UC San Diego | SCRIPPS INSTITUTION OF OCEANOGRAPHY

2019 ANNUAL REPORT

Table of Contents

Cover: Students in the Observational Physical Oceanography class participate in an instructional cruise aboard the research vessel *Robert Gordon Sproul*. The cruise gave students the opportunity to test hand built instruments as part of the curriculum. Students at Scripps are provided access to ship time through the UC Ship Funds program, which awards ship time to students, early-career scientists, faculty and staff to conduct research and instruction at sea.

Inside cover: Graduate students in the Master of Advanced Studies in Climate Science and Policy program ventured to the Kendall-Frost Marsh Reserve in San Diego's Mission Bay to learn about the marsh's ability to draw down and store carbon. The reserve is part of the UC Natural Reserve System, a network of 41 protected natural lands throughout California, and a living laboratory for education and research. Photo by Erik Jepsen

Director's Letter

Thank you to the students, staff, postdoctoral scholars, researchers, faculty, and countless supporters who made this year an outstanding one at Scripps Institution of Oceanography at UC San Diego.

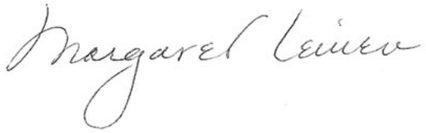
We continue to be a worldwide leader in understanding and protecting our planet, with more than $180 million in contract and grant awards. Our research is informing key decision makers looking to apply and investigate science-based solutions. We saw an increase in California funding (pages 2-5), including the expansion of the ALERTWildfire network, which now has 300 cameras keeping eyes on fire-prone areas of our state. A grant from the California Ocean Protection Council is advancing research into understanding statewide cliff erosion following a year that has seen tragic consequences of collapses and questions about erosion's effects on coastal infrastructure.

This year, we saw private philanthropy nearly double to $26.3 million, as donors are realizing that Scripps can help drive solutions of importance to them. Those causes included a sea-level rise flood alert program in Imperial Beach, the new research vessel *Bob and Betty Beyster* (page 18) that will provide scientists and students critical access to time at sea, awards for students studying the health of coral reefs, and much more.

Another area in which I'm incredibly proud to see sustained progress is with the Scripps Undergraduate Research Fellowship (SURF), the National Science Foundation-supported program that welcomes a diverse group of undergraduate students to Scripps from across the U.S. for a summer research program. That fellowship has continued to thrive, and we are seeing increasing numbers of SURF alumni returning to Scripps as graduate students (page 10).

Sadly, with all the progress that was made, we said goodbye to three legends. Gustaf Arrhenius, with Scripps since 1952, was an essential figure in deep-sea sedimentation research and a leader in analyzing lunar samples from the Apollo missions. He also played a key role in the formation of UC San Diego, assisting with recruiting professors for the new university. Scripps' oldest and most accomplished alumnus Walter Munk, who inspired students, scientists, and the public the world over, passed away at the age of 101, after an 80-year career at Scripps. Walter made groundbreaking observations of waves, tidal energy in the deep ocean, ocean acoustics, and the rotation of the earth, and was a statesman of science who received nearly every science award and accolade possible. We also lost pioneering physical oceanographer Ken Melville. Ken made profound contributions to science's understanding of waves, and was a key member of Scripps' leadership team throughout his career, which included a stint as deputy director of research. We thank Walter, Gustaf, and Ken for showing us how much science can transcend and impact the world. They may be gone, but their impact will never be forgotten.

Thank you,



Margaret Leinen
Vice Chancellor for Marine Sciences, UC San Diego
Director, Scripps Institution of Oceanography

Director's Council

RESEARCH HIGHLIGHTS

Resilient Futures Program Helps Imperial Beach Prepare for Sea-Level Rise

One of California's cities most vulnerable to sea-level rise avoided damage this winter thanks to an early-warning flood system engineered at Scripps. The City of Imperial Beach faced 15-foot waves from a king tide event in January, inundating streets and coastal property. Prior to that event, Scripps' Center for Climate Change Impacts and Adaptation had installed an experimental warning system kickstarted in November 2018 by a donation from the David C. Copley Foundation. The system flagged dangerous flood-threatening wave conditions in advance of when high tides were predicted so the city could close off streets and prepare crews to patrol seaside locations.

"We were all anticipating the flooding being on Monday or Sunday. Scripps really alerted us that this [Friday, January 18] was going to be the day," Imperial Beach Mayor Serge Dedina told *The San Diego Union-Tribune*, regarding the advance notice the city received. "It reinforced that we needed to be out here closing off the street, getting all hands on deck."

The warning system coordinates a network of instruments collecting data on ocean conditions, such as wave buoys deployed by the Coastal Data Information Program at Scripps, LIDAR (light detection and ranging) scanners, and groundwater and tide gauge sensors. It's part of the center's Resilient Futures program that could later customize warning systems for vulnerable cities along both U.S. coasts.

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scripps.ucsd.edu/ImperialBeach

Photo by the Center for Climate Change Impacts and Adaptation.

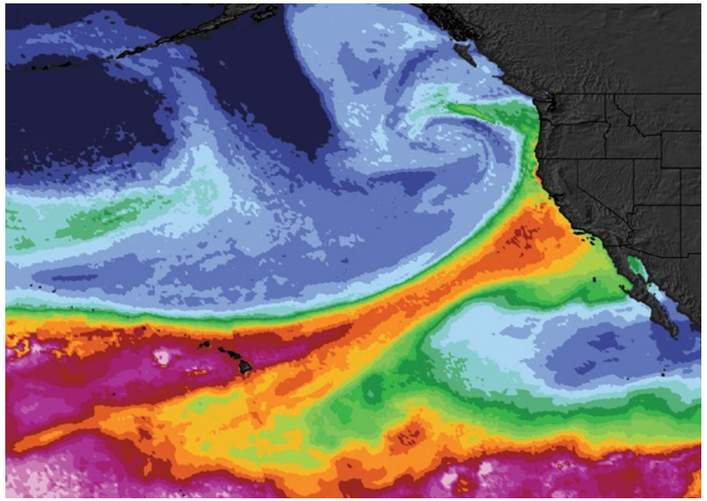
Drone-Mounted Tech Helps Keep Eyes on Erosion

As cliffs throughout California succumb to erosion and collapse due to rising sea levels, moisture from rain and urban runoff, and natural processes, Scripps Oceanography is using new technology to study and assess cliff erosion and retreat. A new LIDAR-equipped drone will supplement efforts to monitor coastal erosion, joining a truck-mounted system. LIDAR uses laser pulses to measure distances and make 3D records of the terrain.

"The drone will help with areas inaccessible to the truck and can be used during high tides when the beach is too narrow to drive," researcher Adam Young said. "It will be able to map features not visible from the beach providing a complete picture of cliffs, and also be used to monitor wave run-up."

The new drone purchase was funded via the U.S. Army Corps of Engineers. Young is also leading the first high-resolution statewide assessment of California coastal cliff erosion via a grant from California's Ocean Protection Council. The goal will be to detect erosion hot spots, map a coastal cliff stability and hazard index, and identify areas prone to future coastal erosion.

Photos by Erik Jepsen



New Scale Developed to Categorize Atmospheric Rivers as Economic Impacts of Storms Realized

The Center for Western Weather and Water Extremes at Scripps introduced a scale that helps weather forecasters evaluate the magnitude of precipitation-bearing bands of moisture known as atmospheric rivers. The scale assigns five categories to atmospheric rivers using as criteria the amount of water vapor they carry and their duration in a given location.

The intention of the scale is to describe a range of scenarios that can prove beneficial or hazardous based on the strength of atmospheric rivers. While Category 1 storms would be expected to bring light rain, Category 5 atmospheric rivers could bring flooding and substantial infrastructure damage to various areas. Atmospheric rivers are a crucial means by which the West Coast receives rain and snow. Scientists expect they will become even more significant as global warming trends increase their intensity.

In separate research, Scripps scientists estimated that atmospheric rivers pose a $1 billion-a-year flood risk in the West. The team led by Scripps postdoctoral researcher Tom Corringham found that flooding has caused nearly $51 billion in damages to western states in the last 40 years. More than 84 percent of these damages were caused by atmospheric rivers.

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scripps.ucsd.edu/ARscale

A satellite view of the integrated water vapor from an atmospheric river that impacted California in April 2018. Image by the Center for Western Weather and Water Extremes at Scripps.

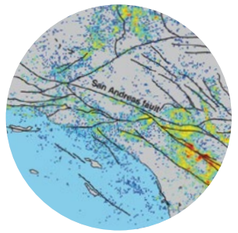
Keeping an Eye on Wildfire Threats, for Today and for the Future

Scripps research continues to aid in California's efforts to understand the causes of deadly wildfires and combat their spread. ALERTWildfire, a multi-hazard-detecting camera network developed by a consortium of academic centers including Scripps, grew significantly this year in high fire-risk areas in the West. The now 300-camera system covering five states is credited for early detection of hundreds of fires in the last two years and enhanced situational awareness for fire officials and first responders.

The need for such technology should only grow, as Scripps researchers helped clarify the link between wildfires and a warming climate. A study published in July showed summer forest fires in Northern California have a strong connection to dry ground conditions brought on by increasing heat. The researchers say forest fire increases are driven by a simple mechanism: when air heats up even modestly, it causes more moisture to evaporate from soils and vegetation. Thus fires start more easily, and can spread faster and farther.

The wildfire cameras are publicly available at www.alertwildfire.org.

Scientists Identify Almost 2 Million "Hidden" Earthquakes



After looking through 10 years' worth of Southern California seismic data, Scripps seismologist Peter Shearer and colleagues identified hundreds of thousands of previously unidentified tiny earthquakes that occurred between 2008 and 2017. The study expands the earthquake catalogue for that region—growing it from about 180,000 recorded earthquakes to more than 1.8 million. This tenfold increase represents the tracking of tiny temblors, between negative magnitude 2.0 (-2.0) and 1.7. The expanded earthquake catalogue, detected via a high-resolution approach, reveals previously undetected foreshocks that precede major earthquakes, as well as the evolution of swarms of earthquakes. The richer data set will provide a clearer picture of how seismic events affect and move through the region.

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scripps.ucsd.edu/hiddenearthquakes

Cal Fire Capt. Kevin Cox points to the screen as he and Capt. Ryan Silva demonstrate the use of wildfire surveillance cameras while in the emergency command center at the Cal Fire San Diego Unit Headquarters in October. Photo by Hayne Palmour IV/The San Diego Union-Tribune.

Arctic Sea Ice Minimum

Scripps researchers calculated that if all Arctic Ocean sea ice were to melt, it would make the same contribution to global warming as would adding one trillion tons of carbon dioxide to the atmosphere. It would consequently speed up the arrival of a global threshold of warming of 2°C greater than the temperatures the world experienced before the Industrial Revolution. Scientists believe exceeding that threshold will lead to catastrophic consequences across the planet.

"Losing the reflective power of Arctic sea ice will advance the 2°C threshold by 25 years. Any rational policy would make preventing this a top climate priority for world leaders," said Veerabhadran Ramanathan, a professor of atmospheric and climate sciences at Scripps and co-author of the report.

The research team noted that climate models have tended to underestimate the speed at which Arctic sea ice is melting, sometimes drastically. Research by other scientists has suggested the possibility of a seasonal ice-free Arctic as early as the 2020s.
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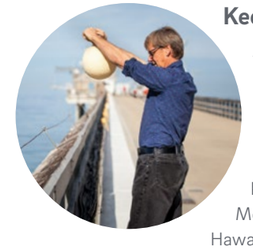
scripps.ucsd.edu/seaice25

Photo by Alex Hamel



Keeling Curve Hits 415 PPM

The Keeling Curve, a daily measurement of carbon dioxide concentration in the atmosphere and one of the founding tools in modern climate change science, passed a daily reading of 415 parts per million in May. This reading was the highest since the late Scripps scientist Charles David Keeling began tracking CO_2 concentration 61 years ago. Measurements are taken at the Mauna Loa Observatory in Hawaii, and are managed by the Scripps CO_2 Program.
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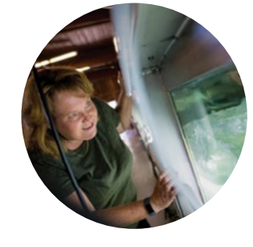
scripps.ucsd.edu/keelingrecord

SeaSCAPE Experiment



A two-month-long experiment by the NSF Center for Aerosol Impacts on Chemistry of the Environment (CAICE) took place in the wave channel at Scripps Hydraulics Lab. Led by CAICE Director Kim Prather, the Sea Spray Chemistry And Particle Evolution project, or SeaSCAPE, was a novel experiment in which scientists unraveled complex ocean-atmosphere interactions. The focus of the project was to understand how human pollution interacts and reacts with ocean emissions of gases and aerosols—and ultimately affects cloud formation, air quality, and climate.
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scripps.ucsd.edu/seascape

Microplastics Found Throughout Water Column

Researchers at Scripps Institution of Oceanography, Monterey Bay Aquarium, and the Monterey Bay Aquarium Research Institute found that microplastics are common from the surface to the seafloor in Monterey Bay. Using underwater robots equipped with sampling devices, the researchers, including Scripps' Anela Choy, filtered plastic particles out of seawater and collected animal specimens. The most common plastics found are those that are used to manufacture consumer products. Additionally, the researchers found that marine animals are also consuming the microplastics, introducing the pollutants to the marine food web.
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scripps.ucsd.edu/microplastic

SeaSCAPE photo by Erik Jepsen
Giant larvacean image courtesy Monterey Bay Aquarium Research Institute

Technology: Argo Captures Two Millionth Profile

The international Argo network of ocean-observing robots recorded its two millionth profile in December 2018, marking a major milestone for the 20-year-old observation program. During profiles, the floats collect data on temperature, salinity, and current speed and direction while diving to a depth of 6,500 feet and resurfacing. The collection of Argo data represents the most detailed observation of ocean physics in history.

As the 4,000 floats in the Argo network continue to collect data in all ocean basins, specialized types of Argo floats are being deployed. One of those is Deep Argo, which can dive three times deeper to the ocean bottom in depths up to 6,000 meters (3.7 miles), helping researchers understand the largely unobserved deep ocean. Biogeochemical Argo floats can measure a range of variables such as oxygen, nitrogen, and pH – critical for addressing pressing environmental issues, such as ocean acidification and low oxygen levels that have been detected in some parts of the ocean. Argo leaders hope to integrate as many as 1,250 Deep Argo and 1,000 biogeochemical Argo floats into the global array to bring its total size to 4,600 floats, starting with deployments being made next year.
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scripps.ucsd.edu/argomilestone

Deep Argo photo by Ben Reineman, Instrument Development Group.

Human Health: Climate Change Likely to Increase Human Exposure to Toxic Mercury

Researchers found that warming oceans are leading to an increase in the harmful neurotoxicant methylmercury. The study was led by Amina Schartup, a new Scripps faculty member. Mercury levels in fish are influenced by diet and how much they swim. Warming temperatures could affect all of these. While the regulation of mercury emissions has successfully reduced methylmercury levels in fish, spiking temperatures are driving those levels back up, which could increase human exposure to mercury through seafood.
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scripps.ucsd.edu/mercury

National Security: U.S. Naval Academy Internship

For six weeks in the summer of 2019, Scripps Oceanography hosted three midshipmen summer interns from the U.S. Naval Academy. Created with the goal of exposing Navy personnel to the latest ocean science and technology development, this was the first year of the program, which plans to continue next summer. Two of the interns worked with Drew Lucas, an assistant professor in the Marine Physical Laboratory, who develops technologies and equipment to observe the oceans. Specifically, they worked on the refitted custom-made sonar system for R/V *Roger Revelle*, the only ship in the U.S. academic fleet with this kind of custom technology. The third midshipman worked with Sean Wiggins and John Hildebrand of the Whale Acoustic Lab to help analyze a large quantity of underwater ambient sound data to identify trends in the presence of ships and ocean storms. This work will also facilitate the discovery of sounds produced by marine mammals. The midshipmen also participated in events alongside the Marine Physical Laboratory Summer Internship Program, a ten-week program for undergraduates interested in marine science and technology.

Climate Change: Low Oxygen Levels Could Temporarily Blind Marine Invertebrates

Former Scripps PhD student and now postdoctoral scholar Lillian McCormick published the first study to demonstrate that vision in marine invertebrates is highly sensitive to the amount of oxygen in the water. Studying four local California marine invertebrates—Market Squid, Two-spot Octopus, Tuna Crab, and a Brachyuran Crab—she found that vision was reduced by 60-100 percent under low-oxygen conditions. In the marine environment, oxygen levels change over daily, seasonal, and inter-annual time scales. However, these conditions are changing due to human-influenced climate change and pollution.
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scripps.ucsd.edu/lowoxygen

EQUITY, DIVERSITY, AND INCLUSION

A Campus Enriched

Every summer, Scripps Oceanography welcomes a diverse group of undergraduates from across the U.S. to spend ten weeks on campus conducting research and networking with peers and mentors. The Scripps Undergraduate Research Fellowship, or SURF program, gives admitted students the opportunity to dive into science, engage in research aimed at understanding and protecting the planet, and forge life-long connections within the science community.

Funded largely by the National Science Foundation, the SURF program serves to increase diversity within STEM fields by encouraging students from underrepresented groups to apply. The program has been successful, as there are 11 former SURF participants now making a splash at Scripps as admitted PhD students. Additionally, four former SURF fellows have graduated from Scripps with either master's degrees or PhDs.

"It is without question that I would have never made the decision to apply to graduate school without the SURF program," said Scripps PhD student Jeramy Dedrick, a former SURF fellow from the 2017 cohort. "Whether it was the research project I participated in, professional/academic seminars and workshops, or interaction with other SURF fellows, graduate students, and professors, I was able to learn about the terrifying and exciting world of research within academia. SURF gave me the tools to become an efficient researcher and inquisitive student in the classroom."

scripps.ucsd.edu/surfnetwork

Current graduate students that were former SURF participants include (front row, left to right) Kiefer Forsch, Amrit Bal, Ivan Moreno, Anai Novoa, (top row, left to right) Jeramy Dedrick, Shailja Gangrade.

New Associate Dean for Faculty Equity

In February 2019, professor and physical oceanographer Jennifer MacKinnon was appointed Associate Dean for Faculty Equity at Scripps. This newly created role is part of the institution's commitment to instill equitable practices for recruitment, retention, and evaluation of professors and researchers, leading to a diverse and inclusive community of faculty.

In this role, MacKinnon will work collaboratively on recruitment to ensure that Scripps maintains the ability to attract and retain excellent faculty from diverse backgrounds, and to evaluate them in a fair and equitable way. This includes providing implicit bias training for search committees and guidance on inclusive practices, reviewing candidates contributions to diversity statements, and more. The position will also work closely with Scripps' Director of Diversity Initiatives Keiara Auzenne to coordinate on institutional initiatives that involve faculty diversity and climate.

"Jennifer MacKinnon has worked informally toward improving and enhancing our practices for faculty diversity for some time," said Scripps Director Margaret Leinen. "This appointment recognizes the importance of this work for Scripps."

MacKinnon was the recipient of a UC San Diego Inclusive Excellence Award in 2018, which recognized her extraordinary mentorship to underrepresented scientists through her participation in the program Mentoring Physical Oceanography Women to Increase Retention, a community-based mentoring program that supports female scientists from late graduate school through their early careers.

EDUCATION

From Microbes to the Mantle, New Faculty Members Explore a Changing World

Seven new faculty members joined Scripps Oceanography during the last two academic years. Their diverse research interests range from marine ecology to biogeochemistry to geophysics, but all are united through Scripps's mission to understand and protect the planet.

Sarah Aarons | Assistant Professor
Geosciences Research Division

Aarons is an isotope geochemist whose research is primarily focused on understanding the evolution of Earth's surface through time as a function of a changing climate. Her research involves measurement of isotope compositions of natural materials such as mineral dust, weathering profiles, river sediment, and ancient rocks.

Anela Choy | Assistant Professor
Integrative Oceanography Division

Choy is a sea going biological oceanographer and marine ecologist who studies the structure and function of open-ocean and deep-sea food webs, which fill Earth's largest habitat and play critical roles in climate regulation and global seafood commerce. Her lab combines a number of research tools and perspectives, including using ROVs to observe feeding events in situ, analyzing stomach contents or diet, and measuring biochemical trophic tracers.

Julia Diaz | Assistant Professor
Geosciences Research Division

Diaz is a biogeochemist whose research explores how the ocean's smallest inhabitants, such as phytoplankton, interact with their chemical environment to shape the natural world in big ways, including impacts on ecosystem health, natural resources, and global climate. The Diaz Lab conducts this work using lab-based experiments with model organisms and field work in diverse ocean settings, from coastal to open-ocean environments.

Jack Gilbert | Professor
Marine Biology Research Division

Gilbert is a microbial ecologist who holds a joint appointment between Scripps Oceanography and the Department of Pediatrics at UC San Diego. His lab is working to answer fundamental questions about the human microbiome and our microbial interaction with built environments. His research also focuses on microbial ecosystems from natural environments including oceans, rivers, soils, air, plants, and animals.

Amina Schartup | Assistant Professor
Geosciences Research Division

Schartup is a multidisciplinary researcher whose work lies at the intersection of marine biogeochemistry and human health. Schartup uses modeling and experimental tools to understand how mercury cycles in aquatic environments where it converts into its toxic form, methylmercury, which accumulates in fish people like to eat.

Ross Parnell-Turner | Assistant Professor
Institute of Geophysics and Planetary Physics

Parnell-Turner is a geophysicist whose research concerns how the lithosphere is created and deformed, using geophysical and geological observations made in the oceans. His primary focus is on the mechanical structure of mid-ocean ridges, using the distribution of micro-earthquakes that occur as the tectonic plates spread apart.

Dovi Kacev | Assistant Teaching Professor
Marine Biology Research Division

Kacev is a marine biologist with a special focus on understanding the ecology of migratory shark species. Kacev uses molecular techniques to analyze mako and thresher shark populations and migration patterns in the Southern California Bight. Most of his time at Scripps will be dedicated to teaching marine biology and ecology labs and courses, and he will also continue doing active research and field work.

BIRCH AQUARIUM

Seadragons & Seahorses Exhibition Debuts

The opening of Birch Aquarium's new exhibition *Seadragons & Seahorses* celebrates more than a family friendly attraction, it is also the establishment of a state-of-the-art laboratory for scientists and the aquarium's husbandry team to gain a better understanding of some very unusual fish. The exhibition aims to breed seadragons in captivity and help scientists answer basic questions about the species. Currently the most common answer to a seadragon question is: "We just don't know."

Leafy and Weedy Seadragons are the highlight of the exhibition, and their new space has been designed with input from Scripps Oceanography researchers and decades of experience from Birch Aquarium's seahorse and seadragon breeding team. Both have studied seadragons in the wild, and contributed that knowledge to inform everything from the seaweed habitat to the depth of the exhibit to ensure room for mating behaviors.

Both Leafy and Weedy Seadragons perform elaborate mating displays, where partners spin together snout-to-snout and move up and down in the water column. This "dance" is essential for the successful transfer of eggs from the female onto the male's tail, where he then fertilizes the eggs. If mating is successful and eggs are deposited, the male will protect the eggs until they hatch about six weeks later.

Weedy Seadragons have been bred successfully in captivity just a handful of times with limited success in the last 30 years. The more ornate Leafy Seadragons have never been bred in captivity, and the new 9-foot-tall, 5,375-gallon habitat hopes to give these ethereal creatures the space they need to ensure mating success.

scripps.ucsd.edu/seadragons

BY THE NUMBERS (FY 18-19)

496,651
On-site attendance*

13,000
Member households*

54,000
Pre-K to Grade 12 students served with 47 percent receiving financial support

30,000
hours donated by over 500 volunteers

19,876
on-the-water experiences

5,688
animals in our care

Milestone

5,000+
seahorses have been sent to 100 aquariums worldwide

*all-time high

Photo by Erik Jepsen

Research and Technology Testing Ground

Research in Action: 100 Island Challenge, Birch Aquarium's largest coral reef community, is unlike any other public aquarium habitat. Beyond a beautiful display, the *Research in Action* exhibit is designed to both showcase and support important Scripps Oceanography research for the 100 Island Challenge, while inspiring guests to take action to understand and protect reef habitats. Over the last year, the exhibit has been used to test equipment, train researchers, and engage the public in active science. Guests can watch UC San Diego Jacobs School of Engineering and Scripps Oceanography researchers testing different types of equipment, from 3D scanners to autonomous robotics. Often, the controls are given to visitors, making them part of the research enterprise. With the help of special communications masks, scientists talk with aquarium guests while under water, while others engage with guests outside the exhibit, explaining their tools and research around the world.

Sea Turtle Novel 3D Scanning Techniques

Sea turtle physicals have become more complex as Birch Aquarium's rescued loggerhead continues to grow. Her 3D-printed brace fits, but as she grows, she may need another. She has outgrown the human CT scanning equipment at UC San Diego's Jacobs Medical Center. Novel non-invasive scanning techniques including 3D sound profiling using low-frequency bathymetry sound, 3D photographic image stitching, and CT/MRIs are being incorporated into her veterinary checks to understand how her shell is changing. With experts from the aquarium's husbandry team along with UC San Diego's Jacobs School of Engineering and Scripps Oceanography, these new scanning techniques will aid in providing the best care possible for one of Birch's most engaging creatures.

Photos by Birch Aquarium

Next Generation Science Standards Alignment

This year, Birch Aquarium's education team completed the gargantuan task of aligning all Discovery Lab classes for pre-K through grade 12 students with national Next Generation Science Standards (NGSS). Birch Aquarium's classes are taught to more than 50,000 students annually in San Diego County and beyond. Students travel from as far as Phoenix, Los Angeles, and Mexico to participate. Discovery Labs take place in Birch Aquarium's classrooms, at schools or in the field at Scripps Beach in the shadow of Scripps Oceanography.

These classes give students opportunities that are not available in the average classroom setting. Discovery Labs often include a unique experience with live animals or provide all of the equipment and materials for dissections. By incorporating NGSS in aquarium classrooms, the information provided integrates seamlessly into what teachers are instructing in their own curriculum.

Birch Aquarium works closely with schools to ensure that all students have the opportunity to learn about the ocean world. Of the 50,000 annual students, nearly 25,000 receive financial aid. Birch hopes that these classes inspire students to pursue science, technology, engineering, and math (STEM) pathways.

Photos by Birch Aquarium

SHIPS

Scripps has one of the largest academic research fleets in the world, with four research vessels—R/V *Sally Ride*, the newest in America's research fleet; R/V *Roger Revelle*; R/V *Robert Gordon Sproul*; and the new scientific workboat R/V *Bob and Betty Beyster*—and the famous research platform FLIP.

New Scientific Workboat Enhances Coastal Research

The research vessel (R/V) *Bob and Betty Beyster* was commissioned in April, and the vessel has filled a need to provide nearshore access at a lower daily cost to scientists, students, and others conducting ocean-based education. R/V *Bob and Betty Beyster* is a 42-foot scientific workboat with a range of 800 kilometers (500 nautical miles) and a fast cruising speed. The vessel has an A-frame hoist, an adaptable deck foundation for configuring mission-specific instruments, and computer-controlled propulsion that enables dynamic positioning and precise maneuvering. Scientific equipment includes a state-of-the-art seafloor mapping system, a knuckle crane that will enable the vessel to deploy and recover autonomous vehicles, and a mini remotely operated vehicle (ROV).

"Scripps operates a world-class fleet of oceangoing research vessels, which is made even more capable with the R/V *Bob and Betty Beyster*," said Bruce Appelgate, associate director at Scripps Oceanography and director of Ship Operations and Marine Technical Support. "As a fast, nimble platform equipped to fulfill heavy coastal scientific applications, the vessel enables tremendous new opportunities, whether conducting experiments in the La Jolla Canyon just offshore, or expeditions throughout the Channel Islands."

Since its arrival in April, the vessel has been heavily subscribed, with missions supporting whale acoustics, wave buoy deployments, physical oceanography surveys, and ROV deployments for student teaching.

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https://scripps.ucsd.edu/ships/beyster

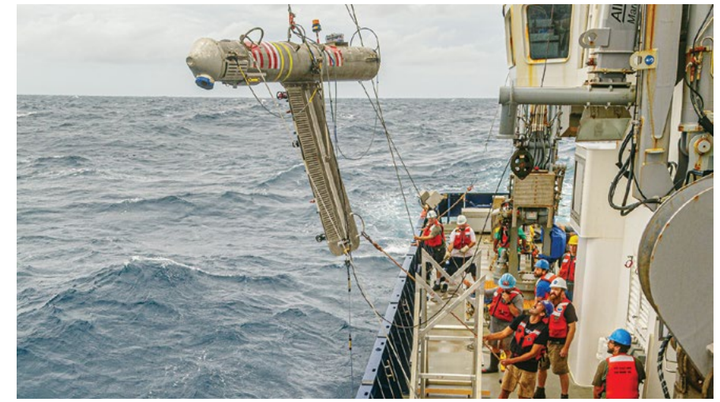
R/V *Roger Revelle* Undergoes Midlife Refit

Research vessel *Roger Revelle* entered service in 1996, and quickly established itself as vitally important to the U.S. oceanographic research effort due to its range, payload, duration, and ability to effectively conduct scientific operations in remote areas.

Since *Roger Revelle*'s delivery, enormous technological advances have taken place in marine engineering, instrumentation, and the ability to reduce environmental impact. To bring these benefits to seagoing scientists, and to extend the service life by 15 to 20 years, *Roger Revelle* was removed from service in April to begin a one-year midlife refit.

Supported by the Office of Naval Research, with ancillary support from the National Science Foundation and Scripps, the midlife refit will deliver significant benefits including:

- A new modern propulsion system
- Improved electrical generators to improve reliability
- New bow thruster with a retractable design and better dynamic positioning
- Modernized safety systems
- Installation of a ballast water treatment system that will prevent invasive marine species from being discharged with the ship's ballast water
- New Tier 3 diesel engines that will reduce emissions by up to two-thirds
- New shipboard climate control systems that will improve ventilation, cooling, and heating while reducing ambient airborne noise
- New scientific capabilities including shipboard cyberinfrastructure, a variety of new modern instruments, and a submerged acoustics gondola for improved sonar performance



R/V *Sally Ride*—Monsoon Research in Bay of Bengal

Research vessel *Sally Ride* hosted two dozen scientists from the U.S. and India for a comprehensive study of the ocean physics that drive the South Asian monsoon every year. A suite of specialized instruments—many custom-made at Scripps—made detailed measurements of turbulence, currents, temperature, and other variables. The researchers' goal is to understand how that activity at the surface ocean is linked to the oscillations between rain and dry weather during monsoon season.

Among the instruments used were the Wirewalker, a platform invented by Scripps oceanographer Rob Pinkel that is powered by the ocean's own energy, and the fast CTD, which enables high-resolution profiling of fundamental variables such as temperature and salinity, traveling up and down in the water column at 11 knots as the vessel travels at four knots.

"You can't go out and buy that kind of technology," said Scripps oceanographer Drew Lucas.

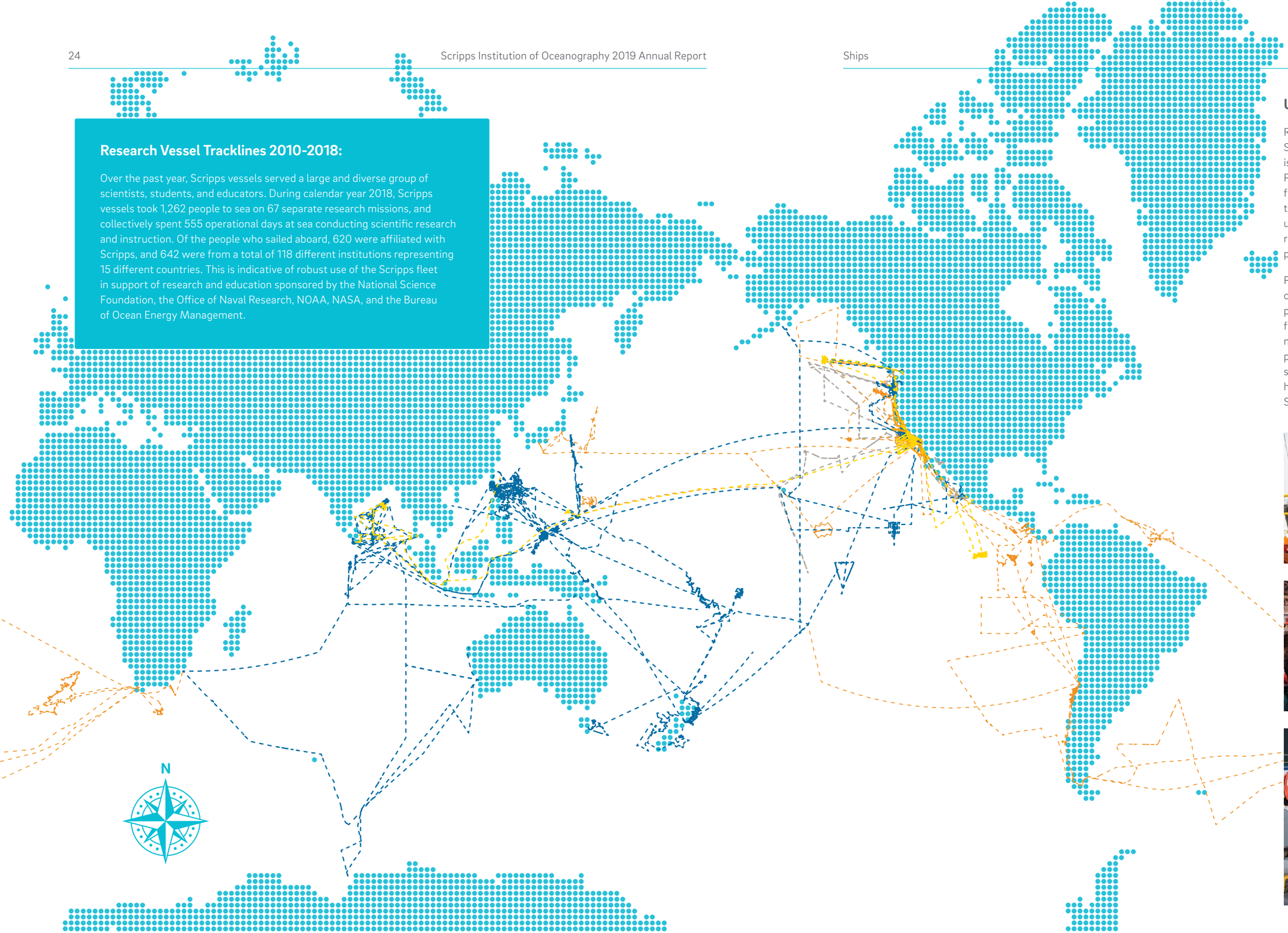
This research program is funded by the Office of Naval Research (ONR).

"Understanding the maritime environment is critical for safe and efficient naval operations around the globe," said ONR program manager Scott Harper. "Research should help support that by improving the Navy's ability to forecast the environment in the future."

Photos by San Nguyen

Research Vessel Tracklines 2010-2018:

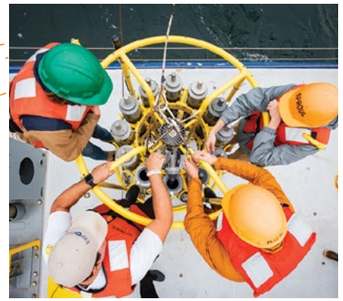
Over the past year, Scripps vessels served a large and diverse group of scientists, students, and educators. During calendar year 2018, Scripps vessels took 1,262 people to sea on 67 separate research missions, and collectively spent 555 operational days at sea conducting scientific research and instruction. Of the people who sailed aboard, 620 were affiliated with Scripps, and 642 were from a total of 118 different institutions representing 15 different countries. This is indicative of robust use of the Scripps fleet in support of research and education sponsored by the National Science Foundation, the Office of Naval Research, NOAA, NASA, and the Bureau of Ocean Energy Management.



UC Ship Funds Program

Research training is fundamental to the Scripps mission, and this commitment is exemplified by the UC Ship Funds Program. Made possible by support from UC San Diego, Scripps, and donors, this program enables graduate and undergraduate students, postdoctoral researchers, and early career faculty to pursue research and instruction at sea.

Program awards are made through a competitive internal peer-reviewed proposal process. Missions can range from one-day trips off San Diego to month-long expeditions from foreign ports. During the 2018 calendar year, 520 students, faculty, and staff obtained first-hand experience at sea courtesy of the UC Ship Funds Program.



Students in the Observational Physical Oceanography class participate in an instructional cruise aboard the research vessel *Robert Gordon Sproul*. The cruise gave students the opportunity to test hand built instruments as part of the curriculum.

SCRIPPS ALUMNI

Alumni of Scripps Oceanography represent nearly 3,000 academics, professionals, experts, and entrepreneurs. Their accomplishments reach far and wide, from education and environment to industry and innovation, and their impact spans the expanse of our planet, from deep oceans to deep space.

Many from our active alumni community stay connected each year, returning to meet and mentor current students, speak at special events, pursue professional goals, and develop partnerships with faculty and researchers. We thank them for returning to share their time and talents here on campus.

CLASS OF 2019

Total Number of Graduates: 230
Female: 140 (61%) Male: 90 (39%)

Undergraduate BA/BS Graduates: 126
Female: 82 (65%) Male: 44 (35%)

9 BA-ESYS Environmental Policy
8 BS-ESYS Earth Sciences
24 BS-ESYS Ecology, Behavior, and Evolution
8 BS-ESYS Environmental Chemistry
16 BS-Earth Sciences
59 BS-Marine Biology
2 BS-Oceanic and Atmospheric Sciences

Master of Advanced Studies Graduates: 32
Female: 20 (62.5%) Male: 12 (37.5%)

25 MAS-MBC, Marine Biology and Conservation

7 MAS-CSP, Climate Science and Policy

Master's Graduates: 30
Female: 21 (70%) Male: 9 (30%)

10 Earth Science

15 Marine Biology

5 Oceanography

PhD Graduates: 42
Female: 17 (40%) Male: 25 (60%)

9 Earth Science

14 Marine Biology

18 Oceanography

1 Marine Biology with a Specialization in Interdisciplinary Environmental Research

Beginning in fall 2017, applicants to UC San Diego have had the option to self-report gender identity with multiple, nonbinary options. Complete data on nonbinary Scripps students is not currently available.

Photo by Erik Jepsen/UC San Diego

NASA astronaut **Jessica Meir, PhD '09**, fulfilled a lifelong dream on Sept. 25, 2019, when she launched to the International Space Station on a Russian Soyuz MS-15 spacecraft. During her six-month mission, Meir and colleagues will conduct hundreds of experiments to study physiological effects of long-duration human spaceflight. This research is crucial for NASA to achieve its goals for the Artemis program, which intends to land the first woman and the next man on the Moon by 2024, and its longer range goal of sending astronauts to Mars. Meir and fellow astronaut Christina Koch made history on Oct. 18, 2019, when they conducted the first all-female spacewalk.

Bob Rex, PhD '58, received the 2019 "True Triton" Alumni Award from Chancellor Pradeep Khosla in February for the many meaningful roles he's played at UC San Diego since its founding in 1960. Rex has been a fixture on campus for most of his life, and still is today at 90 years old, making an impact through his own work and a lifetime of philanthropic support for students.

At the MTS-OES OCEANS conference in Marseille, the Marine Technology Society and the Walter Munk Foundation for the Oceans announced the establishment of the Walter Munk Scholar Award, honoring the late Scripps alumnus. The first ever recipient of this award was another Scripps alumnus, **Alfredo Giron, MS '16, PhD '19**.

In March, San Diego's oldest startup accelerator, Connect, appointed **Silvia Mah, PhD '04, MBA '10**, as its new president. As a prominent angel investor and business accelerator executive, Mah has helped more than 500 women launch or grow their startups, and has helped female founders raise more than $5 million in growth capital.

With record numbers of graduating students, the Scripps commencement ceremony was split into two separate ceremonies, one for undergraduates and one for Master's and PhD graduates. This gave us the opportunity to welcome back two alumni as keynotes; **Doug Tomczik '12, MS '14**, Lead Product Designer at Jupiter Intelligence, and **Jeremy Bassis, PhD '07**, associate professor at the University of Michigan, who studies glaciers past and present to better predict the future of ice sheets over Greenland and Antarctica and the implications for humans.

Caitlin Miller '12, Air Pollution Specialist at the California Air Resources Board, served as the keynote speaker for the annual Environmental Systems Student Symposium. **Kim Cobb, PhD '02**, Professor and Director of the Global Change Program at Georgia Institute of Technology, shared her time with Scripps students as the keynote for the annual Scripps Student Symposium, and as a featured speaker for the student-led "Growing Up in Science" lecture series.

Jessica Meir and Bob Rex photos by Erik Jepsen/UC San Diego

INTERNATIONAL RELATIONS

Bringing Science to Global Climate Talks

In December 2018, more than twenty students and researchers from Scripps Oceanography and the School of Global Policy and Strategy at UC San Diego participated in a global climate conference in Katowice, Poland. The 24th Conference of the Parties, or COP24, was the latest in a series of meetings led by the United Nations to tackle the global issue of climate change.

Scripps and UC San Diego delegates represented the University of California over the course of the two-week event, where they hosted an exhibit, presented press conferences, and participated in side events to communicate the latest scientific research on climate change.

Delegates also gained a nuanced understanding of the intricacies and challenges of climate policy by attending climate talks. Some were able to observe the complex negotiations in which nations hammered out the details of a common rulebook to implement the landmark 2015 Paris Agreement.

"The conference is an enlightening experience that comes with a sense of worldly connectedness and inspires nations to collectively work toward changes for the good of humankind," said Scripps PhD student Tashiana Osborne, a two-time attendee of the UN climate talks.

—

scripps.ucsd.edu/climatetalks

Scripps Partnership with Ensenada Research Institute Reignited

Scripps Oceanography and the Center for Scientific Research and Higher Education in Ensenada (CICESE) have worked together since the center's founding in 1973. Throughout the years the institutions have collaborated on a variety of topics including climate modeling, extreme weather forecasting, currents and waves, biological sampling, earthquake prediction, and more. This year, Scripps and CICESE reinstated a joint seminar series. The first symposium was held on May 3, 2019, in Ensenada, with five Scripps researchers and 12 students and postdocs presenting their research. A poster session and networking reception followed allowing for faculty and students to meet colleagues and discuss collaboration opportunities. The next seminar will be held at Scripps in the spring of 2020.

Workshop with University of Concepción held at Scripps

Twelve researchers from the University of Concepción (UdeC) in Chile visited Scripps for an inaugural joint workshop on October 9-11, 2019. More than 20 Scripps faculty and researchers were involved in the breakout sessions covering five broad themes: biology, chemical oceanography, food webs and ecosystem dynamics, ocean technology, and physical oceanography. Both institutions are looking forward to furthering promising areas of collaboration and joint projects, research cruises, student and faculty mobility and co-mentoring of students as a result of the workshop.

Workshop for Machine Learning and Artificial Intelligence in Biological Observations Organized by Scripps

This past May, POGO's Biological Observations Working Group, chaired by Margaret Leinen, organized the Machine Learning/Artificial Intelligence for Biological Observations Workshop in Oostende, Belgium. Forty-one people representing more than 18 countries attended. Participants were given a general overview of the workshop material, and then divided into three domain-specific groups—acoustics, genomics, or imaging—for hands-on practice. Eric Orenstein, a postdoctoral researcher at Scripps Oceanography, was the lead organizer.

French Biodiversity Event Held at Scripps Forum

In May, Scripps' Center for Marine Biodiversity and Conservation co-hosted a French Ameri-Can Climate Talk on Biodiversity in partnership with the French Embassy. Scripps professors Lisa Levin and Doug Bartlett participated in a panel discussion with Anne Larigaurderie of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Jean-François Silvain of the Foundation for Biodiversity Research in France. In the public event, the researchers discussed the dire global biodiversity assessment released by IPBES, and the need to create baseline knowledge of biodiversity with a particular focus on accounting for biodiversity in deep-sea ecosystems. The session was moderated by Scripps postdoctoral scholar Natalya Gallo.

CORPORATE ALLIANCE

Connecting Students to Careers

The Scripps Talent Recruitment Portal is a web resource for members of Scripps Corporate Alliance and collaborators to connect with Scripps students and postdoctoral fellows, facilitating access to the newest talent at Scripps and internship and career hiring.

Scripps Corporate Alliance is an annual membership program focused on supporting industry members' hiring on campus, connecting with Scripps research, and participating in unique programming. Now with 15 members spanning diverse industries such as cellular aquaculture, geographic information system mapping software, and oceanographic sensors, Scripps Corporate Alliance has supported member visits to campus including laboratory tours and meetings to facilitate collaborations, hosted technical presentations, and student networking events.

The Scripps Talent Recruitment Portal launched in the summer of 2018 as a resource for graduate students to connect with corporate affiliates. In that time, the portal has expanded to also feature recent alumni, postdoctoral fellows, and bachelor's students in their final degree year. The Talent Recruitment Portal has been a resource not only for our corporate affiliates but also for corporate sponsors of the Scripps Student Symposium and the U.S. Navy. In spring 2019, visitors from the Office of Naval Research interviewed students on campus for internship and career opportunities, extending six employment opportunities to Scripps graduate students.

scripps.ucsd.edu/talent

Innovation Highlights

Marizomib is now in Phase 3 clinical trials by Celgene/Bristol-Myers Squibb for the treatment of glioblastoma and other cancers. This compound, originally called Salinosporamide A, was discovered and studied by Scripps professors William Fenical, Paul Jensen, and colleagues before being licensed to industry.

Lenzing Group, a global natural fiber production company for the textile industry, joined the BEST Initiative supporting marine biologist Dimitri Deheyn's laboratory. Deheyn's lab is evaluating degradation of fibers in the ocean environment to understand how synthetic as well as natural fibers and microfibers break down, to inform more sustainable material options with improved biodegradability and less environmental impact.

New Wave Foods, co-founded by Dominique Barnes, MAS '14, successfully closed investment from Tyson Ventures in September. The San Francisco-based startup produces plant-based shellfish as a sustainable seafood alternative.

In 2018, the Triton Innovation Challenge campus business competition featured five teams from Scripps. Two of those teams advanced to the finals, including **Ocean Motion Technologies**, a startup focused on a wave energy module for buoys led by PhD student Jack Pan, who was awarded second place.

Scripps' Mark Merrifield helped organize the inaugural **OceanVisions2019 Climate Summit** in April along with leaders from Georgia Institute of Technology, Stanford University, Monterey Bay Aquarium Research Institute, Monterey Bay Aquarium, University of Georgia, and Georgia Aquarium. The conference focused on supporting innovations that solve ocean challenges.

DEVELOPMENT

Behind the Scenes at Scripps: Superfood Cuts Carbon Footprint

An exclusive event held this summer sponsored by E.W. Scripps Associates, a premier membership group of annual donors, offered a behind-the-scenes look at the lab of professor and marine ecologist Jennifer Smith, including the dazzling array of bubbling flasks filled with a promising algae.

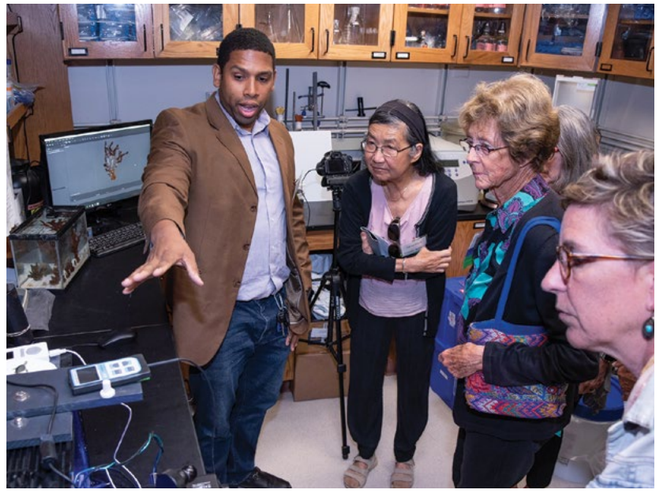
Smith has received funding from E.W. Scripps Associates in the past for her work in investigating the cultivation of edible seaweed in Southern California. Her most recent research involves a specific type of red seaweed, *Asparagopsis taxiformis*, that was found to produce a compound that could reduce bovine production of methane. Methane is a powerful greenhouse gas that is 30 times more potent than carbon dioxide.

Ongoing research led by agricultural scientists at UC Davis has found that adding just a small amount of *Asparagopsis* seaweed to cattle feed can dramatically reduce methane emissions from dairy cows by more than 50 percent. These preliminary results are promising, but little is known about whether it's possible to grow enough seaweed to meet the potential demands of the livestock industry.

Smith was interested in trying to grow *Asparagopsis* in the lab—something which has never been done before—and exploring cultivation of this red algae on a larger scale. She's now collaborating with the UC Davis team trying to find the "sweet spot" where the seaweed is growing at its highest rate while also increasing its concentration of the compound responsible for interfering with the enzymes that make methane in a cow's gut.

scripps.ucsd.edu/cowburps

Photo by Erik Jepsen



Photos by Bob Ross. Top: Members of the Smith Lab including (back, left to right) Clint Edwards, Daniel Conley, Gal Dishon, Brant Chlebowski, (front, left to right) Kelsey Miller, Marie Diaz, Adi Khen, Jennifer Smith, Sam Clements. Middle: Dale Steele. Bottom: Daniel Conley, Lanna Chang, Sue Randerson, Mary Ann Beyster.

Lisa Braun Glazer and Jeff Glazer Name Café and Terrace in New Marine Conservation and Technology Facility

Lisa Braun Glazer and Jeff Glazer made a $750,000 gift in 2018 to name the café and terrace of the new Marine Conservation and Technology Facility.

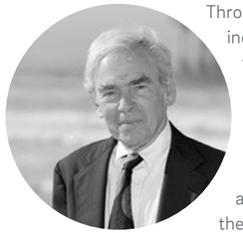
Café "Destiny" will be a communal space for both the campus and the community. A carefully designed space that blurs the line between indoors and out will leverage the building's immediate proximity to the very ecosystems that inspire both Scripps researchers and visitors. The café will be a space to stimulate ideas and bring together scientists, students, visiting global experts, and the local community. It will also offer sustainable seafood options prepared in the facility's demonstration kitchen, where students and researchers will learn about marine resource stewardship and food preparation from local chefs.

Through the naming of the café and terrace, Lisa and Jeff have made a substantial investment in Scripps. The Marine Conservation and Technology Facility will be a state-of-the-art space for collaboration from across campus and beyond, bringing together data scientists, engineers, conservation groups, marine biologists, policy makers, industry leaders, chefs, and more. This interdisciplinary approach to marine conservation research will help inform a world facing rapid and inevitable global change.

Construction is expected to begin in spring 2020.

Rendering of the Marine Conservation and Technology Facility provided by Safdie Rabines Architects

Frieman Endowment to Honor Legacy of Former Director



Throughout his long career in top-level leadership in government, industry, and academia, Edward A. Frieman was deeply dedicated to using science to make the world a better place. During his tenure as the eighth director of Scripps from 1986 to 1996, Frieman transformed the institution by broadening and strengthening its capacity in earth, ocean, and atmospheric science.

He expanded and diversified Scripps' external financial support and recruited premier scientists to join the faculty. He also enlarged the graduate program and facilitated greater integration with the intellectual strength of other opportunities at UC San Diego.

To honor his legacy, Scripps Oceanography, along with support from Frieman family members and friends, has established the Edward A. Frieman Endowment Suite to honor Ed Frieman's outstanding contributions as a renowned figure in American science and his commitment to climate sustainability.

The endowment includes a chair to support a professor of climate science and sustainability and fellowships for a postdoctoral scholar and a graduate student. These three components constitute an enduring and powerful combination to further the important pursuit of climate sustainability. With a nearly completed goal of raising $5 million to fully fund the endowments, these positions have the potential for path-forging research with far-reaching impact, at various levels and for years to come, enabling Frieman's voice and legacy to continue to address the greatest challenge for our planet.

The endowed graduate fellowship and endowed chair have been fully funded, with Scripps renowned atmospheric scientist Veerabhadran Ramanathan named the inaugural recipient of the Edward A. Frieman Endowed Chair in Climate Sustainability.

The Edward A. Frieman Endowed Postdoctoral Fellowship is on its way to complete funding and will ideally be completed in 2020.

Donor Highlight: R/V *Bob and Betty Beyster* Commissioning

Scripps Oceanography welcomed the arrival of the research vessel *Bob and Betty Beyster* at its official commissioning in April 2019 at the Nimitz Marine Facility in Point Loma. The vessel is now part of the Scripps fleet thanks to a philanthropic initiative that raised more than $1.2 million in honor of the late Dr. J. Robert Beyster, founder of Science Applications International Corporation (SAIC), and his widow, Betty Beyster. The philanthropic effort was led by Cindy Glancy, Mary Ann Beyster, Jim Beyster, Tom Dillon, and Mindy Pawinski. Donors included committee members and their spouses, friends and family members, former SAIC associates, Leidos Holdings, and other Director's Council members. Read more about how the new vessel is being used for ocean science education and technology development on Page 18.

Beyster commissioning photo by Erik Jepsen. Jim Beyster, Mary Ann Beyster, Lan and Mark Beyster pictured.

Reef-Like Garden Encourages a Deeper Look

A coral-reef inspired succulent garden has taken root in front of the Eckart Building along the Scripps Coastal Meander Trail. The garden parallels Scripps Oceanography's coral reef research by matching drought-resistant succulent species to their coral zone lookalikes.

Alumni Brant Chlebowski and Nina Rosen, both MAS '17, spearheaded the project in hopes that the garden would educate individuals passing through campus on the conditions of coral reef ecosystems and inspire them to take an active role in combating climate change. Cammie Ingram, director of capital planning and space planning at Scripps, provided guidance for building the garden's foundational architecture, and Clinton Edwards, a PhD student studying coral reef ecology, informed the garden's ecological accuracy to build succulent reefs that mimic what is found in the world's oceans. In April 2019, Christa McReynolds, a neighbor and Scripps supporter, established an endowed student prize dedicated to supporting graduate students studying coral reef ecology.

The coral reef garden is officially celebrated as the "McReynolds Family Coral Reef Garden" in gratitude to the generous donations from the McReynolds family.

scripps.ucsd.edu/coralgarden

Photos by Krissen Kawachi. Nina Rosen, Brant Chlebowski, Christa McReynolds, and Ingrid McReynolds pictured.

Thank you to our donors!

Individuals

$1,000,000+

Anonymous

Nancy E. Cooley and Stuart Goode

Dorothy R.* and Edward J. McCrink*

Kathy and William H. Scripps

$500,000+

Lisa Braun Glazer and Jeffrey Glazer

Allie E.* and Olaf H. Tegner*

$100,000+

Anonymous*

Jennifer and Gregory Alexander

Lynne and Marc Benioff

James Beyster

Mary Ann Beyster

Ellen Lehman, PhD and Charles Kennel, PhD

Christa McReynolds

Leslie and John McQuown

Thomas Page

Robert Rex, PhD '58

Heidy Ryder*

Patricia and William Todd

Mary White

$50,000+

Ronald Campnell '98

Curtis Eakin

Margaret Engel and David Engel, PhD

John Garty

MaeAnn Garty*

Audrey Geisel*

Chrysa Mineo and Mark Stephenson

Caroline Nierenberg and Nicolas Nierenberg '78

Susan and David Rockefeller Jr.

Linda and Stephen Strachan

Randal Vosti

$25,000+

Bev Grant and Art Cooley

Geraldine Cramer

Phyllis and Daniel Epstein

Cindy Glancy '77 and John Glancy Sr.

Kathy Hagan and William Hagan, PhD '86

Linda and James Hervey*

Catherine and Matthew Hervey

Joan Jacobs and Irwin Jacobs, DSc

Susan Chance and Igor Korneitchouk, PhD '87

Jean Scripps

Mary Yang, PhD

Foundations

$1,000,000+

The Gordon & Betty Moore Foundation

The Heising-Simons Foundation

$500,000+

G. Unger Vetlesen Foundation

$250,000+

Cecil H. and Ida M. Green Foundation for Earth Sciences

David C. Copley Foundation

Walton Family Foundation, Inc.

$100,000+

Alan G Lehman and Jane A Lehman Foundation

The BAWD Foundation

The David and Lucille Packard Foundation

Elm Innovations

International Human Frontier Science Program

The Wyss Foundation

$50,000+

American Association for the Advancement of Science

Benioff Ocean Initiative

Catena Foundation

Donald C. and Elizabeth M. Dickinson Foundation

Gail A. Fliesbach Foundation

Gibbet Hill Foundation

The J.M. Kaplan Fund

The Mary Gard Jameson Foundation

National Academies Keck Futures Initiative

Price Philanthropies Foundation

The Schmidt Family Foundation

The Stephen and Mary Birch Foundation

Wilsdorf Mettler Future Foundation

$25,000+

Alfred P. Sloan Foundation

Charles H. Stout Foundation

Cipra Living Trust

Edna Bailey Sussman Foundation

Eppley Foundation for Research

Richard Grand Foundation

WWW Foundation

Corporations

$100,000+

Acacia Partners, LP

American Chemical Society, Inc.

BP Technology Ventures Inc.

Lenzing AG

SDG&E

$50,000+

Global Ocean Design

The Nature Conservancy

$25,000+

BMNT, Inc.

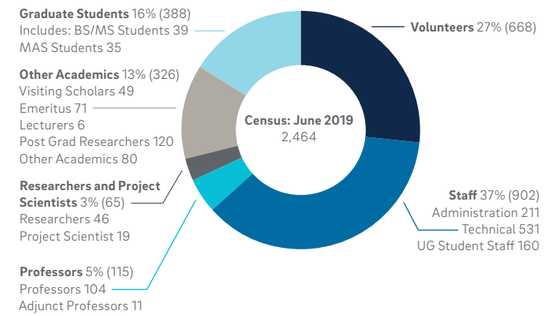
*Indicates the donor is deceased

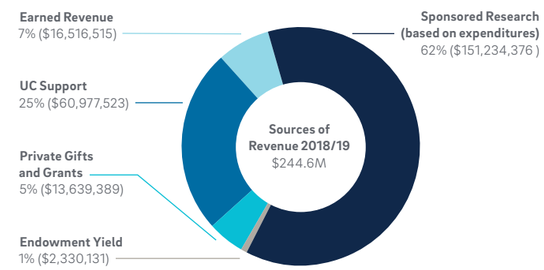
Photo by Erik Jepsen/UC San Diego

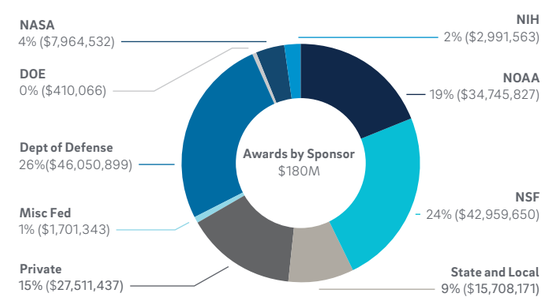
STATEMENT OF ACTIVITY

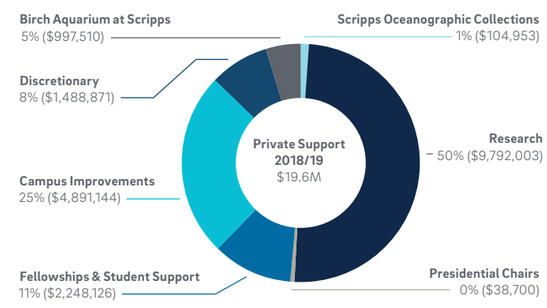
	(expensed this period) FY 17/18	(expensed this period) FY 18/19	Awarded this period FY 18/19
REVENUE			
SPONSORED RESEARCH	**116,850,412**	**151,234,376**	**180,043,488**
Federal Government	106,906,547	138,770,792	136,823,881
National Science Foundation	36,478,158	45,829,540	42,959,650
Department of the Navy	25,284,064	43,883,302	34,089,965
National Aeronautics and Space Administration	7,578,974	10,412,233	7,964,532
National Oceanic and Atmospheric Administration	22,676,798	22,737,666	34,745,827
Department of Energy	1,528,833	1,518,978	410,066
Other Department of Defense Agencies	9,760,744	10,774,291	11,960,934
Other Federal Departments	1,384,845	1,236,156	1,701,343
National Institutes of Health	2,214,131	2,378,625	2,991,563
State Government	5,225,279	6,232,383	15,131,562
Local Government	1,041,686	1,388,303	570,609
Private Contracts	3,573,152	4,867,737	27,511,437
UC Sponsored Research	103,748	(24,839)	6,000
UNIVERSITY OF CALIFORNIA SUPPORT	**54,172,875**	**60,977,523**	
EARNED REVENUE	**15,380,609**	**16,516,515**	
Birch Aquarium at Scripps (BAS)	6,836,130	7,423,527	
Recharge Unit Revenues	7,606,095	8,005,071	
Intellectual Property and Royalty Income	65,866	43,555	
Other Revenue	872,518	1,044,362	
PRIVATE GIVING	**12,892,995**	**13,639,389**	
Birch Aquarium at Scripps (BAS)	1,755,738	1,601,090	
Private Gifts	8,993,470	7,865,043	
Private Grants[1]	2,143,787	4,173,256	
INTEREST INCOME	**2,135,768**	**2,330,131**	
Interest Earned	0	0	
Endowment Yield	2,135,768	2,330,131	
TOTAL REVENUE	**201,432,659**	**244,697,935**	
EXPENSE			
RESEARCH PROGRAMS—SEEK	**(162,353,456)**	**(179,955,842)**	
Sponsored Research	(128,907,831)	(135,559,638)	
Ships	(29,137,194)	(39,737,259)	
Oceanographic Collections	(341,770)	(323,942)	
Contract & Grant Administration	(1,076,814)	(1,120,686)	
Research Development & Planning	(862,735)	(893,631)	
Research Infrastructure & EH&S	(703,509)	(794,896)	
OP Tax on Research Expenditures	(1,323,603)	(1,525,789)	
INSTRUCTION PROGRAMS -TEACH	**(24,412,002)**	**(27,077,783)**	
OUTREACH -COMMUNICATE	**(12,042,790)**	**(12,391,194)**	
Birch Aquarium at Scripps (BAS)	(9,095,575)	(9,359,577)	
Business Development	(119,032)	(54,918)	
Communications (Scripps share) & Web Group	(1,150,694)	(1,215,501)	
Development (Scripps share)	(392,363)	(476,069)	
Diversity	(169,091)	(141,457)	
Special Events (including lectures, awards, conferences)	(314,293)	(340,806)	
Conference Facilities (Forum debt service, staff, maintenance)	(801,741)	(802,867)	
INSTITUTIONAL SUPPORT	**(8,718,866)**	**(8,020,489)**	
Scripps Administration	(3,150,441)	(3,141,555)	
IT Services	(1,632,029)	(1,836,904)	
Facilites Maintenance & Capital Improvements[2]	(3,597,397)	(2,802,030)	
OP Tax on non-core Expenditures	(339,000)	(240,000)	
TOTAL EXPENSES[3]	**(207,527,114)**	**(227,445,307)**	
Annual Balance/(Deficit) from Current Activities	**(6,094,455)**	**17,252,627**	

1. Private grants are typically restricted funds and considered Sponsored Research. However, UC San Diego counts them as Private Giving.
2. Does not include funds transferred to UC San Diego Facilities Design and Construction or Facilities Management and spent by those units on Scripps projects which causes variability in the year-to-year totals. Fiscal year 18-19 total facility/capital improvement expenses paid by Scripps were approximately $6.7M.
3. This statement does not reflect all annual expenditures associated with operating Scripps. Services provided by campus departments are captured in UC San Diego financial reports, e.g. utilities, custodians, central administrative services such as payroll, purchasing, transportation, deferred maintenance costs, etc.









SPONSORED RESEARCH

FEDERAL

Department of Agriculture

- U.S. Forest Service

Department of Commerce

- National Oceanic and Atmospheric Administration

Department of Defense

- Air Force, Office of Scientific Research
- Army, Corps of Engineers
- Defense Advanced Research Projects Agency
- Defense Threat Reduction Agency
- Navy
  - Naval Air Systems Command
  - Naval Facilities Engineering Command
  - Naval Post Graduate School
  - Naval Research Laboratory
  - Naval Sea Systems Command
  - Office of Naval Research
  - Pacific Fleet Commander
  - Space and Naval Warfare Systems Command
- Strategic Environmental Research Development Program

Department of Energy

Department of Health and Human Services

- National Institute of Allergy and Infectious Diseases
- National Institute of Environmental Health Sciences
- National Institute of General Medicine Science
- National Institutes of Health, Clinical Center

Department of Interior

- Bureau of Ocean Energy Management
- Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Environmental Protection Agency

National Aeronautics and Space Administration

National Science Foundation

STATE OF CALIFORNIA

- Coastal Commission
- Delta Stewardship Council
- Department of Fish and Wildlife
- Department of Parks and Recreation
- Department of Water Resources
- Environmental Protection Agency
- Natural Resources Agency
- Ocean Protection Council
- Office of Environmental Health Hazard Assessment
- San Francisco Bay Conservation and Development Commission
- State Coastal Conservancy
- State Lands Commission
- State Water Resources Control Board

REGIONAL GOVERNMENT

- City of San Diego
- County of San Diego
- Orange County Water District
- San Diego Unified Port District
- Sonoma Water
- Yuba Water Agency

INTERNATIONAL

- Australian Museum
- European Union/ European Commission
- Japan Aerospace Exploration Agency
- United Nations Food and Agriculture Organization
- U.S.-Israel Binational Science Foundation

OTHER

- BP Technology Ventures Inc.
- Chevron Corporation
- Earth Networks, Inc.
- Gulf of Mexico Research Initiative
- International Association of Oil & Gas Producers
- Lawrence Livermore National Security, LLC
- Magiq Technologies Inc.
- Mitre Corporation
- Ocean Floor Geophysics, Inc.
- Pacific Gas and Electric Company
- Petrobras S.A
- Royal Dutch Shell PLC
- San Diego Gas and Electric Company
- Southern California Edison Company

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