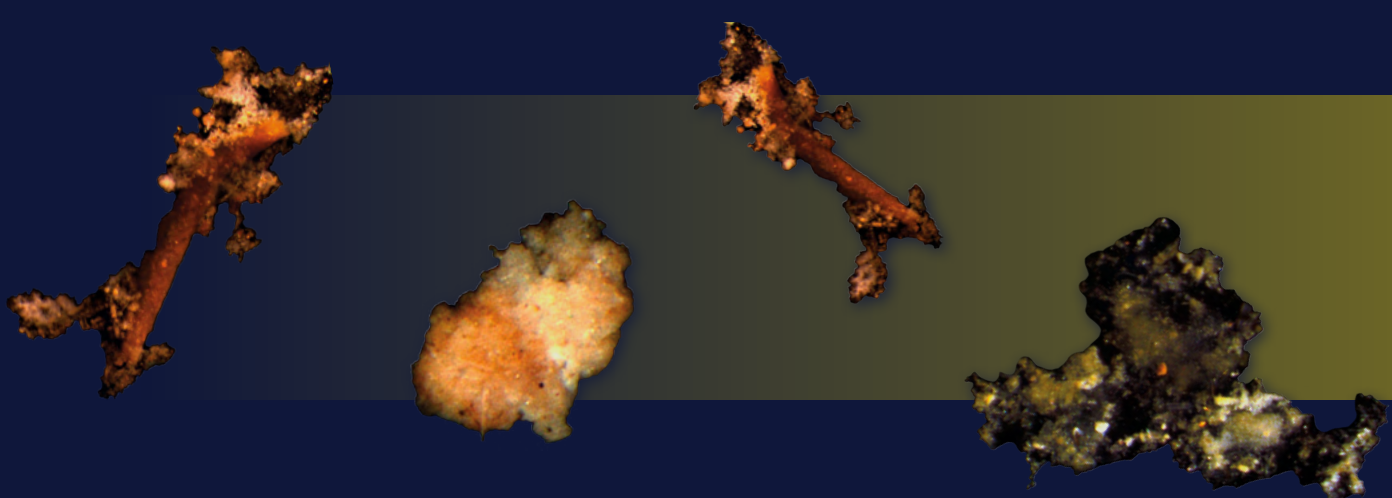
Tracking Carbon from Surface to Seafloor

Looking out her office window at the ocean, WHOI senior scientist Irina Rypina always wonders about what happens beneath the surface, where millions of carbon-rich particles descend into the deeper waters. "The question," she says, "is where they go next and what happens to the carbon they carry?"

For Rypina, that question touches the heart of how our planet stores carbon. The ocean is one of Earth's most powerful carbon dioxide (CO_2) sinks, absorbing a quarter of human emissions each year. This process is driven by the biological carbon pump: the set of processes that pull CO_2 from the atmosphere and store it deep beneath the waves.

The pump relies upon a huge workforce of microscopic phytoplankton which consumes CO_2 through photosynthesis at the sunlit sea surface. When they die, their remains become carbon-rich particles that sink into deeper water layers or are carried to depth by ocean currents.

Yet climate models are missing key data that would help predict if the ocean will sequester these carbon-rich particles for millennia or cycle the CO_2 they store back into the atmosphere—two dramatically different scenarios for the Earth's climate.



“OUR RESEARCH WILL ENABLE LARGE-SCALE MONITORING TO TRACK HOW CARBON FLOWS FROM THE SURFACE OF THE OCEAN TO THE DEEP SEA.”

–Irina Rypina, WHOI Senior Scientist

“We are tackling the mystery of what happens to carbon in the ocean,” said Rypina. “Our research will enable large-scale monitoring to track how carbon flows from the surface of the ocean to the deep sea.”

Rypina’s team will study carbon-rich particles traveling along the New England shelf, across the Gulf Stream, and into waters near Bermuda. Utilizing one of WHOI’s autonomous underwater vehicles equipped with a camera system, they will collect high-resolution images of the particles in the upper 300 meters (984 feet) of the ocean.

Along with these images, Rypina’s team will gather data on key physical characteristics of the particles, local currents, and ocean circulation. They will use highly sensitive respiration measurements on individual particles, combined with detailed genetic, microscopic, and physico-chemical analyses. Layer by layer, the team is building a first-of-its-kind picture of how carbon-rich particles are transported and sequestered at a regional scale.

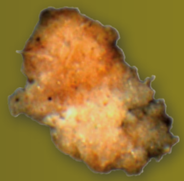
“This pioneering research has never been done before,” said Rypina.

This project is part of the Ocean Vital Signs Network (OVSN), an ambitious WHOI initiative that is establishing a global network of technologies to monitor carbon in the ocean at an unprecedented scale. OVSN is made possible through the generous support of philanthropic donors.

Over the past year, OVSN assembled a leadership team, set strategic planning frameworks, identified technology gaps, and awarded $3.5 million in seed funding to four high-impact projects, including Rypina’s.

Tracking carbon will require broad and diverse oceanographic expertise. OVSN is forging partnerships with leading institutions, including MIT, Stanford, the University of Chicago, and the Ocean Frontier Institute. They are founding members of the Global Ocean Carbon Observatory (GOCO), a working group that will play a pivotal role in modeling carbon dynamics worldwide.

Each breakthrough reveals how the carbon pump truly works, from the ocean’s surface to the seafloor. With donor support, we are advancing the climate forecasts we need to safeguard life on Earth.



Detecting the Deep: Climate Signals at Depth

The ocean absorbs an enormous portion of the carbon dioxide we emit, and it stores vast reservoirs of methane—a potent greenhouse gas—within geological structures many miles below the surface.

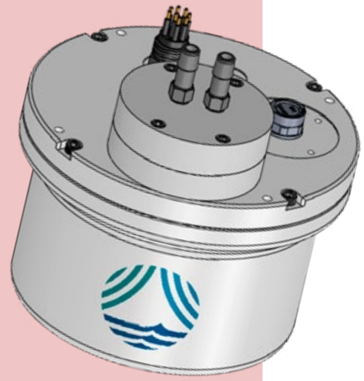
As the planet warms, scientists are searching for something they've never had before: the ability to accurately measure dissolved gases to understand the ocean's dual role in the global carbon cycle as both a vast carbon sink and a potential methane source.

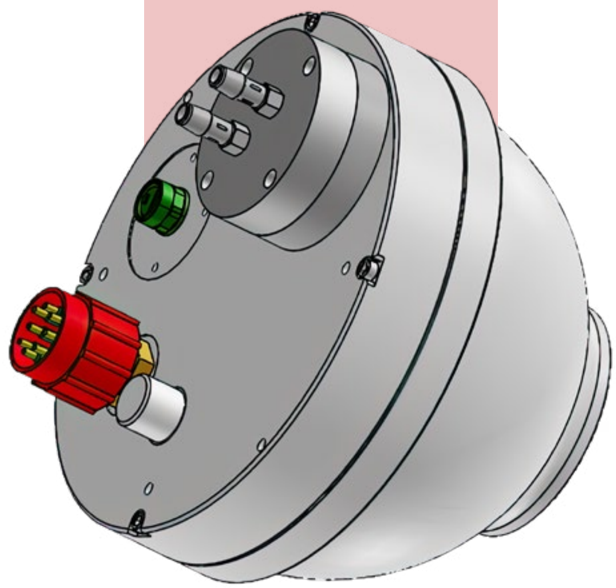
That search is finally over. The Sensor for Aqueous Gases in the Environment (SAGE) is a breakthrough technology developed by Anna Michel, WHOI chief scientist for the National Deep Submergence Facility, and Jason Kapit, WHOI senior engineer. SAGE extracts gas from seawater which is then analyzed using laser-based near-infrared spectroscopy and cutting-edge fiber optics. This technology marks a major advance in ocean chemical sensing, measuring dissolved gases from the coastal shallows to the deep sea.

"In 2025, SAGE made its first dissolved inorganic carbon measurement—a major milestone for ocean sensing," said Michel. "Its utilization as a methane mapper is expanding across a range of environments, including wetlands, continental shelves, and the deep ocean."

Field deployments are demonstrating SAGE's potential. In 2024, the sensor operated aboard remotely operated vehicle Subastian on the Chilean Margin, where it helped identify new deep-sea methane seep sites. In 2025, SAGE joined R/V Endeavor on a mission to Newfoundland to conduct measurements through the water column to look for methane leakage in capped oil wells.

The performance, versatility, and utility of SAGE have demonstrated greater promise than any other commercially available oceanographic gas sensor. Michel and Kapit are currently working to advance SAGE towards reliable, small-scale manufacturing for broader use by the scientific community.





"SAGE's high sensitivity and fast response time allow it to perform ocean mapping of methane and carbon dioxide in higher detail than ever before," said Kapit.

With SAGE, scientists will have the precision data needed to understand how the ocean regulates Earth's carbon cycle and the hidden dynamics shaping climate beneath the waves. ■

"IN 2025, SAGE MADE ITS FIRST DISSOLVED INORGANIC CARBON MEASUREMENT—A MAJOR MILESTONE FOR OCEAN SENSING."

–Anna Michel, WHOI Associate Scientist

FUNDS SUPPORTED BY OUR WAVEMAKERS

GLOBAL IMPACT FUND/UNRESTRICTED

Advancing Ocean Science for the Global Good

Unrestricted gifts to WHOI's Global Impact Fund have advanced all aspects of the Oceanographic's mission. WHOI leadership puts these resources to work immediately to help:

1. Drive breakthrough science and technology
2. Accelerate solutions to confront climate change and pollution
3. Open new possibilities for human lives and livelihoods
4. Protect healthy habitats and thriving wildlife

PRESIDENT'S FUND FOR INNOVATION

Jump-starting Innovation and Collaboration by Incubating the Best Minds and Ideas

To capitalize on the momentum happening both in the world and at the Oceanographic, Peter de Menocal needs a war chest that he can deploy rapidly and in response to emerging opportunities. The President's Fund for Innovation was established for philanthropy to invest in him and in Vision 2030. For WHOI to achieve its goals during the UN Decade for Ocean Science, Peter needs risk capital to invest in the brightest and most cutting-edge, solutions-based science. These funds have enabled WHOI to continue to lead and push the envelope.

PRESIDENT'S SECOND CENTURY FUND

Propelling WHOI into a New Era of Impact-driven Ocean Science

As WHOI prepares for its centennial in 2030, gifts to the Second Century Fund have helped secure our position as a leading champion of ocean science for the global good. This fund, deployed by the President and Director, fuels flagship initiatives, empowers scientists to pursue high-risk, high-reward projects, and strengthens WHOI's role as a powerful voice for our ocean, our planet, and our future. The fund is firmly oriented towards addressing some of the biggest challenges facing our generation, including climate change, plastic pollution, and the protection of marine wildlife and ecosystems.

RESEARCH ACCELERATOR FUNDS

Accelerating Innovation in Ocean Research and Exploration at WHOI

Support for WHOI's Research Accelerator Funds has supercharged innovation by unlocking external funds that require institutional co-investment. With a leverage factor of 4-6x in two years—which we expect to grow over time—research accelerator funds ae a proven way to power the ocean and accelerate the search for solutions to some of our most pressing environmental challenges.

Research Accelerator

IMPACT

BY THE NUMBERS*

SINCE INCEPTION OF THE RESEARCH ACCELERATOR, DONORS HAVE ...

SUPPORTED OVER **640** PEOPLE

(some working on multiple projects over several years)

ENABLED OVER **195** PROJECTS

BETWEEN AUGUST 16, 2024 AND AUGUST 15, 2025

Initiated
20 NEW PROJECTS

Committed over
$3.6M RESEARCH ACCELERATOR FUNDS

Leveraged over
$11M FROM EXTERNAL AGENCIES
(many for multi-year projects)

* Data on productivity reflect results from Research Accelerator Funds combined with some additional unrestricted funds provided by WHOI supporters.

TOTAL COMMITMENTS FOR RESEARCH ACCELERATOR ENDOWMENT

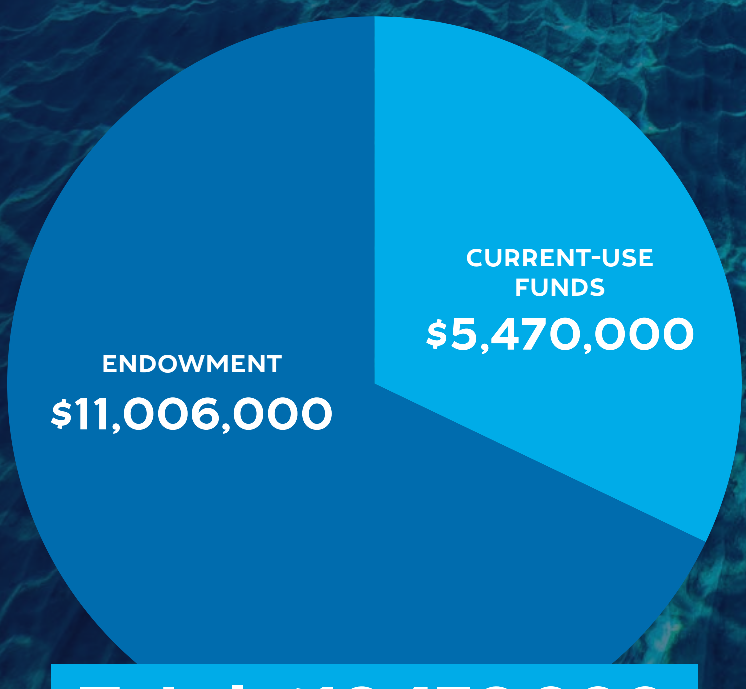
$11,006,000

(103 gifts in total, including the Deerbrook Ocean Science Accelerator (DOSA) Fund, Ducommun Family Sea Grant Accelerator, and the Madin Fund)

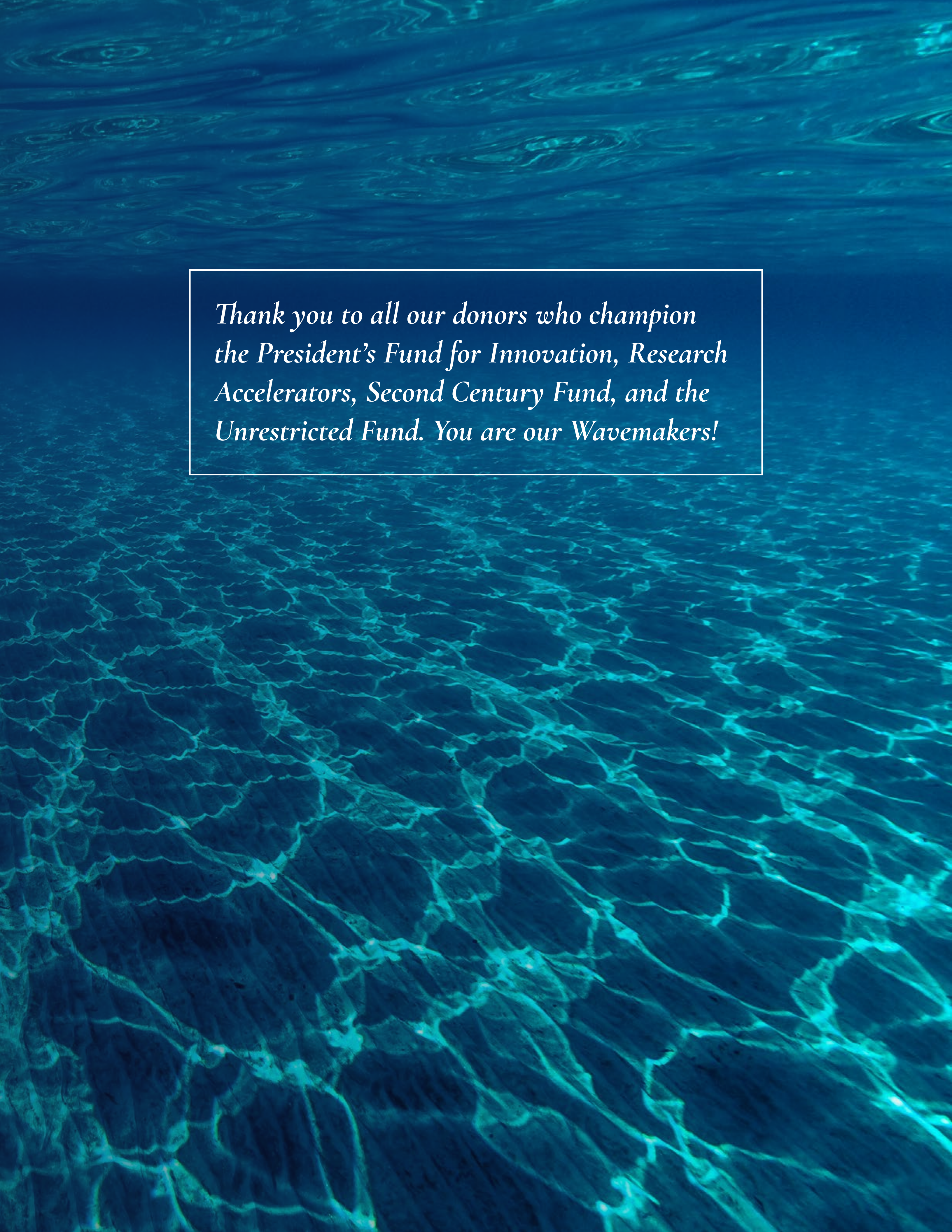
TOTAL COMMITMENTS FOR CURRENT-USE RESEARCH ACCELERATOR FUNDS

$5,470,000

(73 gifts in total, including the Anonymous Trustee Research Accelerator Fund, the Antarctic Ice Accelerator Fund, the DOSA Fund, the Madin Fund, the Hausman Fund, the McConnell Fund, the mCDR Accelerator Fund, the Reef Solutions Accelerator Fund, and the Salem OVSN Accelerator Fund)



Total: $16,476,000



Thank you to all our donors who champion the President's Fund for Innovation, Research Accelerators, Second Century Fund, and the Unrestricted Fund. You are our Wavemakers!

WOODS HOLE
OCEANOGRAPHIC
INSTITUTION

Peter de Menocal, President & Director
266 Woods Hole Road, WHOI MS 40A, Woods Hole, MA 02543
www.whoi.edu