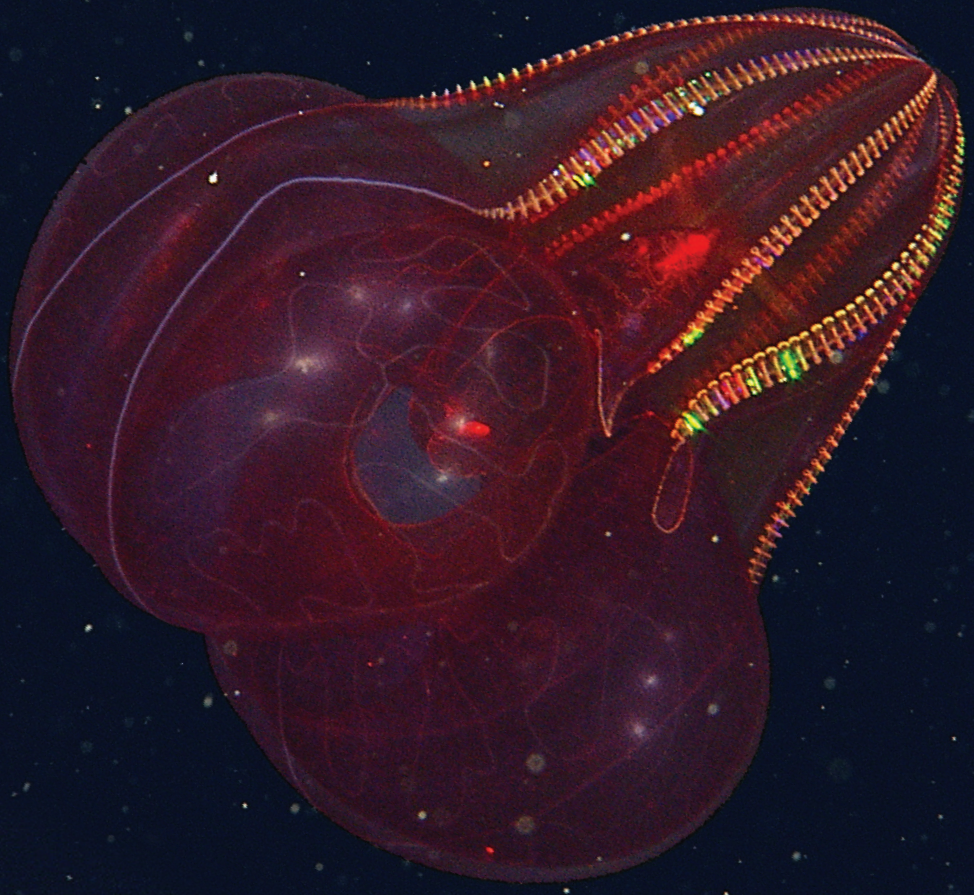
Monterey Bay Aquarium
Research Institute



2018 Annual Report

A SUMMARY

DEEP DIVE

Exploration uncovers mysterious ocean life

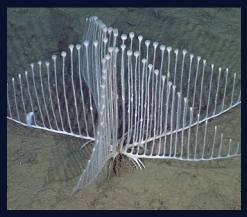
Tiburonia granrojo

Careproctus kamikawai

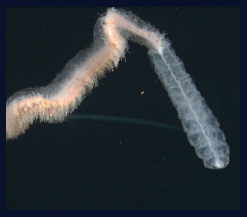
Resomia dunni

Asbestopluma monticola

Erenna sirena

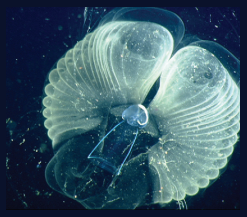


Chondrocladia lyra



Apolemia lanosa

Calyptogena packardana



Bathochordaeus mcnutti

Tritonia nigritigris

Chaetopterus pugiporcinus

Osedax frankpressi

Swima fulgida

Culeolus barryi

Stellamedusa ventana

The full Monterey Bay Aquarium Research Institute annual report is published online. This print companion piece provides highlights of the digital version. The photos above are some of the undescribed species discovered by MBARI over the past 30 years. Visit the online report to learn more about each species, read full stories, and watch videos about our work.

annualreport.mbari.org/2018

Cover photo: *Lampocteis cruentiventer*

Back cover photo by Dave Caress

View from the Masthead

Shining a light on our ocean's future

This coming July marks the 50th anniversary of the first manned mission to the moon. The historic Apollo lunar landing on July 20, 1969 came to symbolize boundless curiosity and the desire to explore the unknown reaches of our universe. Progress in space exploration has since followed by leaps and bounds and sparked the public's imagination of humankind's next stop beyond Earth. Perhaps colonies on the moon or Mars? Or finding life elsewhere in our solar system? Meanwhile, the collective financial investment and social engagement in learning about our own planet—particularly the depths of the global ocean—surprisingly pales in comparison. Despite thousands of years of ocean exploration, vast areas of the seafloor have not been mapped in detail, and we still continue to discover new life forms and oceanic phenomena at every turn. If you have an interest in pursuing a career in the ocean sciences, be assured that there are many mysteries waiting to be solved, new life forms that have not yet been described, and places no person has ever seen before; the age of exploration here on our own planet is far from over.

This autonomous underwater vehicle contains acoustic instruments and a video camera so that scientists can use both types of data to study life in the water column. Photo by Rob Sherlock.

Those thoughts were a key source of inspiration behind this year's annual report cover. The animals shown are but a tiny subset of the hundreds of new species that MBARI researchers have discovered within the past thirty years, and most of those creatures were found in our backyard—Monterey Bay and its adjacent waters, literally an infinitesimal slice of the global ocean. Some of those species are so bizarre that they defy imagination and could easily be mistaken for aliens from another realm. Over the same time, we have also found animal behaviors and interactions that were previously unknown, brought undersea geological features and ancient seafloor communities to light for the first time, uncovered unique chemical and biological processes, and revealed deep-sea volcanic eruptions and massive sediment transport events that have been extremely difficult to document until recently. These landmark discoveries and advancements, all within the span of MBARI's short history, were made possible by fostering partnerships between scientists and engineers, coupled with technology developments, that greatly improved our ability to access and visualize the ocean's interior—precisely what David Packard, MBARI's founder, envisioned. One can only imagine what new discoveries await in the years ahead.

This is why we at MBARI have come to refer to Monterey Bay as a window to the world. Its unique location adjacent to a deep submarine canyon makes it perfect for developing new systems for studying ocean waters and the underlying

seafloor, leading to opportunities for making novel discoveries both locally and far afield. The concentration of institutions surrounding Monterey Bay that touch on some aspect of ocean education, science, engineering, policy, resource management, or conservation naturally brings together experts from many different walks of life and catalyzes interdisciplinary collaboration.

This confluence of place and people served as apt backdrop for the 15th Deep-Sea Biology Symposium held in Monterey, California, last September which MBARI and the Monterey Bay Aquarium co-hosted. The meeting brought together researchers from over 30 countries, providing a forum for leaders from various fields in the deep-sea science community to share findings of their latest research. Among the plenary speakers was Julie Packard, chair of the MBARI Board of Directors and executive director of the Monterey Bay Aquarium. Packard highlighted the benefits of using technology to further ocean exploration and education, and the importance of inspiring people to care for and properly manage the precious resources the sea provides. Ironically, as Packard pointed out, as we accelerate our understanding of the ocean's vital role in sustaining life on Earth, we do so at a time when it is increasingly under threat due to human activities that impact even the most remote and distant corners of our planet—including the deep sea. All of us are inextricably connected to the ocean in some way, regardless of how close or far we may live from the shore.

One of the interesting animal behaviors discovered in Monterey Bay, a small black-eyed squid eating its much larger prey, the owlfish *Bathylagus milleri*. This squid is about 10 centimeters (four inches) long, while the owlfish is about 25 centimeters (10 inches) long.

Julie Packard, the executive director of the Monterey Bay Aquarium and chair of MBARI's board of directors, gives a plenary talk at the Deep-Sea Biology Symposium. Photo by Susan von Thun.

This was the sentiment behind a *New York Times* article published last June that Julie Packard and I had the good fortune to co-author. Challenges stemming from pollution, overfishing, climate change, and deep-sea mining all point to the urgent need to learn about the ocean's myriad of species, its function, and ultimately its health. A cooperative, ocean-wide monitoring network is needed to track and report threats to inform sound climate policy, and to promote sustainable management practices. Given the unprecedented global changes taking place before our eyes, now, more than ever, we need enthusiastic and inquisitive minds to turn their ambitions towards our global ocean—our very lives may one day depend on it.

As MBARI embarks on its fourth decade of furthering ocean science and technology, what we call "MBARI

4.0", we face both the excitement of the unanticipated discoveries that lie ahead as well as the realization that the very animals and processes we seek to learn about are undergoing profound changes and may be irrevocably altered before we can even describe them for the first time. Arguably, never before has there been such a moment in the history of ocean science. Bringing this information to light for a broad audience, inclusive of scientists, engineers, policy makers, and the public at large, is one of MBARI's primary goals, and was a driving force behind Heidi Cullen's arrival at MBARI this past year. Among many other duties, Cullen now oversees communication of an eclectic mix of topics that span from the sea surface to seafloor, encompassing all disciplines of ocean science and technology, even marine archeology. Disseminating results of our work via interactive digital and social media, traditional print and video outlets, and live presentations, are all aimed at sharing the wonder of what lies beneath the ocean surface as well as highlighting the importance and societal benefits that fundamental marine research and engineering afford.

As part of our new outreach strategy, we are working more closely with the Monterey Bay Aquarium (MBA) to take on collaborative projects that benefit from the different perspectives and expertise that each of our organizations provides. This year's articles on the White Shark Café and environmental DNA (eDNA) with the Environmental Sample Processor are but two examples of such joint "MBA/RI" initiatives, each of which includes elements of basic science, engineering, and technology development to meet needs associated with resource management and conservation issues. Other engagements that we report on this year in conjunction with academic, nonprofit, and commercial entities, as well as government agencies, similarly showcase the power and potential of what cooperation and partnership can do to spur fundamental science and engineering advancements while simultaneously achieving outcomes for the public good.

While space exploration understandably holds wide appeal, you may be surprised that a look inward into our ocean also offers a parallel frontier replete with technological challenges, mysteries, and wonders. The sea offers us much to discover, to benefit from, and manage wisely, and, if we are not careful, much to lose before we even know what may be lost.

As I look ahead, there is no doubt that 2019 will prove to be another year of exciting marine science and technology advancements. Please follow us as we continue our journey of ocean exploration and discovery by visiting our website, as well as by subscribing to our Facebook, Twitter, YouTube, and Instagram feeds. Keep in touch—we look forward to hearing from you!

Chris Scholin

President and Chief Executive Officer

Related web content

Values Statement, Strategic Plan, and Technology Roadmap:
www.mbari.org/about/vision

Apolemia lanosa contracts its swimming bells (at the top of the coil) to swim through the water and uses millions of tiny stinging tentacles to capture small animals.

EXPLORATION AND DISCOVERY

Discovering animals never seen before

MBARI has emerged as a leader among the world's oceanographic institutions in the discovery of organisms that are new to science. To date, the institute has discovered more than 200 species, of which 170 have been formally described and named. These discoveries have greatly increased public awareness of how little we know about our planet. Each discovery provides one more piece to the puzzle of life, how organisms may rely on each other to survive, or how they are impacted by a changing ocean.

The continual discoveries of species not previously known to science are made possible by MBARI's long-term investment in remotely operated vehicles (ROV), imaging and sampling technology, and the Video Annotation and Reference System that contains information on every animal seen during thousands of ROV dives.

Work on undescribed species is part of MBARI's effort to promote enhanced scientific understanding of the functioning of marine ecosystems, and to contribute to the David and Lucile Packard Foundation's long-term goal to restore the health and productivity of the ocean on which all life depends.

annualreport.mbari.org/2018/new-species

Signs of coral recovery can be seen on top of dead, algae-covered corals. Photo by Yui Takeshita

CORAL BLEACHING AND RECOVERY

Measuring the impact of climate change on coral reefs

Coral reefs are among the most productive and biologically diverse ecosystems in the world. While only occupying about one percent of the ocean floor, it is estimated that they provide habitat for roughly a quarter of all known marine species. Coral reefs also form a base for, and help stabilize, other ecosystems, such as seagrass beds that can grow around them. This makes coral reefs crucial components of tropical marine ecosystems. Furthermore, they benefit society worldwide, providing food for millions of people and storm protection for coastal communities. Sadly, coral reefs have been deteriorating worldwide due to human activity.

Cutting-edge chemical-analysis tools and techniques developed by MBARI Scientist Yui Takeshita are helping shed light on how coral reefs fare after severe damage from stressors like cyclone damage and bleaching events (climate change). Takeshita and his collaborators have begun a systematic study of changes in one section of the Great Barrier Reef. It is very important to understand how this critical building block of a healthy reef system will fare in the future.

A fleet of long-range autonomous underwater vehicles, some carrying Environmental Sample Processors, is prepared for an important role in the MBON project. Photo by Brian Kieft.

ENVIRONMENTAL DNA

Using advanced technology to survey marine biodiversity

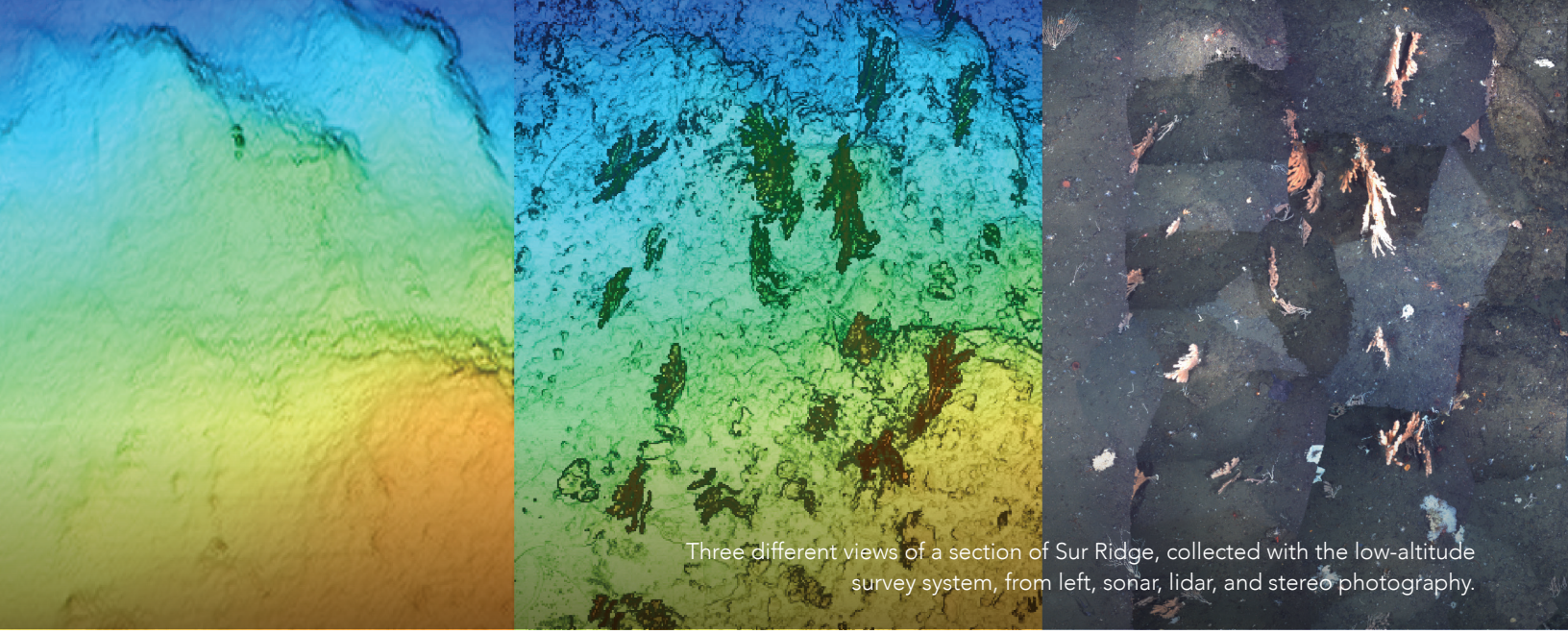
Life in the sea is threatened by a myriad of forces, including global warming, an increasingly acidic ocean, pollution, and over-harvest of living marine resources. A first step to understanding how these forces are driving changes in life in the sea is to establish a record of which species currently inhabit an area. But observing the complex and varied diversity of life in the sea is exceedingly difficult.

Read the full article

annualreport.mbari.org/2018/mbon

National and international entities have recently come together to organize a program to improve assessments of life in the sea at regional to global scales. MBARI and collaborators are using the Monterey Bay National Marine Sanctuary as a demonstration site for a Marine Biodiversity Observation Network (MBON). Under the leadership of Scientist Francisco Chavez, MBARI is developing new and innovative means to assess life in the sea.

Environmental DNA (or eDNA) is left behind in seawater by all forms of life, from microbes to fish or marine mammals. As a result it is now possible to analyze for the presence of all forms of life in the sea from seawater samples. Merging eDNA with MBARI's developments in autonomous vehicles and sampling technologies we are now able to observe marine ecosystems on a scale never seen before.



Three different views of a section of Sur Ridge, collected with the low-altitude survey system, from left, sonar, lidar, and stereo photography.

MAPPING THE OCEAN

Visualizing the fine details of the deep seafloor

For two decades, MBARI engineers have worked to develop deep-sea mapping capabilities to the point that it is now possible to map objects as small as one centimeter (0.4 inch) on the seafloor. Thanks to these major technological advances, MBARI now has the ability to produce maps that—for the first time—bring together geology and biology.

Using the new low-altitude survey system in 2018, MBARI surveyed Sur Ridge at one-centimeter resolution with sonar, lidar, and stereo photography. Sur Ridge is a steep, biologically-rich seamount offshore of the coast of Central California. MBARI also mapped hydrothermal vents offshore of Mexico, and a methane gas seep and an active fault as part of a study of potential geological hazards offshore of Southern California.

Read the full article: annualreport.mbari.org/2018/ocean-imaging

A great white shark with one prototype of the shark camera attached to its dorsal fin. Photo courtesy of the Monterey Bay Aquarium.

GETTING A SHARK'S-EYE VIEW

Tagging along with sharks to a mysterious deep ocean gathering spot

Great white sharks live along the coast of central and northern California where abundant populations of seals provide a rich and ready source of food. Why the sharks would ever leave this highly productive coastal range is a mystery. But research by scientists from the Monterey Bay Aquarium and Stanford University revealed that each winter the sharks turn seaward, traveling south and west to a region of the central Pacific roughly midway between Hawai'i and the Baja Peninsula. The area where the sharks congregate was nicknamed the White Shark Café.

MBARI has played two important roles in the research into shark behavior. Scientist Bruce Robison participated in an expedition to the White Shark Café in 2018. His research there showed that the Café region has plenty of food to support a migrating population of several hundred sharks.

In a concurrent effort, Engineers Thom Maughan and Larry Bird designed systems to attach cameras to shark fins so that the Monterey Bay Aquarium could study their behaviors.

Read the full article: annualreport.mbari.org/2018/shark-cam

Processing sediment cores from the region of a proposed wind farm. From left, Roberto Gwiazda, Charlie Paull, and Eve Lundsten. Photo by Nora Nieminski.

SEAFLOOR DYNAMICS

Lending expertise in the pursuit of clean energy off the California coast

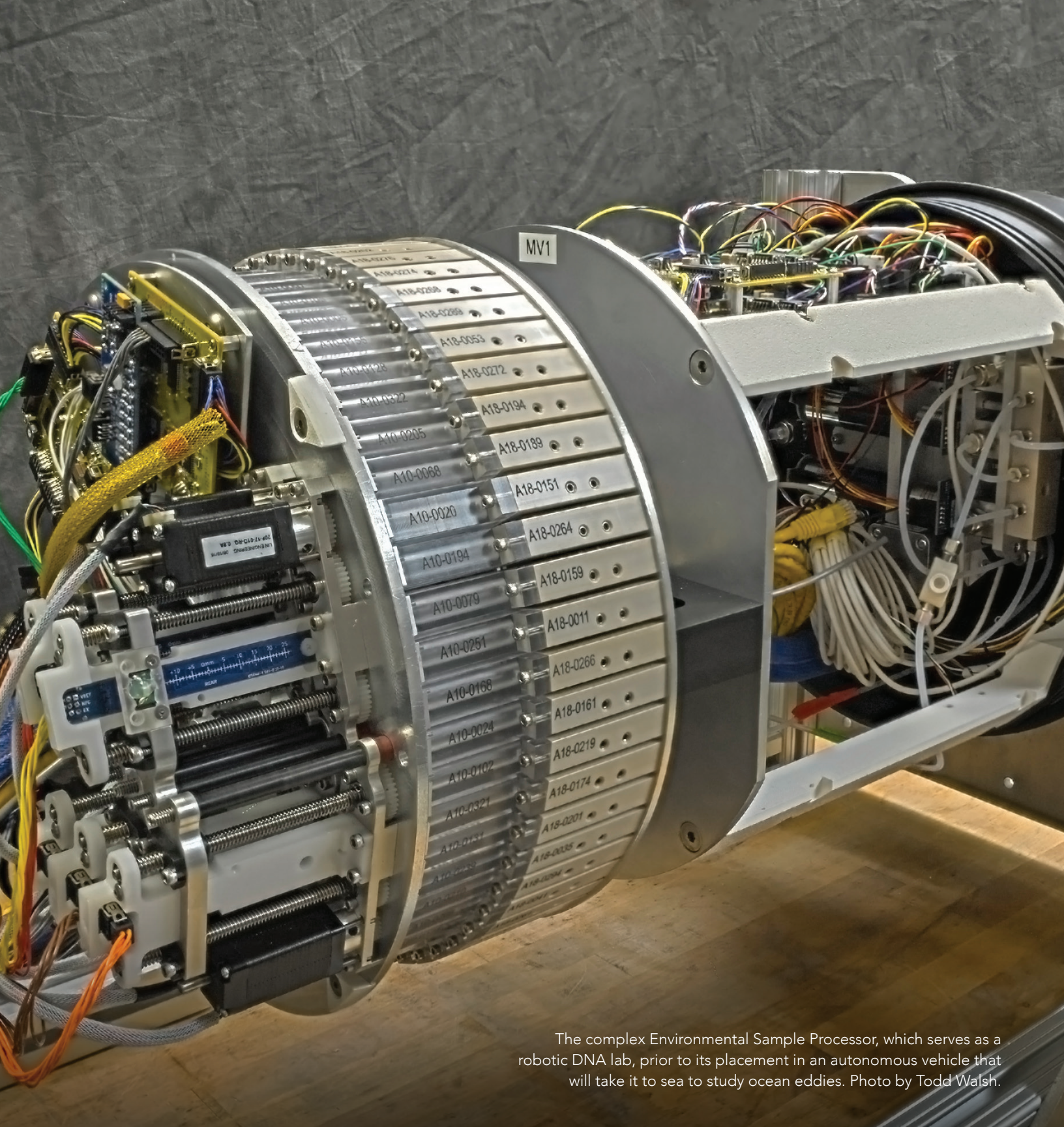
A fleet of floating wind turbines anchored in deep water off the California coast could boost the state's production of clean energy. But for that vision to become reality, the seafloor in the area of the proposed wind farm must be stable enough for the turbine anchors and the cables that will carry the energy to shore. With his long career of studying the seafloor—including the specific location of this proposed wind farm—MBARI Geologist Charlie Paull is the perfect person to lead the study of the wind-farm seafloor site.

MBARI conducted eight high-resolution autonomous underwater vehicle (AUV) mapping surveys of the region in April 2018 to help establish how rapidly seafloor features form and identify the seafloor footprint of existing buried submarine cables. These surveys were followed up with remotely operated vehicle dives to further study the site and to collect sediment cores to learn more about the processes that shape the seafloor and affect its stability.

Read the full article

annualreport.mbari.org/2018/wind-farm

MBARI is proud to be able to contribute its marine operations and science expertise to this effort to address societal needs, and is able to do so through its steady commitment to technology development and improved understanding of basic ocean processes.



The complex Environmental Sample Processor, which serves as a robotic DNA lab, prior to its placement in an autonomous vehicle that will take it to sea to study ocean eddies. Photo by Todd Walsh.

ENVIRONMENTAL SAMPLE PROCESSOR

MBARI's water-sampling technology finds use in marine and freshwater settings

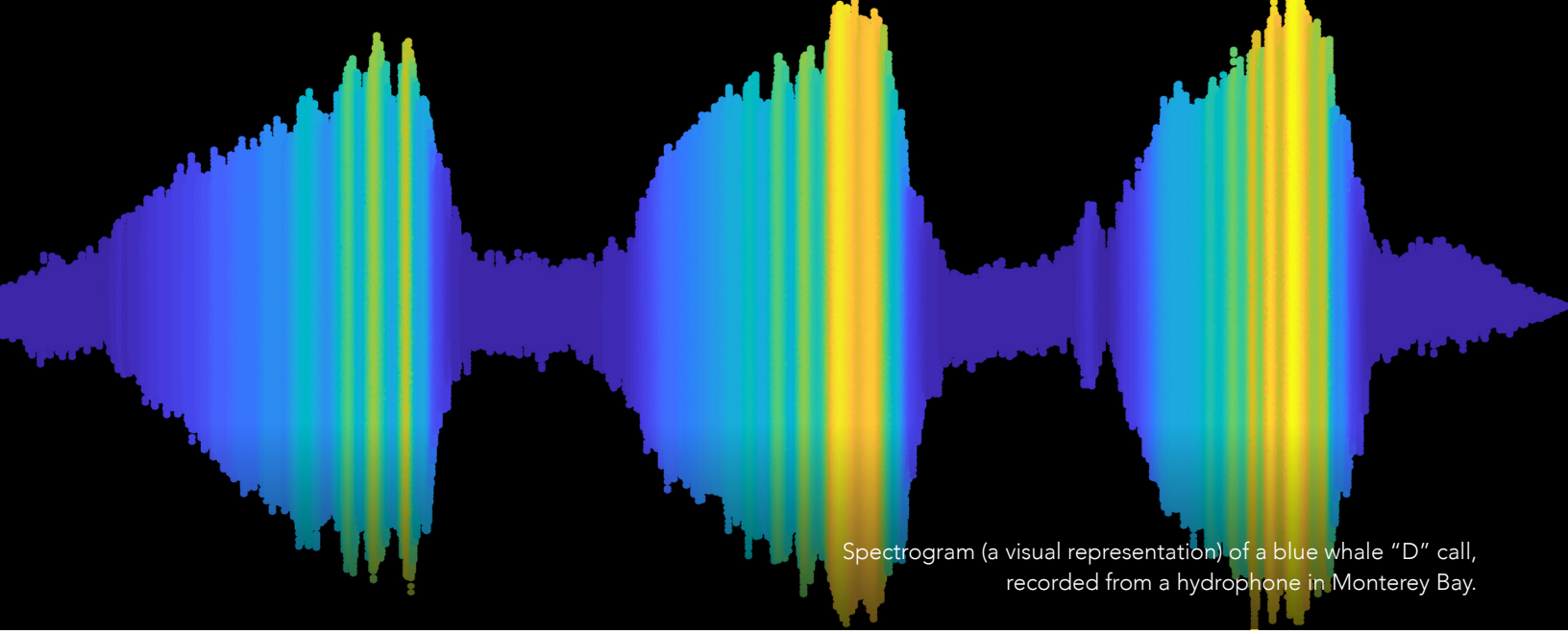
The fluid realm presents a three-dimensional playing field that can change dramatically at any given moment. The challenge of just being in the right spot at the right time to observe the life that comes and goes at the whim of currents, seasons, and biology, is a primary inspiration for developing platforms and sensors that can persist in the environment for extended periods of time and operate without anyone in attendance.

MBARI's homegrown Environmental Sample Processor (ESP) is a robotic water sampler designed specifically for collecting and analyzing microbes in the ocean and providing that persistent presence. The ESP has also recently proven useful for collecting bits of DNA shed from larger animals both in the ocean and freshwater settings. This capability opened the door in 2018 to a number of field studies ranging from the open waters of the tropical Pacific, coastal waters of Monterey Bay, and coastal streams in Central California, to Lake Erie, the Yellowstone River, and the National Elk Reserve.

Read the full article

annualreport.mbari.org/2018/esp

In all these locations, research scientists and resource managers are turning to these new instruments to repeatedly acquire water samples from remote places to determine the presence of native species as well as pathogens, toxins, and invasive animals without necessarily being there in person.



Spectrogram (a visual representation) of a blue whale "D" call, recorded from a hydrophone in Monterey Bay.

OCEAN SOUNDSCAPE

Hearing what the ocean is really saying

Our ocean is alive with sound, most of which we are never lucky enough to hear. Sound waves propagate fast and far across Earth's largest habitat. Highly evolved life forms in the ocean produce, receive, and interpret sound for the essential life activities of communication, navigation, and foraging. This invisible auditory landscape provides scientists with the opportunity to learn about the oceanic realm by listening carefully. It also presents a responsibility to recognize how human noise pollution is impacting marine life and what can be done to mitigate these impacts.

MBARI is recording the sounds of Monterey Bay with an underwater microphone connected to a cabled observatory on the seafloor. Sounds stream through the hydrophone to a shore-side computer, enabling many unanticipated discoveries. These sound recordings are producing more data than humans alone can analyze, so the MBARI team is employing machine learning to decipher the different sounds. Together, the cabled observatory that provides the persistent presence in the deep sea and the software developed to analyze the information it conveys are enabling development of an auditory system for the sea.

Read the full article: annualreport.mbari.org/2018/soundscape

The Information, Technology, and Dissemination Division organizes the Annual MBARI Open House which attracts a large crowd interested in MBARI's work. Photo by Charles Boch.

EDUCATION AND OUTREACH

Giving the ocean the attention it deserves

MBARI Founder David Packard sought to give the ocean more attention. This imperative has, in many ways, been the North Star of MBARI's Information, Technology, and Dissemination Division, or ITD, since its inception over 20 years ago.

Under the new leadership of Heidi Cullen, ITD is focusing on raising MBARI's profile, strengthening the culture of outreach within the institution, and a strategy for managing the pressing challenges of an ever-increasing stream of data. Cullen is engaging in strategic efforts with the Monterey Bay Aquarium to target areas where MBARI technology can be applied to solve real-world conservation problems.

The ITD team shares accomplishments of the institute through mainstream media coverage (more than 120 news stories published in 2018) and on social media, where MBARI now has over 145,000 followers and reaches roughly 40,000 people on a weekly basis. Education efforts include a teacher-education program, a robust summer internship program, and program to connect students with hands-on science and conservation efforts, and real-world science experiments.

Read the full article: annualreport.mbari.org/2018/outreach

On the Horizon

Read the full articles:
annualreport.mbari.org/2018/horizon

Observations of deep ocean old growth corals thriving in hard-rock environments.

Keeping an eye on a deep-sea coral garden

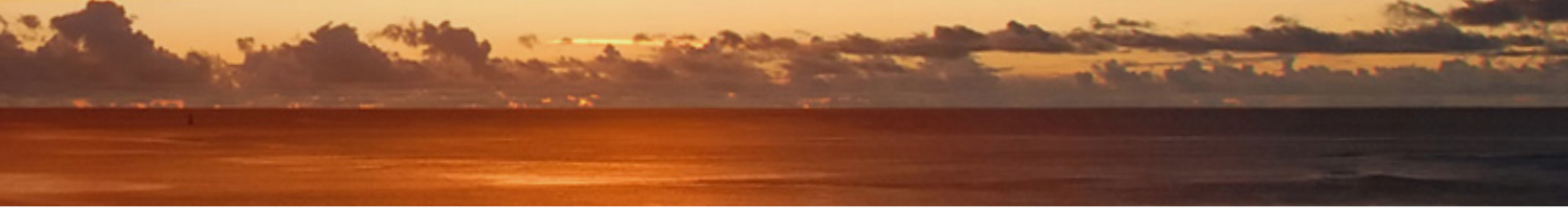
Forests of stunning, old-growth corals thrive on seamounts and other hard-rock environments in the dark, cold waters of the deep ocean where they provide critical habitat for a wealth of fishes and invertebrates. MBARI Scientist Jim Barry and his team have set out to develop a system for studying these enigmatic communities over time. Observations and samples collected during occasional expeditions to seamounts can provide only a snapshot of the processes that shape coral communities. Therefore, a dedicated, autonomous deep-sea coral observatory is now under development. This observatory will be used as a hub for deploying sensors into these unique ecosystems. Our goal is to record the behavior and condition of corals and other species in relation to daily, seasonal, or episodic changes in environmental conditions that may shape these ecosystems.

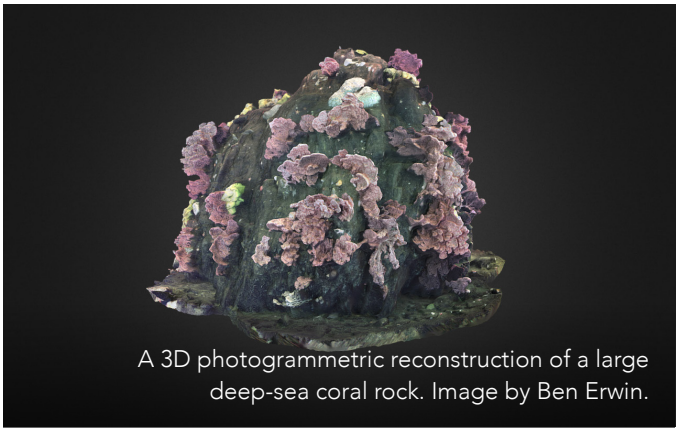
Biodegradable dye released as part of an experiment in Monterey Bay. Photo by Todd Walsh.

Seeking a bird's-eye view of the ocean to gain new insights

Many critical ocean processes occur, or are exposed at, the interface of the air and the ocean surface. Aerial sensing platforms can provide safe, inexpensive methods to observe these phenomena in great detail, with regularity, and on short notice. To advance access to this area, without adding more ships to the MBARI fleet, a team of scientists and engineers is perfecting how to use the rapidly developing technology of unmanned aerial vehicles (UAVs).

UAVs will enable a wide variety of repeatable and low-cost science applications including repeatable surveys of animal counts and locations, thermal and color ocean-front tracking, harmful algal bloom detection and monitoring, kelp forest health, predation behavior, marine debris, distressed animal detection, and lost-vehicle recovery. This technology will also document MBARI at-sea operations for educational and outreach purposes.



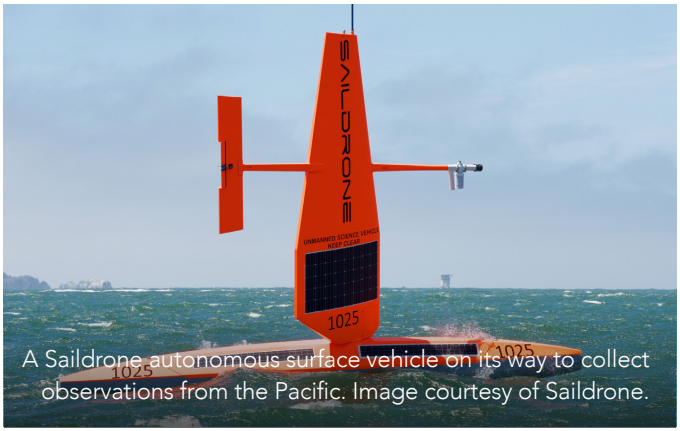


A 3D photogrammetric reconstruction of a large deep-sea coral rock. Image by Ben Erwin.

Creating an immersive ocean experience

Virtual reality (VR) is a potentially powerful new tool for environmental learning. A team of MBARI scientists and engineers are testing its application in the deep. The goal is to use VR not only as a tool to engage and teach the general public, but also as an aid for immersing researchers themselves in their environment of study.

In 2019, MBARI's VR team will work with leading industry developers and educators to design and build a deep-water VR camera system to be installed onto MBARI's remotely operated vehicle (ROV) *Doc Ricketts*. When viewed through a virtual-reality headset, the viewer will partake in a 3D experience that will feel like actually riding along on the ROV. The resulting content will be distributed through various channels to make it available to a broad audience.



A Saildrone autonomous surface vehicle on its way to collect observations from the Pacific. Image courtesy of Saildrone.

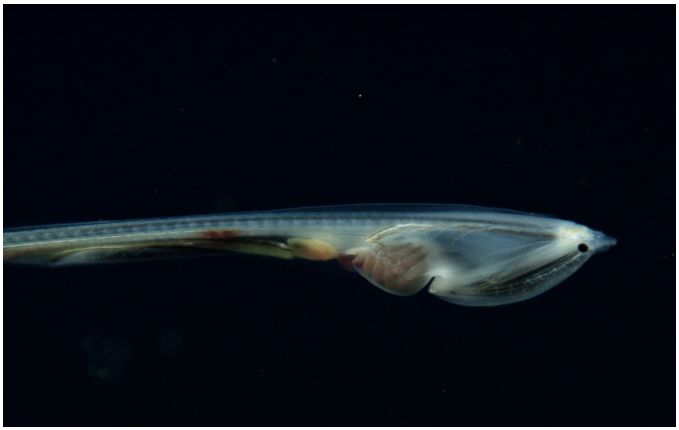
Autonomous sailboat used for global carbon studies

Our ocean is a massive conveyor belt, transporting heat and carbon around the globe. Heat is moved from the equator toward the poles through a series of current systems, which also influence the exchange of carbon dioxide between the ocean and atmosphere. Satellites, ocean robots, and arrays of fixed moorings provide important observations of these processes. New observations from the Southern Ocean are causing scientists to reconsider the global carbon budget, which is important for determining the longevity and stability of carbon storage under global warming. However additional observing approaches are needed.

MBARI Scientist Andrea Fassbender and collaborators are tackling this problem using the Saildrone autonomous surface vehicle, equipped with instrumentation to measure carbon dioxide in the air and the sea. The team will test the Saildrone in the Gulf Stream during 2019.

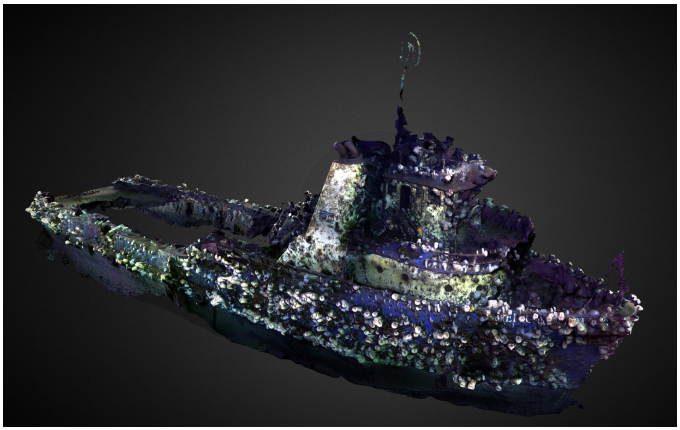
Weird and Wonderful

Read the full articles:
annualreport.mbari.org/2018/weird



Gulper eel inspires the MBARI logo

Gulper eels are deep-sea fish that live throughout the world's ocean from a few hundred meters deep to over 2,000 meters (over 6,500 feet) deep in the midwater. The gulper eel's adaptations make it a very successful deep-sea predator—its oversized jaws and stomach allow it to capture prey, swallowing it whole. Using MBARI's remotely operated vehicles, we've seen gulper eels fewer than 20 times in 30 years of exploration in the deep midwater. Despite its rare appearance, this quintessential deep-sea fish is featured in MBARI's logo.



ROV pilot helps discover sunken ship that he sailed

More than 23 years ago, MBARI Chief ROV Pilot Knute Brekke was part of a crew set to sail on the *American Heritage*, an oil-industry supply ship, but the ship sank. In 2018, Brekke was on hand and able to identify the ship when it was found in Santa Monica Bay, off the coast of Southern California.

Seafloor maps generated by MBARI in the area clearly revealed a 60-meter-long shipwreck (200 feet long) lying on the seafloor almost 700 meters (2,300 feet) below the ocean surface. Brekke was operating the ROV when they dove on the shipwreck, now covered in sponges. Eventually the team spotted the letters A, M, E, and R on the bow of the boat. Then they knew then it was the same ship Brekke was set to sail on all those years ago.

Long-armed crabs reach out for food

The long-armed crab *Sternostylus perarmatus* perches on a long-lived bubblegum coral, ready to capture prey. It is one of several deep-sea crabs with extremely long arms that extend the reach of their claws to grab pieces of food that float by. Small food particles in the passing current can also become trapped on their spiny arms, from which the crab scrapes the bits off and eats them. The total span of the arms can be up to 30 centimeters (one foot). These long-armed crabs (family Sternostylidae) rely on their coral partners in the deep-sea, where survival is dependent on the health of all its inhabitants.

Bioluminescent organisms featured on postal stamps

The diverse and beautiful world of deep-sea bioluminescence is featured in a series of postage stamps produced by the United States Postal Service in 2018. Bioluminescence is characterized as the production and emission of light by living organisms. This process is found across phyla, from deep-sea corals to fireflies. The collection of stamps includes photos of 10 organisms that display bioluminescence. Photos by MBARI Senior Scientist Steve Haddock and MBARI Adjunct Edith Widder are included on the stamps.

Haddock's contribution was a photo of *Tomopteris*—an agile polychaete worm that lives at depths of about 2,500 meters, and is a voracious predator of other midwater animals. *Tomopteris* is unusual in that it makes yellow light, instead of the typical green or blue bioluminescence created by most marine organisms.

Awards

Peter Brewer

National Science and Technology Award

The People's Republic of China

Steve Haddock

Ed Ricketts Memorial Award

Monterey Bay National Marine Sanctuary

Bill Kirkwood

Autonomous Underwater Systems Lifetime Technical Achievement Award

Institute of Electrical and Electronics Engineers/ Oceanic Engineering Society

Jacki Long

Sackett Prize for Innovative Research

University of South Florida

Victoria Orphan

Distinguished Scientist and Scholar Award

NOMIS Foundation

Charles Paull

Francis P. Shepard Award for Excellence in Marine Geology

Society for Sedimentary Geology

John Ryan

Visiting Fellowship of Antarctic Gateway Partnership

University of Tasmania, Australia

Yanwu Zhang

Visiting Fellowship of Antarctic Gateway Partnership

University of Tasmania, Australia





Anela Choy, Steve Haddock, Bruce Robison, Kyra Schlining, Susan von Thun

Honorable Mention

Ocean 180 Video Challenge

Board of Directors

Officers

Julie Packard, Chair
Executive Director
Monterey Bay Aquarium

Franklin M. Orr Jr., Ph.D., Vice Chair
Keleen and Carlton Beal Professor in Petroleum Engineering, Emeritus
Stanford University

Christopher Scholin, Ph.D., President and Chief Executive Officer
Monterey Bay Aquarium Research Institute

Basilio Martinez, Treasurer and Chief Financial Officer
Monterey Bay Aquarium Research Institute

Barbara P. Wright, Secretary
Partner, Finch Montgomery Wright LLP

Mandy Allen, Assistant Secretary
Monterey Bay Aquarium Research Institute

Board of Directors

Julie Packard, Chair
Executive Director
Monterey Bay Aquarium

Franklin M. Orr Jr., Ph.D., Vice Chair
Keleen and Carlton Beal Professor in Petroleum Engineering, Emeritus
Stanford University

Christopher Scholin, Ph.D., President and Chief Executive Officer
Monterey Bay Aquarium Research Institute

Barbara P. Wright, Secretary
Partner, Finch Montgomery Wright LLP

Edward W. Barnholt
Chairman, President, CEO (Retired)
Agilent Technologies

Joel S. Birnbaum, Ph.D.
Senior Vice-President, Research and Development
Director, HP Laboratories (Retired)
Hewlett-Packard Company

Christopher Burnett
San Francisco Culinary Ventures LLC

Nancy Burnett
The David and Lucile Packard Foundation

Curtis Collins, Ph.D.
Professor Emeritus
Naval Postgraduate School

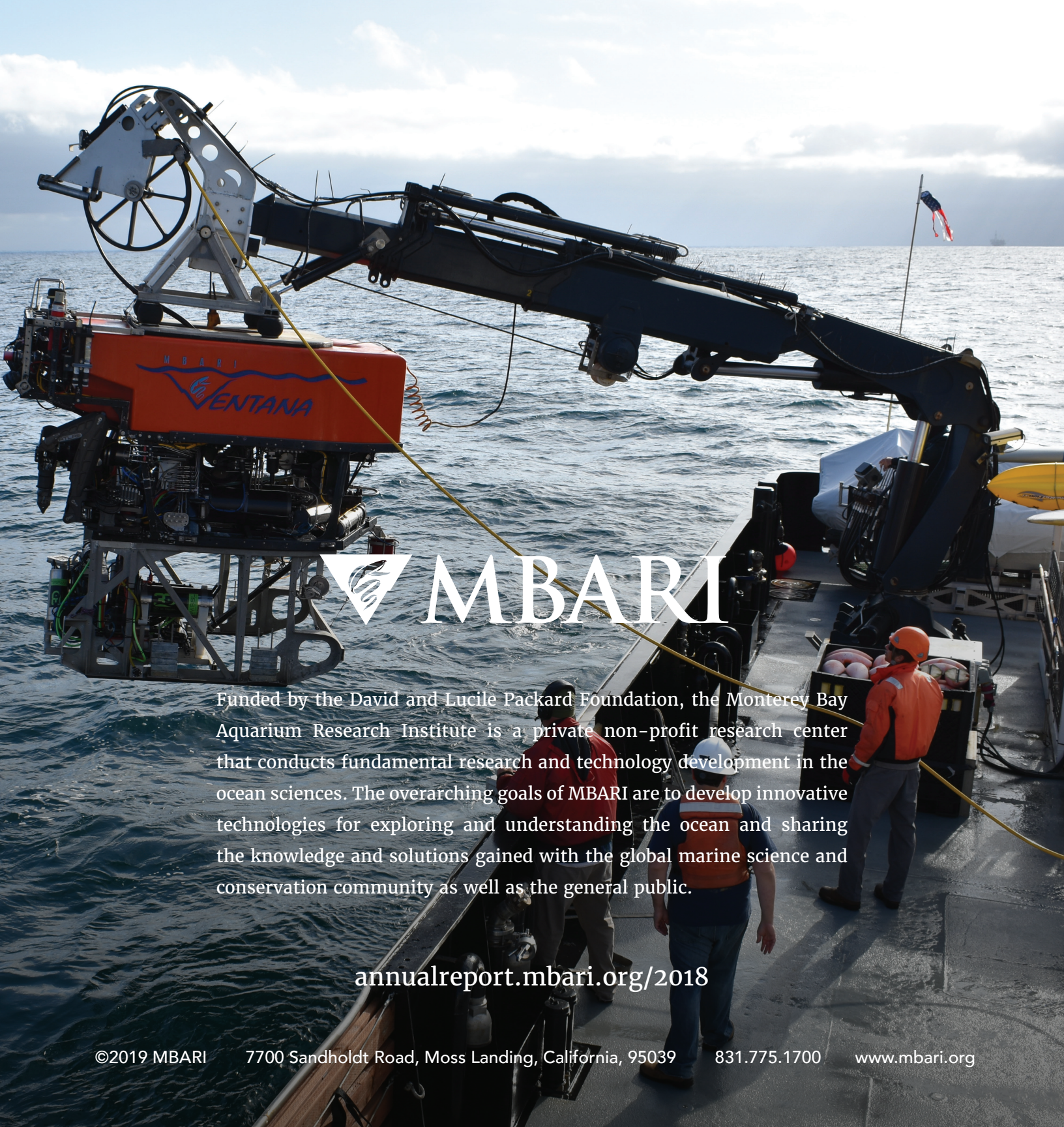
Dona Crawford
Associate Director of Computation (Retired)
Lawrence Livermore National Laboratory

Susan Hackwood, Ph.D.
Executive Director (Retired), California Council on Science and Technology

Eric O. Hartwig, Ph.D.
Associate Director of Research (Retired)
Naval Research Laboratory

G. Ross Heath, Ph.D.
Dean Emeritus, College of Ocean and Fishery Sciences
Professor Emeritus, School of Oceanography, University of Washington

George N. Somero, Ph.D.
David and Lucile Packard Professor of Marine Sciences, Emeritus
Hopkins Marine Station,
Stanford University



MBARI

Funded by the David and Lucile Packard Foundation, the Monterey Bay Aquarium Research Institute is a private non-profit research center that conducts fundamental research and technology development in the ocean sciences. The overarching goals of MBARI are to develop innovative technologies for exploring and understanding the ocean and sharing the knowledge and solutions gained with the global marine science and conservation community as well as the general public.

annualreport.mbari.org/2018

7700 Sandholdt Road, Moss Landing, California, 95039 831.775.1700 www.mbari.org