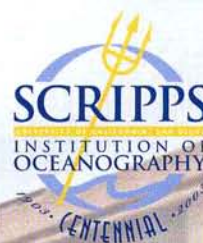


THE LEGACY

CONTINUES
IN A
NEW CENTURY

After nearly a century of investigations off the La Jolla coast, Scripps students, such as Jenna Munson, continue to sample and study marine life.



In 2003, Scripps Institution of Oceanography is celebrating its first century of oceanographic exploration, research, and discovery. This feature is the final in a series of articles that presents special features about the history of Scripps Institution and the science, people, ideas, and technology that have played major roles in its century of leadership.

BY JANET E. HOWARD

WHEN SCRIPPS INSTITUTION OF OCEANOGRAPHY'S founders established a small research station in La Jolla, they created a place where scientists and students could study marine organisms up close along the coast of southern California.

Today, Scripps has a century of accomplishments to celebrate, having stretched the geographical and disciplinary boundaries of its science and made significant contributions to the San Diego region, the state, nation, and world. Yet its scientists and leaders are also preparing the institution for what lies ahead.

They recognize that Scripps must be poised for change in a continually changing world, that its research must be integrated and concerned with sustainability, and that there's much more to learn about the oceans and the earth.

Communicating this new knowledge will mean fostering interaction among many disciplines within the physical, biological, and social sciences. And despite temporary stumbling blocks like budget shortfalls, Scripps is striving to uphold its legacy by educating outstanding graduate students and supporting its world-renowned scientists.

"We see the centennial as a launching point for scientific advances and contributions throughout the next century," said Charles F. Kennel, director of Scripps.

PRESERVING THE PLANET

There are many challenges ahead for Scripps scientists in all disciplines, as a growing world population has begun to test Earth's environmental sustainability.

"It is clear that the planet is approaching some fundamental environmental limits," Kennel said. "We know that 70 percent of the world's fisheries are threatened or are in decline. We know that stocks of California rockfish have declined to less than 10 percent of what they were 50 years ago. We know that the fishing industry is no longer able to economically fish cod on the Grand Banks of Newfoundland, once the world's richest fishery. We know that we have lost 25 percent of the world's bird species in the last millennium and that the vast majority of rivers in the United States have been diverted for human use."



As part of its effort to address the crisis facing the world's marine ecosystems, Scripps formed the Center for Marine Biodiversity and Conservation and recruited Nancy Knowlton, a marine biologist widely recognized for her studies of marine diversity, to serve as its director.

Knowlton believes that in the twenty-first century, scientists will need to confront how humans can continue to interact with the ocean in a sustainable way. The evidence of the negative impact of human interaction with the oceans is now overwhelming.

"We have whole ecosystems suffering catastrophic mortality events. Coral reefs are a good example of this phenomenon, because a combination of disease, global warming, and overfishing has resulted in some coral ecosystems dropping from about 50 percent living coral to five percent living coral over the last several decades."

Equally threatening to the planet's well-being is global climate change, a threat many agree was first identified by Charles D. Keeling at Scripps. As a young scientist in the late 1950s, Keeling was the first to discover that concentrations of atmospheric carbon dioxide, a so-called



Left, Biologist Nancy Knowlton finds evidence of catastrophic ecosystem collapse in reef communities. **Above,** Freshwater resources in the Sierras are monitored by Scripps scientists.

greenhouse gas, were on the rise. Scientists, including Scripps Director Roger Revelle, soon recognized that this phenomenon would cause the planet to warm.

In 2002, President George W. Bush awarded Keeling the National Medal of Science, the nation's highest award for lifetime achievement in scientific research, to honor his pioneering studies on the carbon cycle and climate change.

"Global warming is the most enveloping global environmental threat of them all," Kennel said. "Every single person on Earth is already being affected by it, and will continue to be."

One critical effect of global warming being monitored by Scripps scientists is the alarming rate of disappearance of temperate and, especially, equatorial glaciers. Scripps geophysicist Bernard Minster and his students are part of a science team that has worked for more than a decade to design the Geoscience Laser Altimeter System (GLAS). In January, GLAS was launched with the satellite ICESat (Ice, Cloud, and Land Elevation Satellite) to begin collecting detailed data about changes in the Greenland and Antarctica ice sheets, as well as other climate and topography data.

Californians may also be affected by rising temperatures through the impact that warmer weather will have on the snowpack in the 400-



Chemist Charles D. Keeling receives the National Medal of Science from President George W. Bush.

mile-long Sierra Nevada mountain range, the state's largest single source of water.

"The state of California has become aware of the possibility that we could lose half of our snowpack by the end of this current century," noted Daniel Cayan, director of the Scripps Climate Research Division. "That doesn't mean we are going to lose water, it means that our water supply is going to be of a different form and it is going to be more challenging to manage."

Currently, snowpack levels in the Sierras reach their maximum at the beginning of April. The snow then begins to melt gradually as temperatures warm, thus providing a water supply for the spring and summer months.

"In a warmer climate, there is less snow and more rain," explained Richard Somerville, a



Scripps Director Charles F. Kennel often represents Scripps in Washington, DC.

meteorologist at Scripps whose research focuses on improving global climate models. "So the very elaborate, costly infrastructure—the reservoirs, dams, and pipes—we have in this state to get the snowpack in the Sierras in the winter down to Los Angeles and San Diego in the summer may be far from optimal or adequate for the new climate regime."

OCEANOGRAPHY IN THE TWENTY-FIRST CENTURY

To undertake such broad challenges as determining how the climate may change or how to stabilize plummeting fish stocks, Scripps scientists will have to learn even more about the ocean itself.



"THE GROWTH OF SCRIPPS INSTITUTION OF OCEANOGRAPHY OVER

THE LAST CENTURY HAS PARALLELED THE STRIDES MADE BY THE CITY OF SAN DIEGO. AN EXTRAORDINARY PLACE OF STUDY, SCRIPPS HAS BLOSSOMED FROM A TINY LABORATORY TO ONE OF THE WORLD'S MOST IMPORTANT OCEANOGRAPHIC INSTITUTIONS. OUR CITY, WHICH ALSO HAS RISEN TO WORLDWIDE PROMINENCE, BENEFITS TREMENDOUSLY FROM THE TALENTED PEOPLE SCRIPPS DRAWS HERE, THE PRESTIGE IT LENDS TO OUR COMMUNITY, AND THE MANY LEARNING OPPORTUNITIES THE INSTITUTION OFFERS OUR CITIZENS."

—SAN DIEGO MAYOR DICK MURPHY

The development of satellite technology, like that used on ICESat, has revolutionized the ability of oceanographers to study large expanses of ocean rather than relying exclusively on shipboard observations. However, neither this technology nor meaningful computer models can replace exploration at sea. According to renowned physicist Walter Munk, who has been at Scripps since 1939, ship-based measurements are the

only way to give oceanographers a "realistic picture of what the ocean is like."

Whether tomorrow's oceanographers rely more on seagoing expeditions or technology, Scripps's leaders almost universally agree on one point: The secret to success in the next century will lie in the institution's ability to become more interdisciplinary in its approach.

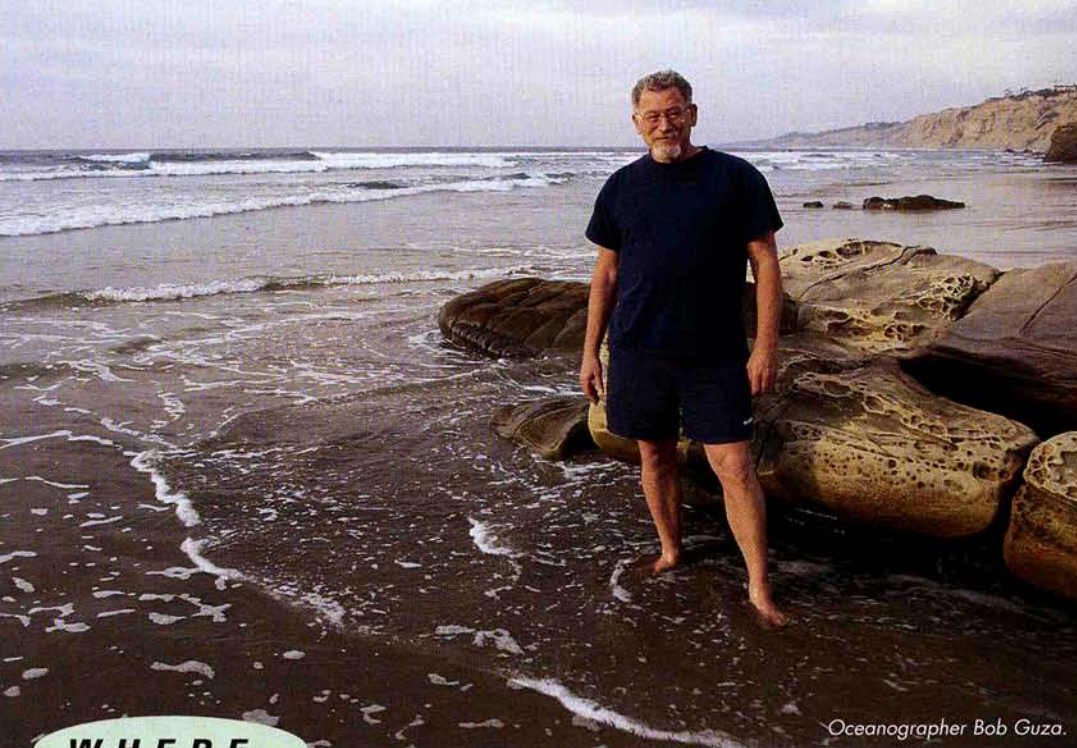


Above, Physicist Walter Munk (left) with Deputy Director of Scripps John A. Orcutt.

"It is no longer enough to just study geology or marine biology or atmospheric science," said Lisa Shaffer, Scripps director of international relations. "To understand how the pieces fit together, you need to make the connections between the different earth systems."

In addition to blurring the boundaries between the disciplines within ocean and earth sciences, Scripps researchers are increasingly working with economists, social scientists, and public policy makers to ensure that their scientific research benefits society as a whole.

Shaffer recently organized a new course called Marine Science Law and Policy for students at Scripps, the political science and economic departments at UCSD,



Oceanographer Bob Guza.

WHERE

HAS ALL THE SAND GONE?


FROM APRIL THROUGH September 2001, 2.1 million cubic yards of sand were pumped onto 12 San Diego-area beaches to replenish sand lost to erosion. San Diego Association of Governments officials spent \$17.5 million on the project, which made headlines and caused controversy in the region.

Now, Scripps scientists Bob Guza, Richard Seymour, and Bill O'Reilly are trying to find out how long the deposited sand remained on the beaches and where it has ended up, nearly two years later. A team of Scripps engineers and technicians participating in the project has been using a jet ski and an all-terrain vehicle (ATV), both equipped with Global Positioning Satellite (GPS) equipment, to take monthly measurements of sand on Torrey Pines State Beach.

"The GPS on the jet ski allows us to know exactly where we are offshore," said Guza. "Then we measure the distance from the jet ski to the seafloor using a depth finder. That tells us how the sand level is changing."

The scientists track the movement of sand on the beach by using the same basic method, only with an ATV.

Results of the research, which is sponsored by the California Department of Boating and Waterways, indicate that the sand dumped on Torrey Pines beach was at least a partial success.

"The sand at Torrey Pines beach stayed for the whole summer and provided a nice, wide recreational beach," Guza said. "Around Thanksgiving, there was a large storm and the sand was rapidly eroded away from above the water line. We found some of that sand was in a sandbar not too far offshore, and it appears that some of it has come back." 

and the University of San Diego School of Law. In fall 2002, it drew 25 graduate students from the involved disciplines.

Somerville said such courses are exactly the type of cross-disciplinary experience that Scripps students are now demanding. To accommodate this crossover, in the late 1990s Scripps established a new curricular group in climate sciences that allows students to enroll in broader coursework.

"We are getting a lot of graduate students who say that they could see themselves in a non-traditional science career after they get their Ph.D. at Scripps," Somerville said. "They are interested in getting policy, economics, or political science expertise and may have a career in the private sector or the State Department or on a congressional staff."

THE STATE OF THINGS

The heightened focus on interdisciplinary research and education has many Scripps scientists predicting that the institution will become more closely tied to the larger university—which it helped establish—a prediction made all the more likely by a state budget crisis that began in 2002.

"It is kind of odd that we find our centennial year to be probably the most difficult year of our history, with the cuts to the budget that are coming close to the heart of the institution and removing support for many programs that we simply cannot afford to walk away from," said John A. Orcutt, deputy director of Scripps and associate vice chancellor for marine sciences.

Chief among those programs is the California Cooperative



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RIGHT HERE IN SAN DIEGO. THIS IS THE
PLACE WHERE PEOPLE ALL OVER THE
WORLD ARE LOOKING FOR ANSWERS,
STUDIES THAT TELL US WHAT WE
MIGHT DO ABOUT OUR ENVIRONMENTAL
CRISIS. IN THAT SENSE, I CAN'T THINK
OF A MORE IMPORTANT PLACE IN THE
WORLD THAN SAN DIEGO AND
SCRIPPS INSTITUTION.”

—FORMER CBS NEWS ANCHOR
WALTER CRONKITE

Oceanic Fisheries Investigations (CalCOFI). Established in response to the 1949 collapse of the state's sardine fishery, CalCOFI is a monitoring program that takes seasonal measurements along a gridwork of locations off the California coast using nets, sensors, and other instruments. It represents the longest scientific time series of the oceans ever undertaken.

“CalCOFI provides us with data that stretch back for many, many years, so we've got a good baseline in California against which to judge the changes that we will observe in the future,” Orcutt said. “We can't possibly afford to see that disappear even though the state support for it has been essentially removed.”

The funding cutbacks will also affect support for the Scripps Oceanographic Collections, which includes an extensive assortment of marine specimens as well as geological cores drilled from the ocean floor. Some members of the Scripps staff have already been laid off.

Kenel said the budget crisis knocked the wind out of the institution just as it was enthusiastically recruiting new, young faculty and welcoming one of its largest classes of graduate students ever. Despite these obstacles, he believes the institution will eventually flourish again by relying on the character of its people and by ensuring it stays true to its core mission.

HOPE FOR TOMORROW

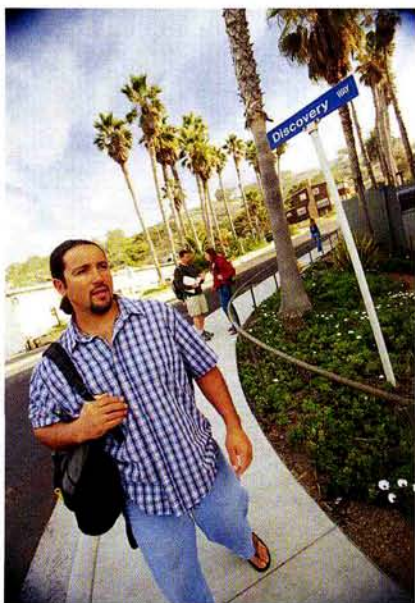
One way Scripps plans to improve its financial outlook is by becoming more active in undergraduate education. While Scripps's state funding has



“THIS CENTENNIAL YEAR IS A TIME TO REFLECT ON HOW MUCH UCSD, SAN DIEGO, AND THE WORLD OWE TO SCRIPPS INSTITUTION OF OCEANOGRAPHY. SCRIPPS LEADERS HELPED FOUND THIS GREAT RESEARCH UNIVERSITY, AND THEY LAID THE FOUNDATION FOR A HIGH-TECH AND BIOTECH HUB IN SAN DIEGO THAT GREW INTO A REGIONAL ECONOMIC POWERHOUSE. SCRIPPS SCIENTISTS HAVE SHAPED OCEAN AND ENVIRONMENTAL SCIENCES THROUGH STUDIES THAT HAVE HAD A PROFOUND GLOBAL IMPACT. I SALUTE SCRIPPS’S ACCOMPLISHMENTS AND THE VITAL FUTURE ROLE IT WILL PLAY IN PROTECTING OUR BELOVED PLANET.”

—UCSD CHANCELLOR ROBERT DYNES

plummeted over the past few years, funding for UCSD has actually increased to help cover the cost of a steep rise in its undergraduate enrollment—an increase that is anticipated to continue over the next decade. Helping to educate more of those incoming undergraduates would likely guarantee Scripps additional state funding.



Graduate student Chugey Sepulveda.

“The University of California has an enormous problem in trying to accommodate all of the new undergraduates that are coming in every year,” Orcutt said. “We can’t afford to ignore the university’s problem of an expanding undergraduate community and at the same time expect them to be serious about our problem of decreasing state funds.”

ON THE TRAIL OF A MOSQUITO


ST. LOUIS ENCEPHALITIS is the most common variety of viral encephalitis in the United States. The virus, which can be fatal, is harbored in birds and then transmitted to humans by the blood-feeding females of a mosquito species known as *Culex tarsalis*.

Mosquitoes are conditioned by naturally occurring climate patterns—water, for example, is a necessary component of their life cycle, and the rate at which they reproduce is regulated by temperature. Researchers studying St. Louis encephalitis are concerned that climate fluctuations such as El Niño could cause mosquito populations to grow in the future, increasing the threat posed by the disease.

Scripps scientists Daniel Cayan, Michael Dettinger, and Mary Tyree have teamed with researchers from UC Davis to estimate the potential for outbreaks of the disease using forecasted moisture and temperature data one season to one year in advance.

“We are trying to build an alert system that will consider climate conditions and mosquito-district surveillance measures along with actual cases of encephalitis if they occur. Then we’ll feed these data back to the mosquito-control agencies so they can mitigate the danger,” Cayan said.

The researchers are conducting similar studies on the western equine encephalomyelitis virus, which affects horses. While no vaccine is available to protect humans from St. Louis encephalitis, horses can be vaccinated for western equine encephalitis.

“We are also looking around the corner toward the possibility of West Nile virus moving into the West,” Cayan said. About 2,800 cases of West Nile virus have been reported in the United States to date, resulting in nearly 150 deaths. Like the encephalitis viruses, West Nile virus is harbored in bird populations and spread by female mosquitoes. 

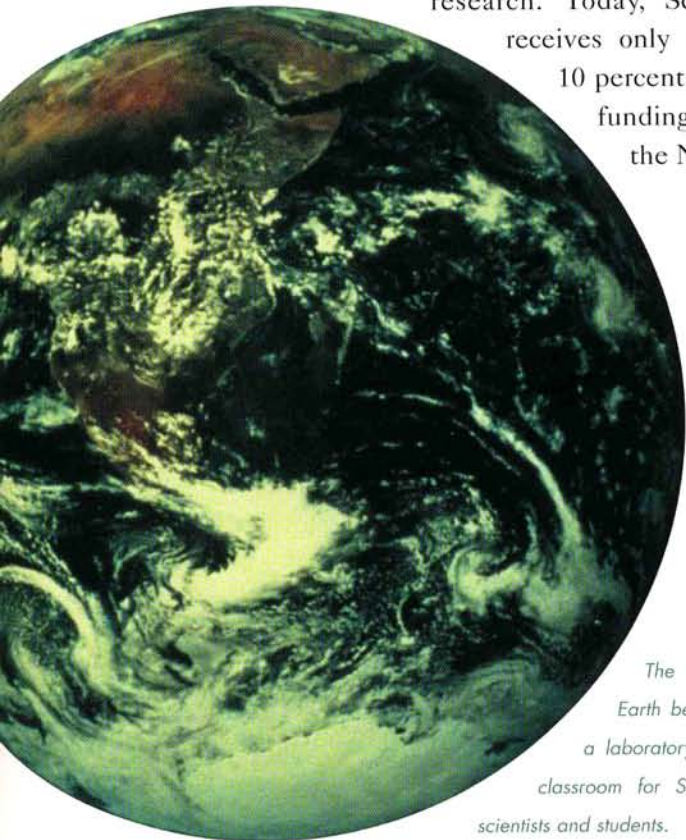
Kennel said Scripps is considering offering new courses and perhaps even new majors to undergraduates over the next several years.

“Although planning is still under way, I believe that cooperative programs with UCSD to train both graduates and undergraduates will help distinguish Scripps’s future,” he said.

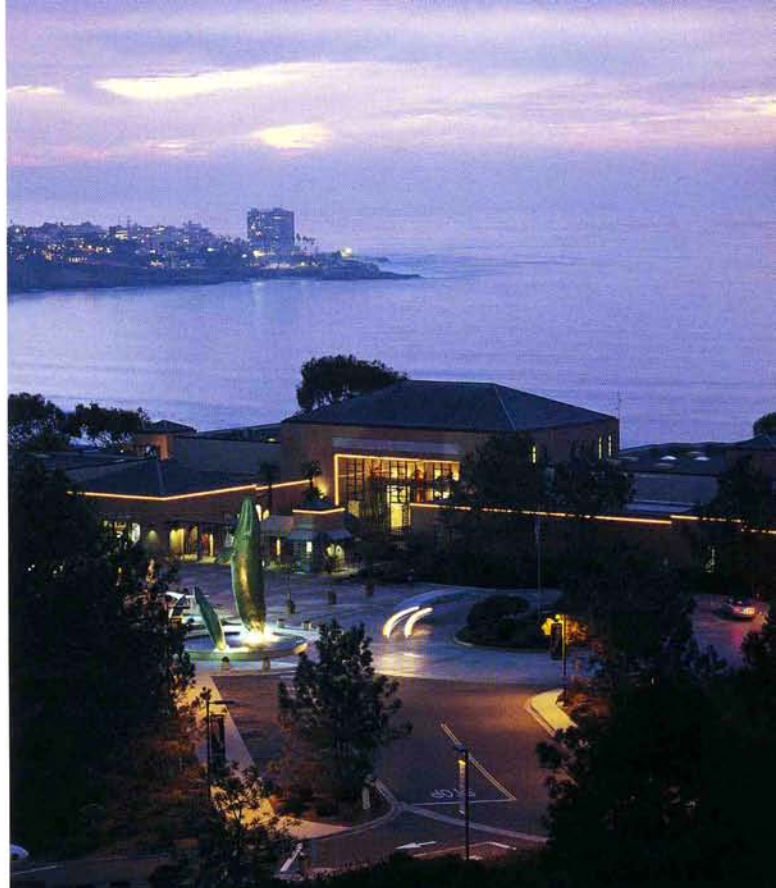
At the same time that Scripps has faced eroding support from the state of California, its historically robust relationship with the U.S. Navy—which began during World War II, when many of the institution’s researchers contributed to the war effort—has also begun to wane.

“Scripps changed drastically during the war and immediately thereafter,” Orcutt said. “Before the war, we had these relatively small sailboats used as scientific vessels that were restricted to the coast. By the time the war was over, we had substantial ships that were capable of going to any sea on the planet. All thanks to the Navy.”

The institution’s relationship with the Navy remained strong throughout the Cold War, but as the threat from the Soviet Union diminished, so did the Navy’s investment in oceanographic research. Today, Scripps receives only about 10 percent of its funding from the Navy.



The entire Earth became a laboratory and classroom for Scripps scientists and students.




BIRCH AQUARIUM AT SCRIPPS

THE BIRCH AQUARIUM AT SCRIPPS is a state-of-the-art aquarium–museum facility overlooking the Pacific Ocean and Scripps Institution of Oceanography. Each year, more than 350,000 visitors wander the Hall of Fishes, where a diverse display of marine ecosystems—including the northwest coast of the Pacific Ocean, the lagoons of the Gulf of California, and tropical seas—are highlighted in 33 separate tanks.

The museum at Birch Aquarium is one of largest oceanographic museums in the world, serving as an interpretive center for Scripps research. In the Scripps Hall of Oceanography, adults and children explore the blue planet as they discover the tools and techniques of ocean science, access daily satellite information, view real-time earthquake data, or discover the properties of water and how waves form.

As Scripps research continues in a second century of research, Birch Aquarium will continue to communicate these exciting discoveries in the form of dynamic, interactive exhibits at both the museum and the aquarium.

For information on exhibits, education programs, and activities, visit aquarium.ucsd.edu or call 858/534-FISH. 

WARNING: AN EARTHQUAKE WILL STRIKE IN SECONDS

NEW WIRELESS TECHNOLOGY that Scripps has developed in conjunction with the California Institute for Telecommunications and Information Technology may soon be able to issue alerts of impending earthquake vibrations before they arrive.

Yehuda Bock (below), director of the California Spatial Reference Center (CSRC), headquartered at Scripps, along with scientists at NASA's Jet Propulsion Laboratory and the U.S. Geological Survey, have spent the last decade building a network of 260 Global Positioning Satellite (GPS) tracking stations across southern California to measure tectonic motion.

"The transfer of data over the wireless system is faster than the travel time of the waves through the earth's crust," Bock said. "So, you can get a warning of a few seconds depending on how far you are from where the earthquake is centered."

Seconds may not sound like very long, but when it comes to large earthquakes, it can mean the difference between catastrophe and survival.

"There is a lot you can do in that kind of time span," said John Orcutt, Scripps deputy director of scientific affairs. "People can get out of bed and stand in doorways if they know there is a problem, and you can stop trains, close valves on pipelines, and take a variety of other protective measures."

The CSRC team also has installed GPS detectors on the tops of dams to monitor changes in their integrity due to ground movements, and there are plans to work with researchers at UC Irvine to develop "smart cars" armed with automatic navigation and collision avoidance systems. Bock also foresees the potential for emergency personnel to make use of precision GPS devices for a variety of public safety applications. 🌐



CSRC Director Yehuda Bock.

Around the campus, graduate students discuss and discover the interrelations between marine organisms and their surrounding environment.



Some areas of research funding remain strong, with the National Science Foundation and the National Oceanic and Atmospheric


Administration supplying nearly 30 percent of Scripps's total annual budget. However, these funds, which are for specific research projects, rely on frequent and time-consuming cycles of proposals and contracts, and are subject to political change and overall federal budget reductions.

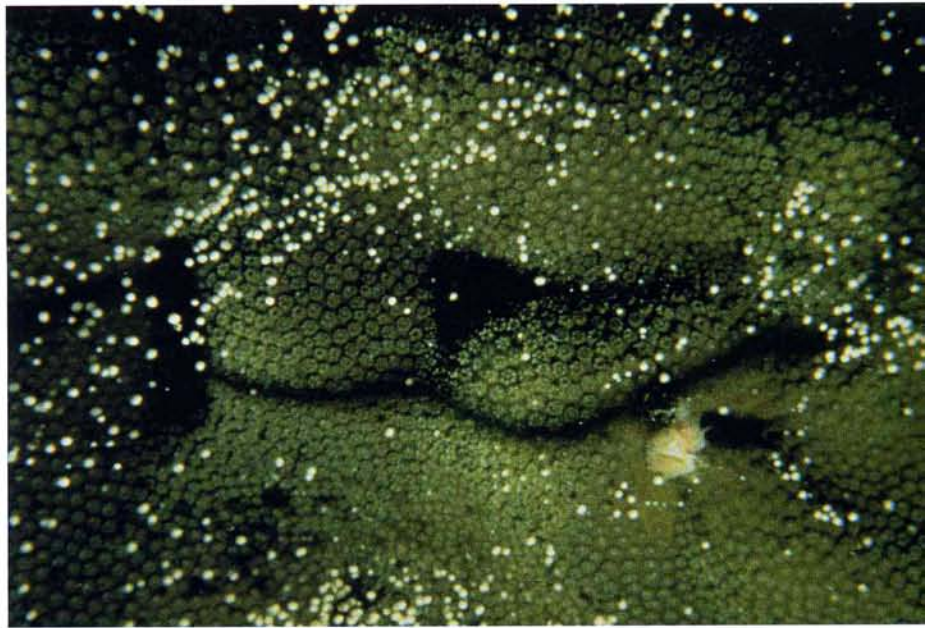
Instead of hoping for a reversal in declining funds from the Navy or the state of California, the institution must look for new sources of income, particularly from private contributors. To help accomplish this, the institution has increased the size of its Development Office staff and recruited faculty and others to assist in fund-raising efforts.

"The next few years are going to be a struggle to find new directions for the programs that have been affected, and the institution may be vastly different five years from now," Orcutt said.

Kennel said that communicating the results of scientific research to policy makers and the public will be a crucial role for Scripps over the coming century, because the global issues that Scripps science addresses affect everyone on Earth.

"It has long been my view that institutions prosper when they do

not shirk their responsibility to the most fundamental issues in their area of concern," Kennel said. "So, at the end of the twentieth century, Scripps has directly positioned itself to bring the clarity of science into the public discussion. If we succeed, then Scripps will have realized the next challenge in its long history—and people will celebrate that fact on its bicentennial." 



TRACKING A CORAL KILLER



CORAL REEFS ARE among the numerous ecosystems around the world threatened by a host of stresses: fluctuations in ocean temperature, changes in sea level, excess nutrients, and toxic pollutants. Scientists at the Center for Marine Biodiversity and Conservation at Scripps (CMBC) are studying how normally benign bacteria may become coral killers when subjected to these stresses.

"The idea is that some diseases might not be caused so much by a specific disease—a pathogen that always causes disease—but by the loss of equilibrium among members of bacterial communities under stress," said Nancy Knowlton, director of CMBC.

In cooperation with CMBC scientists, Scripps graduate student Davey Kline is studying threatened coral reefs in Panama. Small tufts from coral colonies are taken to a lab where they are exposed to precise, premeasured stresses, such as increased water temperature, high nutrient levels, and pollutants. Kline then watches for the onset of disease and compares it to coral subjected to the same stresses that has been treated with antibiotics.

"If the coral treated with antibiotics does not fall prey to pathogens and the untreated coral does, then we know the bacteria are indeed the culprit," Knowlton said. 