Tsunamis in the Sierras
Fathoming Seafloor Movements
The Call to War
Notes from the Director
Research Highlights.............................................2

FEATURES
Tsunamis in the Sierras......................................4
Seismic Activity and Environmental Conditions Under Investigation at Lake Tahoe

Fathoming Seafloor Movements from Space..............12
Scripps Researchers Achieve Earth Science Milestone

The Call to War..................................................20
Scripps Institution of Oceanography 1930 to 1948

INSIDE SCRIPPS
Scripps PartnerShip............................................30
Around the Pier................................................32
Standing Watch...............................................33
The Water Column..........................................34

VOYAGER
2000 Annual Report...........................................41
As Scripps director, Harald Sverdrup (subject of a feature in this issue) created the first American curriculum for the study of oceanography in 1946.

As we approach our second century, Scripps is redefining not only what it means to study oceanography, but also what it means to be a scientist who studies the oceans. To get a feel for how the future appears to our graduate students, we asked a few of them to tell us about their chosen fields.

Physical oceanography student Kara Lavender responded, "It seems to be more difficult to attract students—future scientists—into this field. This is part of a larger problem of declining numbers of people studying science in general. Hopefully, as global climate issues bring more publicity to the field, more people will pursue careers in oceanography."

Geochemistry student Rob Rhew pointed out, "My primary focus is on studying atmospheric chemistry, but even those of us who study the atmosphere need to study the oceans as well. Oceanographers need to be creative and interdisciplinary."

I think Harald Sverdrup would have agreed, and he would be proud of both our students today and the results of the legacy he created for them half of a century ago.

Charles F. Kennel
Director
Scripps Institution of Oceanography

EL NIÑO AFFECTS PHYTOPLANKTON LEVELS

THE MOST RECENT El Niño event brought torrential rain and destruction to the west coast of North America before it dissipated in 1998, but a pair of Scripps researchers discovered that it also profoundly disrupted life in the ocean surface.

Biologists Greg Mitchell and Mati Kahru found that phytoplankton, the most fundamental food source in the ocean, decreased to less than half its normal population off California during the El Niño of 1997–98, but recovered in 1999. Because of the position of phytoplankton at the base of the ocean’s food web, its levels can affect the population of fishes higher on the food chain and in turn people who rely on those fishes for a living.

The two researchers used ocean color satellite images to measure chlorophyll variations in the California Current System between Northern California and the tip of Baja California, Mexico, during a four-year period. By knowing how much chlorophyll is in the water, researchers can estimate how many phytoplankton organisms are there.

Phytoplankton thrives in surface waters enriched in nutrients from deeper waters. El Niño, however, suppressed that upwelling and created predominantly warm, nutrient-sparse waters off California and Mexico.

Above, (l to r): Greg Mitchell, John Wieland, and Mati Kahru with a bio-optical profiler used in plankton studies.
global discoveries for tomorrow's world
"On behalf of Scripps Institution of Oceanography,

I want to thank those who have supported the institution in its mission to seek, teach, and communicate scientific understanding of our oceans, atmosphere, Earth, and other planets for the benefit of society and the environment."

—Charles F. Kennel
# Table of Contents

- **Dedication**
- **Director's Report**
- **Scientific Affairs Report**
- **Scripps Science News**
- **Birch Aquarium at Scripps Report**
- **Graduate Report**
- **Academic Staff**
- **Awards & Honors**
- **Seagoing Operations Report**
- **Financial Report**
- **Donor Listing**
- **Publications**
- **Current Funds/Campus Census Chart**
- **Organizational Charts**
- **SIO Council/Director's Cabinet**
- **In Memoriam**

**Managing Editor**
Chuck Colgan

**Editor**
Marianne Maggini

**Designers**
Blaize Mekinna
Gail Look-Yan
Scotti Taylor

**Photography**
Fred Greaves

**Writers**
Joe Hlebica
Robert Monroe
HARMON CRAIG

The year 1999 marked Harmon Craig’s 44th year of a long and unconventional career at Scripps Institution of Oceanography as one of geochemistry’s most dedicated, influential, and irascible pioneers. He arrived at Scripps in 1955 from the University of Chicago’s Institute for Nuclear Studies, to form, with Hans Suess and Walter Elsasser, Roger Revelle’s original nucleus for establishing UCSD, which was founded in 1960. Since then, he has pioneered isotopic studies of ocean water, the atmospheric water cycle, polar ice sheets, volcanic gases and fluids, and oceanic basalts. Craig has published more than 180 scientific papers and has received numerous honors and awards, culminating with the 1998 Balzan Prize—the equivalent of the Nobel Prize for earth science.

One of his lifelong quests on land and sea has been the mapping of sites where the rare isotope of helium—Helium-3—is emerging at Earth’s surface, brought up by deep-mantle plumes originating at the mantle-core interface. This isotope, the first evidence of deep-mantle volatile degassing, was discovered by Craig and W. B. Clarke in the Kermadec Trench of the South Pacific Ocean and traced by them across the Pacific to the East Pacific Rise crest in the Pacific Ocean. At that time, the now familiar deep-sea hydrothermal vents were unknown, but “we proposed that the Helium-3 was emanating from hot fluids on the oceanic spreading axes. The only way to make direct observations was to use the deep-diving submersible Alvin,” Craig explained.

“In order to get funding to use the Alvin, we needed to come up with some very strong evidence. Ray Weiss, Peter Lonsdale, and I used the MPL Deep Tow vehicle to get water samples, which we found to be very high in Helium-3 and radon. The only explanation for these high levels, as well as for the anomalous temperature and salinity values, was that there were deep-sea hot springs along the crest of the rise.”

Based on this compelling evidence, the first dives were made on these hot springs, which became known as the Galápagos hydrothermal vents. Craig and his team later discovered hydrothermal vents in the submerged crater of Loihi Seamount, the youngest Hawaiian volcano, and in the back-arc spreading axis of the Marianas Trough.

Expedition work at sea and field work on land is what Craig likes best about scientific work. He has been chief scientist on more than 28 oceanographic expeditions, has made 17 Alvin dives to the seafloor, and has led more than a dozen land expeditions, which include a sampling traverse for volcanic rocks and gases along the entire length of the East African Rift Valley. In much of this work he has been accompanied by his wife, Valerie, who serves as aide-de-camp and technical assistant.

Among their many and varied achievements as a team, Harmon and Valerie Craig have shown that carbon and oxygen isotopes can be used to determine the regional origins of the marble used in ancient Greek sculptures and temples, reflecting another of the Craig’s broad spectrum of interests.

“Poetry is one of my greatest loves,” Craig said, the grandson of stage actors. In his latest paper, a detailed study of the mineral that carries volatiles up from the deep interior of the earth, he handily fuses mineralogy with drama, starting the paper with lines from Shakespeare’s Othello:

Make me such another world,
Of one entire and perfect chrysolite.

Emphasizing the importance of serendipity in his scientific discoveries, Craig frequently quotes Bernard Shaw’s Dark Lady of the Sonnets: “After all,” the Dark Lady says, “The wrong road always leads somewhere.”
Above: Dr. Harmon Craig holding a monkfish (Lophius spp.) collected during a deep submersible dive on Lohe Seamount in the Hawaiian Island chain, 1987.

Left: Dr. Harmon Craig samples basaltic lava on La Perouse Pinnacles in the Hawaiian Island Chain.
To seek, teach, and communicate scientific understanding of the oceans, atmosphere, Earth, and other planets for the benefit of society and the environment.

—Scripps Mission Statement
SCRIPPS VISION STATEMENT: To be an international leader in originating basic research, in developing scientists, and in advancing the science needed in the search for a sustainable balance between the natural environment and human activity.

ON THE EVE OF A NEW MILLENNIUM, SCRIPPS EXPERIENCED A YEAR OF RENEWAL.

Scripps is in the process of hiring 13 extraordinary faculty and research scientists in fields spanning the entire range of interests of the institution. They were chosen from a pool of more than 500 applicants, and we look forward to the intellectual stimulation they will bring.

We have hired our first Nobel laureate, Paul Crutzen, who joins the Center for Atmospheric Sciences. Crutzen's findings regarding the formation and depletion of ozone above the atmosphere led to his 1995 prize in chemistry, shared with two other recipients.

To guide us through this ever-changing world and environment, we have revised our mission and vision statements. These statements, indicated in this report, serve to remind us of the importance of our pursuits at Scripps and our obligations as both scientists and stewards of the oceans, atmosphere, and Earth.

Progress at Scripps is also evident in the form of new construction. In November 1999, we saw the renovation of Ritter Hall completed and the $18.9-million Endurance Hall welcome its first occupants. Endurance Hall houses 45 faculty offices, 27 laboratories, and a 60-seat classroom among other facilities.

The Fish Ball 2000 held at the Birch Aquarium in May raised $150,000 for a planned sea horse exhibit that is part of the Sea Horse Conservation Program at the aquarium. In a related development, the American Zoo and Aquarium Association recognized Curator Robert Burhans and Aquarist Debbie Melenchinsky for their accomplishments in breeding sea horses.

Generous donations from friends of Scripps have helped raise about half the $5-million cost to construct the SIO Commons, a state-of-the-art conference center and auditorium that is projected to open in 2003, the year Scripps celebrates its centennial.

We continue striving to provide an enriched intellectual atmosphere for our faculty, researchers, and students, one that moves the institution's research commitment into critical areas of human concern. In planning our SIO Initiatives and participation in the larger UCSD campaign, we have identified the need for five new centers for multidisciplinary research that will foster greater integration of our diverse interests.

Researchers here at Scripps also have brought science to public policy discussions on national and international levels. In January, we welcomed Senator Dianne Feinstein to Scripps. Several of our top climate scientists shared their perspectives with the senator on global warming and its potential impact on the state. She pledged to support computing needs for the Accelerated Climate Prediction Initiative (ACPI), a Scripps-led program. In July, I began to serve as a member of the Pew Oceans Commission, a group of leaders from the science, business, and government communities who are holding a national dialogue on the policies we need to restore and protect our living marine resources. Members of the new UC Revelle Program on Climate Science and Policy discussed with policy makers the latest climate research findings at the sixth Conference of the Parties in The Hague, The Netherlands, in November.

This past year, we've dealt with several jarring reminders of life's fragility. As I write this, the whole institution is deeply mourning the recent early deaths of two of our most distinguished and loved biologists, Michael Mullin and Mia Tegner. Their deaths followed, by three months, the passing of our seventh director; Bill Nierenberg, who served Scripps for 21 years.

Despite our grievous losses, we continue in the spirit of renewal, knowing that the opportunities ahead and the mission of our work will call forth new energy and new ideas.

Charles F. Kennel
DIRECTOR
SCRIPPS INSTITUTION OF OCEANOGRAPHY
"Individually and in collaboration, scientists here have continued to contribute as research leaders in matters global and local."

sio.ucsd.edu/res_groups
Since my appointment as deputy director of scientific affairs in July 1998, I’ve had the opportunity to become familiar with the full scope of research done at Scripps. The achievements of my fellow researchers are tremendously exciting.

Our scientific interests are very broad and range from earth, ocean, and atmospheric sciences to space science. Individually and in collaboration, scientists here have continued to contribute as research leaders in matters global and local.

During the past year, we joined with others in the scientific community to reach out to policy makers and the public. Our scientific collaborations also bore fruit in the form of innovative projects that promise to profoundly enhance how people understand the planet on which they live.

Scripps researchers have had the opportunity to place scientific objectives on a par with economic and political concerns in international talks to create policy to protect Earth’s fragile climate. In November 2000, the newly formed UC Revelle Program on Climate Science and Policy sent a delegation of the nation’s top scientific researchers to the United Nations climate negotiations in The Hague, The Netherlands. Scripps has taken a leading role in creating this innovative program to include science in these critical international discussions.

The delegates’ only agenda was to share their knowledge of the latest climate research staged special presentations during the negotiations to educate policy makers on the most recent scientific findings.

On another political stage, Scripps Director Charles Kennel hosted the first formal meeting of the new Partnership for Observation of the Global Oceans in December 1999. This collaborative organization includes leaders of 17 oceanographic institutions in 12 countries united in the goal of promoting an integrated observing system throughout the oceans of the world.

The year 2000 saw the first 12 Argo floats launched in the Pacific Ocean. They will soon be part of an array of 3,000 floats that will drift through the world’s oceans measuring water temperature and salinity. Meanwhile, the Estimation of the Circulation and Climate of the Ocean (ECCO) program, launched in November 1999, will combine data from satellite and sea-level observations to create a tool for ocean-state estimation.

And in December 2000, Scripps’s Donna Blackman and other members of a multi-institutional team made a surprise discovery of a hydrothermal vent field on the Mid-Atlantic Ridge.
“Our scientific interests are very broad and range from earth, ocean, and atmospheric sciences to space science. Individually and in collaboration, scientists here have continued to contribute as research leaders in matters global and local.”

This unprecedented find took place as the researchers studied the forces that created a 12,000-foot (3,700-m) undersea mountain at the discovery site.

Oceanic research advancements such as these are complemented by innovative atmospheric studies. An international effort led by Scripps researchers saw more than 200 scientists from 12 countries team up to make some startling conclusions about the interplay of climate and clouds. The $25-million Indian Ocean Experiment (INDOEX) led by Scripps’s Veerabhadran Ramanathan uncovered an extensive disruption of the natural atmosphere over that ocean caused by pollution produced in Asia and the Indian subcontinent.

In the case of Triana, an ambitious Earth-observing satellite developed chiefly by Scripps researcher Francisco P. J. Valero, scientific objectives overcame political obstacles in 2000. Last spring, the National Academy of Sciences affirmed Valero’s work by formally endorsing the spacecraft project. The academy’s scrutiny of the mission’s scientific merit had come at the request of members of the U.S. Congress controlling its funding. Valero leads researchers from the United States and Europe in the endeavor. The satellite is scheduled for launch in spring 2002.

Other programs dealing with issues closer to home reached important milestones. The California Cooperative Oceanic Fisheries Investigations (CalCOFI) celebrated their 50th anniversary by creating a new ocean observation program that will benefit scientists and educators concerned with coastal climates.

In their 50 years, CalCOFI observations of the California Current System have created the world’s most comprehensive record of an oceanic region. A pair of Scripps researchers relied in part on that information to uncover new facts about the 1997–98 El Niño phenomenon that occurred nearly two years later. Greg Mitchell and Mati Kahru found that weather patterns not only affected land dwellers around the world but depleted nutrient levels at the foundation of the ocean’s food web.

On dry land, a Scripps team performed an unprecedented feat days after the Oct. 17, 1999, Hector Mine earthquake in California’s Mojave Desert. Using satellite technology and radar images, the team created a rippling image of surface deformation caused by the quake. Such near real-time images could eventually replace surface maps that normally take geologists weeks or months to compile after an earthquake has occurred.
A wireless computer network being established now will benefit not only seismic research at Scripps but will provide high-speed Internet access to residents of remote communities throughout California. A science team that includes Scripps researcher Frank Vernon is establishing the network in sites close to the faults running through the state’s deserts and mountains. This network will allow transmission of information about earthquake activity from areas that electricity and phone service do not reach.

The project was a model used in UC San Diego’s proposal to create the California Institute for Telecommunications and Information Technology, an entity that Governor Gray Davis designated as one of three California Institutes for Science and Innovation in December 2000. The institute, a $300-million UCSD collaboration with sister campus UC Irvine, strives to transform telecommunications and information technologies worldwide.

Despite the presence of Scripps around the world and even beyond, I believe it is important to note that behind the large-scale collaborations lies the individual research that is the backbone of Scripps. Individual investigations on a variety of scales continue to provide a critical component of the creativity that characterizes our institution. It will remain so for years to come.

My colleagues and the students here at Scripps constitute the strength of this institution. They will continue to seek innovative approaches to environmental science, communicate new understanding of scientific discoveries, and continue Scripps’s role as a world leader in the oceanographic community as this new century progresses.

William S. Hodgkiss
Deputy Director of Scientific Affairs
The California Space Institute (CalSpace), a multicampus research unit of the University of California, supports space and earth sciences, education, and technology. CalSpace scientists conduct both pure and applied research in various interdisciplinary, space-related fields. Many CalSpace researchers emphasize the atmosphere and atmosphere-ocean interactions. Some scientists study space plasma physics and planetary science, whereas others investigate Earth’s environment using remote sensing from satellites.

DR. DAN LUBIN recently started two projects designed to help researchers better understand climate in Antarctica. The first aims to improve how the continent is represented in global climate models. Because of the inaccessibility of most of the continent’s interior, the physics of Antarctica’s unique atmosphere is difficult to study and replicate in models.

Lubin will use satellite imagery to map Antarctica’s clouds, which have a large impact on its energy budget. The physical properties of these clouds are unknown for the most part.

A second project will help researchers measure the distribution of ultraviolet radiation throughout Antarctica and the Southern Ocean. Lubin will include 22 years of data from NASA’s Total Ozone Mapping Spectrometer (TOMS) in this project. This will enable him to generate a complete history of solar radiation and climatology for Antarctica since the ozone hole started growing.

AFTER MORE THAN a decade of global research, Dr. John Roads says that Earth’s water cycle is beginning to play an ever-larger role in climate policy.

The Water-Cycle Committee of the U.S. Global Change Research program, a panel on which Roads recently served, released a report detailing science’s current ability to characterize, simulate, and predict water-cycle phenomena. This cycle—the path water takes from oceans to the atmosphere to Earth and back to the oceans—is the subject of localized studies now taking place around the world, all spinoffs from the original study of the Mississippi River Basin in which Roads participated.

CALSPACE HAS PARTNERED with Scripps scientists and the Birch Aquarium to deliver web-based earth science materials to schools and teachers. The CalSpace/SIO Earthguide program has created educational web sites highlighting the work of SIO and CalSpace researchers for the past two years.

Earthguide project manager Memorie Yasuda said that researchers with the fledgling program have completed several projects this year. In November and December, Earthguide team members presented the Descent to the Mid-Atlantic Ridge web site highlighting SIO researcher Donna Blackman’s real-time expedition in the Atlantic Ocean.
Researchers at the Center for Atmospheric Sciences (CAS) focus on fundamental investigations of the atmosphere related to large-scale climate change. To interpret and predict these changes, CAS scientists design and conduct field experiments, undertake new satellite missions, and use regional and global atmospheric models. Their analyses include integration of the models with space and in-situ observations.

cirrus.ucsd.edu

Researchers and students at CAS are investigating intriguing cloud-climate interplay by developing a new generation of tools to examine cloud interactions and by refining the computational methods used in models to forecast climate. These multifaceted methods are being developed by Drs. Andrew Vogelmann, Guang Zhang, Igor Podgorny, and Dance Zurovac-Jevtic and graduate students Baijun Tian and Eric Wilcox. Their research is improving how different types of clouds, energy within clouds, and the scales on which they operate are addressed in climate models.

The scheduled 2001 launch of the ambitious Triana satellite was postponed because of a congressionally mandated review of the project and space shuttle scheduling conflicts. But in the March 2000 review, the National Academy of Sciences voiced its strong support of the new observational capabilities to be made possible by Triana, concluding that the project could have been an earlier NASA priority "had adequate technology been available at a reasonable cost."

Dr. Francisco P. J. Valero

The mission is now scheduled for an April 2002 launch, and the team is currently completing an extensive program of testing and calibration of the mission's instruments, the Scripps National Institute of Standards and Technology Advanced Radiometer (Scripps-NISTAR), and the Scripps Earth Polychromatic Imaging Camera (Scripps-EPIC), according to Dr. Francisco P. J. Valero, the Triana principal investigator.

The 1999 Indian Ocean Experiment (INDOEX) linked dense pollution in Asia with significant atmospheric disruptions over the Indian Ocean. Dr. Veerabhadran Ramanathan, INDOEX co-chief scientist and director of CAS, and others have started a follow-up to the experiment.

This new project will include an atmospheric observation network on both sides of the Pacific Ocean and creation of a dialogue with climate policy makers. Computer modeling of the region's effects on global climate has already begun.

Dr. Veerabhadran Ramanathan

Simulation of "hotspot" within clouds
Scientists in the Center for Coastal Studies (CCS) focus on observing and modeling the physical and sedimentary processes that occur along the coastlines of the world. Ongoing research at CCS concerns surf zone hydrodynamics, fluid–sediment interactions responsible for sand transport along beaches, circulation in coastal waters and bays, propagation of surface waves across continental shelves, and coastal meteorology.

CCS RESEARCHER DR. Clive Dorman recently released findings that support what fishermen off the coast of California have known for years. The marine layer of air off the coast, considered stagnant and stable by meteorologists, actually produces strong gusts at certain points thanks to a condition known as supercritical flow. Dorman likens the southward flow of the moist layer to water flowing over a spillway. Outcroppings like Point Sur and Point Conception in Central California disturb the even flow, kicking up strong winds in the lees, or downwind sides, of such capes.

The finding could help meteorologists make more accurate wind measurements and forecasts.

JAMES LERCZAK, a graduate student working with Drs. Clinton Winant and Myrl Hendershott, recently observed the daily variation of ocean currents off Mission Beach, close to the Scripps campus. Surprisingly, they found that the currents there and the daily sea breeze, though both strong, do not closely correspond.

Nearshore ocean currents along many different coasts are probably profoundly influenced by local sea breezes, which makes it important to understand the seabreeze–current relationship.

Lerczak’s computer models of currents and winds predict that the ocean’s response to the breezes in Central and Northern California is very different from the response off Baja California in Mexico, and that currents along the Southern California coast are different from either of those.

More data are needed, however, to confirm the prediction.

GRADUATE STUDENT BILL Schmidt, engineers Brian Woodward and Kimball Millikan, and Dr. Robert Guza, director of CCS, are developing and testing a surf zone drifter that takes its cue from message-bearing bottles tossed into the sea.

Such drifters, consisting of global positioning and radio communication systems housed in PVC pipe, send messages of a different sort when they are tossed into the surf, telling researchers their location at any given time. The data derived from the drifters let researchers track water motion near shorelines and better understand the dynamics of rip currents and nearshore circulation.

Wave and wind patterns from Mission Beach, near Scripps
The Center for Marine Biotechnology and Biomedicine (CMBB), housed at Scripps, is a UCSD campuswide center dedicated to the exploration of potential biotechnological and biomedical resources found in the world's oceans. CMBB researchers investigate a broad range of areas, from the special properties of deep-sea marine microbes to the genetic engineering of commercially important marine animals.

CMBB RESEARCHER DR. Steve Taylor recently published his finding that substances belonging to a group of molecules called cationic peptides are contained in the blood cells of ascidians, marine animals better known as sea squirts. Such peptides have antibiotic properties as well as being sticky.

In collaboration with Dr. Robert Lehrer, a professor at UCLA's School of Medicine, Taylor found that the peptides contain unexpected modifications of amino acids, which allow the peptides to kill bacterial invaders in acidic and salty conditions.

"Some of these modifications have never been seen before in nature," Taylor said.

The researchers' challenge is to understand how the peptides kill bacteria and to determine whether the modifications can help "fine-tune" synthetic peptides so that they can be used as antibiotics in humans.

AS PART OF a three-pronged study of emperor penguins, Dr. Paul Ponganis found that during dives into frigid Antarctic waters penguins maintain their body temperatures. This new finding counters earlier hypotheses among penguin physiologists that penguins' body temperatures drop during dives to slow metabolism and allow submersion for long periods.

Ponganis has also studied penguin behavior during dives by fitting penguins with small underwater video cameras. He is also attempting to understand the mechanism that causes penguins to produce extreme quantities of myoglobin, an oxygen-storage protein. In related physiological research, he is studying sleep apnea in seals, who regularly stop breathing in episodes lasting as long as 10 minutes.

DR. GERALD KOOYMAN has been studying a different aspect of emperor penguin activity, namely, where the birds go to moult. Kooyman recently reported that they swim some 750 miles (1,200 km) to reach an ice pack near the eastern Ross Sea to undergo this crucial ritual.

The penguins need the ice pack so that they can remain dry during moulting, an approximately four-week process. Unlike other penguins, emperors seldom if ever moult on land. They instead rely on ice for their moulting grounds, so the stability of the pack ice is crucial to the success of the moult. Knowledge of their behavior might indirectly reveal climate changes that could cause ice packs to melt prematurely.
In a program aired on Dutch television, Dr. Richard Somerville discusses the likelihood of future climate change. In the Climate Research Division (CRD), scientists study phenomena spanning time scales from weeks to decades. They identify and predict the natural variability of climate and the consequences of anthropogenic increases in the greenhouse effect. CRD researchers use the principles of meteorology, oceanography, hydrology, and other disciplines to understand the complex interactions among the atmosphere, the seas, the land, and the world of living things.

Dr. Richard Somerville was among nine climate experts and three graduate students in a UC-sponsored delegation that attended the meeting of the United Nations Framework Convention on Climate Change in November in The Hague, The Netherlands. Scientific findings still have only a small influence on policy aimed toward reducing greenhouse gas emissions, compared to political and economic concerns. Scientists' continued participation in the conventions, however, is pushing scientific facts further into the discussions.

The UC delegation is part of the new UC Revelle Program on Climate Science and Policy, which was created to enhance the impact of natural and social sciences on global climate change policy.

Dr. Tim Barnett coordinates the Accelerated Climate Prediction Initiative demonstration project, a new attempt to upgrade the computer infrastructure used in the United States for long-term climate modeling and assessment of human-based threats to the environment.

The first phase of the project is the assessment of the current physical state of the world's oceans. Observations of salinity and subsurface temperature create a starting point for running models of anthropogenic change through 2100.

New measurement technology developed by Scripps physical oceanographer Detlef Stammer has provided Barnett's team with the fundamental measurements incorporated into runs of the Parallel Climate Model. In the final phase of the project, from the global-scale picture developed by the model, researchers at Scripps and collaborating institutions are working to regionalize these model predictions to problems relating to water resources and wildfire management in the western United States.

Dr. Arthur J. Miller and graduate student Emanuele Di Lorenzo are developing and implementing sophisticated computer models to link observations of physical properties describing small-scale features such as eddies, which are transient currents that quickly swirl through normally slow currents, with observations of phytoplankton and zooplankton blooms along the California coast.

If successful, these simulations would be the basis for short-term forecasts of eddies and blooms. The forecasts could aid fisheries managers and fishermen whose industries are tied to sardine, anchovy, and other fish that feed on plankton. Emergency officials could use them to predict more accurately the course of oil spills in the coastal zone.
The Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics (IGPP) at Scripps is a branch of the University of California IGPP and houses the systemwide office. IGPP operates a global network of seismic stations; several modern seismic arrays in places such as Montana, California, and Kyrgyzstan; a permanent space geodesy network in California; an acoustic thermometry network in the North Pacific; and an X-band antenna for satellite communications. It also maintains an active seagoing program including the measurement of gravity and absolute gravity on the seafloor, acoustic thermometry, seafloor electromagnetic and seismic measurements, and an active multichannel seismic program.

Since 1997, graduate student Linden Clarke and Dr. Brad Werner of the Complex Systems Laboratory have been monitoring cyclical events on Scripps Beach where the sand bed below the waves is dimpled with patterns of megaripples—underwater sand dunes. To understand the processes forming these dunes, Clarke has devised a method for viewing megaripples and measuring their pattern and development through time.

A basic video camera mounted roughly 130 feet (40 m) above the beach supplies images to a computer program that identifies and retains image fragments of the underwater sand bed. Every 10 minutes, the computer program assembles these image fragments like a puzzle to produce an aerial view of the megaripples. (See complex-systems.ucsd.edu.)

The team plans to use these images in conjunction with wave and current measurements to probe interactions between waves and currents, megaripples, and sand bars and to test whether characteristics of surf zone currents can be inferred from megaripple patterns.

Dr. Frank Vernon is among the members of a team bringing wireless network access to some of the state’s most remote areas. The High Performance Wireless Research and Education Network (HPWREN) not only will deliver real-time earthquake data from remote sensors to analysts but will bring wireless Internet access to remote communities.

Scientists recently established a connection to Mt. Laguna Observatory near San Diego, the first of several mountaintop locations that will become nodes in the network.

Researchers are poring over samples of water and life brought back by Donna Blackman and other scientists from a giant hydrothermal vent field in the Atlantic Ocean; they stumbled upon it in December 2000. The research group discovered the 180-foot-tall (55 m) vents while investigating the geological and hydrothermal processes that created a 12,000-foot-tall (3,700 m) mountain on the Mid-Atlantic Ridge. Scientists have observed nothing like them before.

The submarine hot springs are unusual because of the absence of animal life near the vent field. Blackman said that one aspect of follow-up research will be to date the vents and determine how long they have been active.

igpp.ucsd.edu

A 180-foot (55 m) vent discovered in the Atlantic Ocean
Scientists within the Geosciences Research Division (GRD) address a wide range of topics in the earth, ocean, and atmospheric sciences. GRD researchers study the physical, chemical, and geobiological processes of Earth's mantle, crust, ocean, and atmosphere. They carry out detailed investigations in marine geology, petrology, paleomagnetism, tectonics, geophysics, isotope geology, geochemistry, mantle and crustal evolution, and paleontology.

**DR. CHRIS CHARLES** and his students have spent several years obtaining climate data by analyzing fossilized coral. Graduate student Kim Cobb and Charles hope to publish findings based on coral readings that could help characterize the El Niño phenomenon.

Researchers can measure isotopes of various elements embedded within layers of coral skeleton. The presence of certain isotopes signifies higher or lower temperatures of the seawater surrounding coral. Spikes in temperature every few years in coral sample analyses correspond with El Niño events, which are characterized by warmer water in parts of the Pacific Ocean.

On the basis of preliminary findings, Charles and Cobb report that El Niño events appear to have been no stronger in recent years than in earlier episodes throughout history.

**IN AN EFFORT** to obtain the most accurate measure of Earth's geomagnetic intensity to date, Dr. Jeff Gee and Scripps colleagues towed a magnetometer across the Pacific Ocean seafloor in an area where tectonic plates are rapidly spreading apart. This location allowed them to access a record of geomagnetic intensity reaching back 780,000 years—the last known period in which the geomagnetic field was reversed and compasses would have pointed south.

The readings provide independent confirmation of fluctuations in magnetic intensity over time that have been made from sediment records, Gee said. The new data reveal several fluctuations, including a large decrease in the field intensity over the past few thousand years, which will allow more detailed studies of how crust is constructed at midocean ridges.

**SCIENTISTS HAVE DEBATED** whether a giant meteorite or earthbound sources like volcanoes killed off dinosaurs and many other species 65 million years ago. Through analysis of sediments dated to this period, Dr. Alex Shukolyukov and colleagues found supportive evidence that the cataclysmic change between the Cretaceous and Tertiary periods had an extraterrestrial cause.

The isotopic chromium signature in sediments from this period was found to be significantly different from the signature provided by any terrestrial sample. From this, the researchers concluded that the material was from meteorite dust. Shukolyukov and colleagues have more recently duplicated the method to provide evidence for two other major meteorite impacts that took place more than 3 billion years ago in South Africa.
Scientists in the Marine Biology Research Division (MBRD) investigate the fundamental processes affecting life and energy flow in marine ecosystems. They examine biodiversity at all levels of organization, from geographical and ecological to physiological and molecular. MBRD investigators explore a variety of habitats, including coral reefs, the deep sea, Antarctica, and coastal California ecosystems.

**DRS. NICHOLAS HOLLAND** and Linda Holland are studying the developmental expression patterns of the genes of *Amphioxus*, a fishlike invertebrate, to determine whether the ancient ancestors of today’s fishes had vertebrate-like brains. They recently completed a decade of work showing that *Amphioxus* brains contain most but not all components of vertebrate brains. They’ve concluded that fairly complex brains were present at the dawn of vertebrate evolution, which runs contrary to some theories about the evolution of fishes. However, recently discovered fossils of early fishes were found to have complex brains already developed at the time of this evolution, thus confirming the Hollands’ research.

**GRADUATE STUDENT SCOTT** Rapoport and Dr. Robert Shadwick are studying the unusual structure and mechanical properties of egg casings produced by certain sea snails called whelks. The substance, an insoluble protein polymer, appears to have properties not commonly seen in natural or anthropogenic materials. Female whelks anchor strings of the coin-shaped casings to undersea structures.

The material that makes up these structures, which may reach 3 feet (.90 m) in length in some species, can be stretched like a rubber band. Unlike rubber, though, the material becomes dramatically less stiff when stretched beyond about 5 percent of its original length, but reverts back to its original shape and stiffness when released. Understanding this novel two-phase mechanical behavior could be important in biomimetic applications. “What we want to do is figure out what the snails have done at the molecular level to create this type of polymer,” Shadwick said.

**DRS. BRIAN PALENIK** and Bianca Brahamsha, supported by the Department of Energy, have nearly finished sequencing the genome of a bacterium at the base of the oceanic food web. Their year-old study of *Synechococcus*, among the smallest phytoplankton, has revealed a heretofore unknown degree of genetic diversity among seemingly similar species of cyanobacteria, one of the largest and most important groups of bacteria on Earth. The significance of this diversity is yet to be determined.

Understanding the genetic characteristics and capabilities of *Synechococcus*, an important link in the ocean food web, could lead to greater understanding of ocean biodynamics.
Scientists in the Marine Life Research Group (MLRG) cooperate with the California Department of Fish and Game and the Southwest Fisheries Science Center of the National Marine Fisheries Service in the California Cooperative Oceanic Fisheries Investigations (CalCOFI). This study of the California Current system provides one of the world's most complete sets of time-series data (50 years) from an oceanic ecosystem. Scientists examine variability in the physics, chemistry, ecology, and fisheries of this eastern boundary current system from the seasonal scale to the interannual scale.

Scientists continue to try to understand why populations of food fishes like anchovy and sardine rise and fall in cycles that span decades. To provide answers, Dr. David Checkley developed a means of tracking populations of these fishes by counting the eggs they spawn.

Now Checkley, UCSD engineering professor Mohan Trivedi, and their students are developing the Real-Time Flow Imaging and Classification System (REFLICS), a computerized device that will automate the counting process. Improved resolution of the images will allow more exact comparisons between fish egg populations and the physical factors like water temperature and salinity in their surroundings.

Working with colleagues in the U.S. GLOBEC (Global Ocean Ecosystem Dynamics) program, Dr. Mark Ohman has studied the birth and death rates of planktonic copepods, small crustaceans that graze on phytoplankton and that are themselves among the most important links in ocean food webs.

He recently found a trade-off in copepod life histories: one species, *Calanus finmarchicus*, releases large numbers of eggs freely in the ocean where very few survive, whereas others, *Pseudocalanus* spp., protect the small number of offspring they produce, thus increasing their likelihood of survival. His goal is to understand what controls the population dynamics of the ocean's dominant copepod species.

Overfishing has long been the apparent culprit in the decline of abalone populations off the West Coast. As at least one species of the once-abundant gastropod now faces extinction, the late Dr. Mia Tegner was studying the role of another player, climate variability, in the population dynamics of abalone.

Tegner, who held a Pew Fellowship in Marine Conservation, had recently documented the profound effects that water temperature and food quality and quantity have on abalone physiology, recording the influence of these forces on activities such as shell development. Her goal was to incorporate such environmental variables into fisheries management.

*Tegner tragically died Jan. 7, 2001, in a scuba diving accident off the coast of San Diego.*

Above left: Copepod *Calanus finmarchicus*

Above right: Copepod *Pseudocalanus newmani*
Scientists in the Marine Physical Laboratory (MPL) use knowledge of the ocean and its boundaries to solve problems in ocean acoustics, ocean optics, marine physics, marine geophysics, signal processing, and ocean technology. MPL scientists develop advanced ocean technology both for in-situ and remote environmental measurement programs and for testing of new engineering concepts.

**Dr. William Kuperman** and William Hodgkiss and graduate students Seongil Kim and Geoffrey Edelmann, in collaboration with Dr. Tuncay Akal of the NATO SACLANT Undersea Research Center, demonstrated an acoustic technique to undo some effects of the reverberant echoes the ocean inflicts on underwater sound transmission. The method, called a time-reversal mirror, can focus underwater acoustic waves at a specific range and depth regardless of the complexity of the ocean.

The July 2000 Mediterranean experiment was carried out north of Elba Island off the coast of Tuscany in the Mediterranean Sea and successfully demonstrated time-reversal focusing. It also demonstrated its applicability to communication among underwater vehicles, sonar, and the measurement of the variability of our ever-changing ocean.

**The bubbles** that form as waves crash are important vessels of gases exchanged between the ocean and the air. Instruments developed by Dr. Eric Terrill with Dr. Ken Melville measure the acoustic properties in bubbly ocean surface water, even when the sea is at its most turbulent. Using their understanding of sound propagation through bubbly water, scientists interpret acoustic measurements in terms of bubble densities by employing data inversions.

While the acoustic properties of the upper ocean have received much attention from underwater acousticians, Terrill has recently found ways of using the data to assist visual interpretation of the ocean. Satellite imagery of chlorophyll concentrations on ocean surfaces, for example, can potentially be in error if the optical properties of bubbles are not accounted for.

**To better understand** what satellites see when they view the world's oceans, scientists are continuing to improve their understanding of ocean optics. Dr. Dariusz Stramski is looking for a way to better quantify light-absorbing phytoplankton pigments and light-scattering particles of organic carbon in the ocean.

Stramski's other recent efforts include creation of a database of the optical properties of marine particles. The details of the database are a departure from previous models of ocean optics, in which the description of water composition has been overly simplified and could not explain the substantial optical variability in the ocean.

Stramski's research in both of these areas could ultimately lead to more knowledge about light within the ocean, ocean biogeochemistry, and the carbon cycle.
Studies within the Marine Research Division (MRD) encompass the disciplines of marine chemistry and biological oceanography. MRD scientists study variations of atmospheric oxygen with time and their relationship to the global carbon cycle and climate change. They also examine marine pollution and environmental issues, interstitial water chemistry of deep-sea cores, the geochemistry of nearshore sediments, and extraterrestrial geochemistry and chemistry related to the origin of life.

IN AN EFFORT to understand the physiology, ecology, and production of phytoplankton, biological oceanographer Greg Mitchell deploys optical devices during the California Cooperative Oceanic Fisheries Investigations (CalCOFI) and global cruises. The color of the ocean is governed by the abundance, type, and physiological status of this microscopic plant life.

Working with Scripps colleagues Mati Kahru, Dariusz Stramski, and Robert Frouin, Mitchell develops mathematical relationships relating surface phytoplankton chlorophyll and carbon concentrations to ocean color signals imaged by satellites. Mitchell and Kahru reported in September 2000 that El Niño-driven forces diminished phytoplankton stocks off the coast of California in 1997–98 but doubled the numbers of one form, cyanobacteria, in offshore waters of southern Baja California in Mexico.

THE MARINE NATURAL Products Group of Dr. John Faulkner has sought to find an inhibitor to the enzyme HIV-1 integrase, one of three encoded by the human immunodeficiency virus.

The team has extracted an initially promising serinolipid produced by a tunicate from the tropical Pacific island nation of Palau. While investigating the lipid’s potential properties as an integrase inhibitor, team members learned that the tunicate, Didemnum guttatum, uses a chemical to kill coral. Didemnum affixes itself to coral and secretes a substance that kills the coral, leaving only its skeleton behind.

Group member Dr. Markus Heubes said researchers at Scripps, working with colleagues at the Coral Reef Research Foundation in Palau, will identify the components of the secretion that are toxic to coral.

DRS. JORIS GIESKES, Osmund Holm-Hansen, and Alberto Zirino set out with colleagues from the Naval Research Group in Point Loma, California, last summer to understand in greater detail the distribution of trace metal deposits in San Diego Bay. The Gieskes group made preliminary findings of nickel, zinc, copper, chromium, and manganese distributions in the bay sediments.

The aim of this research is to determine if sediment in the bay is the source of such metals or a sink—collecting metals from other sources in the bay. The group will also investigate the effects of these metals on plant and animal life in the bay.

Above right: Drs. Joris Gieskes (center) and Bart Chadwick (left) and Peter Weber with a mini-multi core sampler
Scientists in the Physical Oceanography Research Division (PORD) study a range of observational and theoretical topics related to the physics of the ocean. Some researchers study the large-scale circulation of the world's oceans or the specifics of smaller environments such as the continental shelf, estuaries, or the shoreline. Others examine the interaction between the ocean and atmosphere. PORD scientists also develop new technologies, such as autonomous drifters, specialized sensors, and new versions of current profilers.

Two drifters designed and operated by PORD researchers reached milestones in 2000. A team led by Dr. Dean Roemmich deployed a dozen floats in the Pacific Ocean in the launch of the Argo profiling float project. The 12 are the first in a planned global array that will include 3,000 floats by 2005. The National Oceanic and Atmospheric Administration (NOAA) is among the international agencies from 12 nations that are providing and deploying instruments. The temperature, salinity, and ocean current data from the floats will be publicly available to scientific and operational users anywhere in the world.

In September, NOAA and the U.S. Navy substantiated the work of Dr. Peter Niiler when they procured 37 drifters built according to his design for use in day-to-day weather observations. The drifters, known as MINIMETs, measure ocean current, wind speed, wind direction, ocean surface temperature, and atmospheric pressure. NOAA and the Navy plan to place MINIMETs in the path of hurricanes to provide data on the early stages of storms. The data will allow models to predict hurricane paths more accurately.

nhbo.ucsd.edu/pord.dir

Dr. Dan Rudnick is teaming with Dr. Robert Pinkel of Scripps's Marine Physical Laboratory and other Scripps oceanographers as part of an international consortium studying how layers of cold and warm ocean water mix. They launched the Hawaii Ocean Mixing Experiment (HOME) in August. One anticipated result of the project is an accounting of how much energy the ocean stores.

Like prospectors searching for mother lodes, researchers spent the first phase of the project looking for sites near the island chain with signs of intense subsurface activity. They pinpointed two sites, one near an underwater segment of the island chain known as French Frigate Shoals and another in the Kauai channel between the islands of Kauai and Oahu.

With the sites chosen, HOME will measure how energy dissipates as deep-ocean currents collide with the island chain's base.
"The aquarium has kicked off the new century with remarkable achievements in promoting ocean science education and conservation."

aquarium.ucsd.edu

**ON-SITE VISITORS**
274,315 (including 41,020 schoolchildren on educational field trips)

**PUBLIC EDUCATION ACTIVITIES**
- 105 on-site and field programs
- 31 naturalist-led whale watching cruises
- 6 scout programs
- Total participants: 5,200

**SUMMER LEARNING ADVENTURES**
65 sessions with 855 participants

**OUTREACH PROGRAM PARTICIPANTS**
- 230 programs for 6,430 students K–14
- 34 charity programs for 543 participants
- 12 fairs reaching 400,000
- 276 total programs reaching a total of 406,973 people

**SCRIPPS OCEANOGRAPHIC SOCIETY**
6,501 memberships

**VOLUNTEER HOURS**
24,274

**STAFF MEMBERS**
- 37 career, 2 casual, 17 by agreement,
- 11 students

**EARNED INCOME**
$2,343,392

**DONOR-DESIGNATED GIFTS AND GRANTS**
$916,976

**IN-KIND DONATIONS**
$38,879

**OPERATING EXPENSES**
$2,843,460
SO MUCH HAS TAKEN PLACE SINCE THE DAYS I worked as a college student at the Scripps Aquarium-Museum, forerunner of the Birch Aquarium at Scripps (BAS). I have returned as executive director of BAS and am proud to announce that the aquarium has kicked off the past year with remarkable achievements in promoting ocean science education and marine conservation.

BAS staff efforts enabled us to receive another award from the Institute of Museum and Library Sciences. Receipt of this award twice is an honor; and reaffirms our commitment to provide innovative educational opportunities to the San Diego community. As it did in 1996, the Institute awarded $112,500 to fund continuing aquarium operations for a two-year period. Our current award term runs through September 2001.

Several of the honors we received in the past year reflect the high professional standards of our staff. Curator Robert Burhans and Aquarist Debbie Melenchinsky won the American Zoo and Aquarium Association’s Edward H. Bean Award in September 1999 for their work breeding and culturing sea horses. Aquarists Leslee Yasukochi and Fernando Nosratpour have also made important advances conserving rare and threatened species. Yasukochi has been extremely successful in the cultivation and display of rare medusa jellyfish while Nosratpour has developed culture facilities for Caribbean corals in collaboration with Scripps faculty member Dr. Nancy Knowlton and graduate student Davey Kline.

Public outreach at the aquarium included several innovative programs. Education Director Arlene de Strulle initiated Exploring the Science of Our Oceans and Earth, which refocused and expanded BAS school and public programs. New K-12 programs now integrate Scripps research topics, incorporate the use of educational technology, and assist the academic needs of schools to achieve science literacy. New teacher workshops focus on Scripps research and data collection resources for K-12 classrooms. For the public, Scripps research topics were infused into exciting new lectures and classroom and field programs for children and adults. More than 185,548 students, teachers, and the public participated in Aquarium education programs and outreach efforts. Our Planet Earth Express outreach van traveled to 12 community fairs throughout Southern California, exposing 400,000 people to ocean science.

Attractions back at Birch Aquarium also advanced our educational mission. For instance, Shark Discovery Days in August provided lectures, exhibits, and opportunities to make laboratory observations of sharks. An April exhibit celebrated the life’s work of Scripps marine biologist and naturalist Dr. Gerald Kooyman, who has spent several decades studying the physiology of marine mammals and birds, especially those of Antarctica.

More than 5,400 people, 75 percent of them nonmembers, took part in public activities programs such as naturalist-guided field trips, whale watching cruises, classes, and lectures. Scripps biologist Dr. Nicholas Holland and senior museum scientist H. J. Walker gave lectures in our popular Meet the Scientist series. Of our 78 course offerings, 12 were new.

Grants provided by The McCarthy Foundation and Union Bank of California helped create the interpretive program coordinator position in the education unit. This coordinator is responsible for the training, education, and support of the science interpretive volunteers and assists in developing new and seasonal interpretive programs. The science interpreters enhance visitors’ experiences by providing interpretation of the many exhibits here at BAS.

The year also saw the retirement of Dr. Ned Smith as aquarium executive director. Ned was instrumental in developing the BAS Advisory Board and he played a significant role in launching several funding initiatives.

Finally, I want to thank our members, board, donors, and many friends and visitors for their continued support of the Birch Aquarium at Scripps.
"We are working with the Development Office to create and fund new first-year fellowships so that we can continue to attract the brightest students."

siograddept.ucsd.edu
THE PAST YEAR HAS BEEN A TIME OF REVIEW AND GROWTH at Scripps, especially in the graduate department. Following the recommendations of an external committee that reviewed our program in the fall of 1999, we have spent much of the year responding to many of their suggestions. These included the following points: to "consider the students first," to maintain our commitment to the highest educational and research standards, to address the demographics of the faculty, and to reconfigure the department for the challenges ahead.

The director's office authorized the hiring of nine new faculty at the end of 1999. So far we have filled six of these positions, and three others (including one jointly with Mechanical and Aerospace Engineering department at UCSD), with excellent appointments at the assistant professor level. Of these new members of the Scripps community, four are women; increasing the number of female faculty by 50 percent.

In the course of reviewing and revising our curricula, we have undertaken a survey of teaching loads and teaching evaluations and will be instituting new approaches before the end of this academic year; along with Scripps awards for excellence in teaching.

Always a source of institutional pride for their accomplishments, Scripps students have created a new representative body, Students@SIO, providing a forum to work among themselves and with the graduate department to enrich their experience at Scripps. As a part of this effort, student committees now provide a formal evaluation of candidates in all faculty searches.

Finally, we are working with the support of the Development Office to create and fund new first-year fellowships so that we can continue to attract the brightest students to one of the world's leading scientific institutions.

W. Kendall Melville
SIO GRADUATE DEPARTMENT CHAIR
CURRICULAR PROGRAMS

The Graduate Department of Scripps Institution of Oceanography offers instruction leading to Ph.D. degrees in oceanography, marine biology, and earth sciences. Because of the interdisciplinary nature of the ocean sciences, the department provides a choice of eight curricular programs through which the student may pursue a Ph.D. degree. Each curricular group has prerequisites for admission in addition to the departmental requirements.

Applied Ocean Science (AOS)
This interdepartmental program serves as a bridge between the classical disciplines of biological, geological, and physical oceanography and the UCSD engineering departments. The aim of the AOS program is to develop scientists capable of designing and operating novel instrumentation in support of ocean research, as well as analyzing and interpreting the data.

Biological Oceanography
In the biological oceanography curriculum, the interactions of marine organisms with the physical-chemical environment and with each other are studied. Research and instruction in this curriculum range from food-web dynamics and community structure to systematics, behavior, biogeography, and physical-biological interactions.

Climate Sciences
The climate sciences curriculum concerns the study of the climate system of the earth with emphasis on the physical, dynamical, and chemical interactions of the atmosphere, ocean, land, ice, and the terrestrial and marine biospheres. The program includes investigations of changes on seasonal to interannual time scales, changes induced by human activities, and paleoclimatic changes on time scales from centuries to millions of years.

Geological Sciences
This curriculum applies observational, experimental, and theoretical methods to the understanding of the solid earth and the solar system and how they relate to the ocean and the atmosphere. Principal subprograms are marine geology and geophysics, tectonics, sedimentology, micropaleontology and paleoceanography, petrology and geochemistry, and isotope geology. Expedition work at sea and field work on land are emphasized as essential complements to laboratory and theoretical studies.

Geophysics
This curriculum educates the student about the physics of the solid earth including the earth's magnetic field, the mechanics of tectonic processes, earthquakes and the waves they produce, the physics of the earth's interior, and mathematical methods for analyzing data and interpreting them in terms of models of the earth. Physical and mathematical approaches to geophysical research are emphasized.

Marine Biology
The marine biology curriculum emphasizes course work, seminars, and research on all aspects of the biology of marine organisms. Teaching and research focusing on both prokaryotes and eukaryotes encompass the disciplines of cell and molecular biology, biochemistry, developmental biology, physiology, biomechanics, genetics, ecology, and evolutionary biology.

Marine Chemistry and Geochemistry
The marine chemistry and geochemistry curriculum emphasizes the chemical and geochemical processes operating in the oceans, atmosphere, and other environments, and includes the subdiscipline of marine natural product chemistry. Education and research in this curriculum combine field observations with laboratory or modeling projects. Studies of natural systems are often multidisciplinary and integrate chemical concepts and techniques with information about physical, geological, or biological processes, including the effects of human activity.

Physical Oceanography
The physical oceanography curriculum deals with mechanisms of energy transfer through the sea and across its boundaries and with the physical interactions of the sea with its surroundings, especially its influence on climate. Research activities are both observational and theoretical. These include study of the general circulation of the oceans, mechanisms of transport of energy, momentum, and physical substances within the sea and across its boundaries; properties of wind waves, internal waves, tsunami waves, and planetary waves and the thermodynamic description of the sea as a system not in equilibrium and optical and acoustical properties of the sea.

Student Enrollment
In the fall of 1999, 32 new students were admitted to graduate study. Of these, 3 were in applied ocean sciences, 4 in biological oceanography, 2 in climate sciences, 3 in geological sciences, 4 in geophysics, 10 in marine biology, 4 in marine chemistry and geochemistry, and 2 in physical oceanography. Enrollment at the beginning of the academic year was 227. UCSD awarded 25 doctor of philosophy degrees and 6 master of science degrees to the students listed in this section.
Doctor of Philosophy Degrees Awarded, with Titles of Dissertations

EARTH SCIENCES

Gregory J. Anderson

Sara Bazin
"Three-Dimensional Crustal Structure of East Pacific Rise Discontinuities from Tomographic Inversions."

Julianna E. Fessenden
"Terrestrial Influence on Atmospheric CO₂, A Mechanistic Study Using 8¹⁸O." 

Ulysses S. Ninnemann
"Deep Sea Sedimentary Record of Southern Ocean Physical and Chemical Heterogeneity: Implications for Climate and Ocean Circulation."

Helen M. Perks

Linette M. Prawirodirdjo
"A Geodetic Study of Sumatra and the Indonesian Region."

Liliya Victorovna Posiolova
"Internal Structure of the Clipperton Transform Fault, East Pacific Rise."

Evelyn J. Price
"Coseismic and Postseismic Deformations Associated with the 1992 Landers, California, Earthquake Measured by Synthetic Aperature Radar Interferometry."

MARINE BIOLOGY

Nancy Maria Aguilar
"Comparative Physiology of Air-Breathing Gobies."

Seana K. Davidson

Sonya T. Dyhrman
"Cellular Markers of Phosphate Stress in Phytoplankton."

Andrew Walter Leising
"The Relationship Between Copepod Foraging Behavior and Their Microscale Distribution."

Tiffany A. Moisan
"Mechanisms for Phytophysiological Acclimation of Phaeocystis antarctica Karsten: Ecological Implications and Model Parameterizations for Predicting Net Primary Productivity."

Scott Mathew Rumsey

OCEANOGRAPHY

Shannon Lea Cass-Calay
"The Effect of Prey Availability and Physical Variables on the Feeding and Growth Rates of Larval Pacific Hake, Merluccius productus, in the California Region."

William Christopher Conant
"Interactions between Aerosol, Water Vapor, and Solar Radiation."

Claudio DiBacco
"Bay–Ocean Exchange of Crab Larvae: The Roles of Larval Behavior, Origins, Distribution and Physical Processes."

Paul A. Dixon
"Larval Supply of Dynamics."

Kathleen Anne Edwards
"A Large-Scale Wind Maximum Off California in Summertime."

Dana E. Lane
"Stochastic Theory and Cloud–Radiation Interactions."

Cleridy Eve Lennert-Cody
"Phytoplankton and High-Frequency Internal Waves: Predictable Patchiness Through the Water Column."

Peter Graham Mortyn
"Planktonic foraminifera and Upper Water Column Variability in the South Atlantic: A Multiple Species Approach to the Deep Sea Sedimentary Record of Climate Change."

Joellen Louise Russell
"The Biogeochemistry of Southern Ocean Intermediate and Mode Waters."

Britton B. Stephens
"Field-Based Atmospheric Oxygen Measurements and the Ocean Carbon Cycle."

Aaron Michael Thode
"Localization, Inversion, and Source Signal Recovery of Blue Whale Sounds Using Matched Field Processing."

Master of Science Degrees Awarded

EARTH SCIENCES

David Lowe
Deirdre Wendel

MARINE BIOLOGY

David Hamm
Jonny Lyon

OCEANOGRAPHY

Xi Chen
Wendy Storms

For application procedures and more information, please write to:
University of California, San Diego
Scripps Institution of Oceanography
Graduate Department
9500 Gilman Drive, Dept. 0208
La Jolla, CA 92093-0208
siodept@sio.ucsd.edu
"The achievements of my fellow researchers are tremendously exciting."

—William S. Hodgkiss
Donald W. Forsyth, IGPP, Marine Geophysics
Theodore D. Foster, GRD, Physics
Peter J. S. Franks, MLRG, Biological Oceanography
Helen A. Fricker, IGPP, Glaciology
Edward A. Frieman, Director Emeritus/IGPP, Physics
Robert J. Frouin, CSI, Meteorology
Eran Fuchs, MPL, Optical Oceanography
Hernan E. Garcia, MRD, Oceanography
Eliane Garo, MRD, Natural Products Chemistry
Scott Haskell, IGPP, Ecology & Evolutionary Biology
Konstantine Georgakakos, CRD, Geological Engineering
Paul J. Gendron, MPL, Electrical Engineering
Eliane Garo, MRD, Natural Products Chemistry
Scott Haskell, IGPP, Ecology & Evolutionary Biology
Ronald Kaufmann, MBRD, Marine Biology
John A. Knauss, PORD, Oceanography
Eran Fuchs, MPL, Optical Oceanography
Edward D. Goldberg, MRD, Chemistry
Ralf Goericke, MLRG, Biological Oceanography
Denise Hagan, GRD, Chemistry
Helen A. Fricker, IGPP, Glaciology
Margaret Haygood, MBRD/CMBB, Marine Botany
Francis T. Hawx, GRD, Geology
Margo G. Haygood, MBRD/CMBB, Marine Biology
Thomas L. Hayward, MLRG, Biological Oceanography
Michael A. Hedlin, IGPP, Earth Science
Edward A. Hemmingsen, CMBB, Physiology
Myr I. Hendershot, CCS/PORD, Physical Oceanography
Thomas H. Herbers, CCS, Radiation Stress
Juan C. Heraguera, GRD, Oceanography
Robert R. Hessler, MBRD, Biological Oceanography
Francois Heuze, IGPP, Geological Engineering
John A. Hildebrand, MPL/GRD, Applied Physics
Richard Hilt, IGPP, Geophysics
David R. Hilton, GRD, Isotope Geochemistry
William S. Hodgkiss, Jr., MPL, Signal Processing
Linda Z. Holland, MBRD, Molecular Biology
Nicholas D. Holland, MBRD, Marine Biology
Rainer Hollebach, IGPP, Earth Sciences
Osmond Holm-Hansen, MBRD, Marine Biology
John R. Hunter, D-SIO, Ichthyology
Sam F. Iacobellis, CRD, Physical Oceanography
Glenn R. Ierley, IGPP/PORD, Physical Oceanography
Anand K. Inamdar, CAS, Radiative Transfer/Computational Physics
Douglas L. Inman, CCS, Physical Oceanography
Jeremy B. C. Jackson, GRD/MBRD, Geology
Jules S. Jaffe, MPL, Biophysics
Bernd Jaene, PORD, Atmospheric Chemistry
Paul R. Jensen, MBRD, Microbiology
Zhonghai Jin, MLRG, Atmospheric Science
Edward R. Johnson, IGPP, Applied Mathematics
Hadley O. Johnson, IGPP, Geophysics
Kenneth G. Johnson, GRD, Geology
Peggy Just, MBRD, Marine Biology
James B. Kadke, MPL, Physics
Mari Kahru, MBRD, Biological Oceanography
Adrianus J. Kalmijn, PORD, Biology/Physics
Eric J. Kantorowsk i, MRD, Chemistry
Miriam Kastner, GRD, Geology
Ronald Kaufmann, MBRD, Marine Biology
Charles D. Keeling, GRD, Marine Chemistry
Ralph F. Keeling, MRD, Atmospheric Chemistry
Sean C. Kennan, PORD, Oceanography
Michael P. Kennedy, GRD, Geology
Charles F. Kennel, Director, Astrophysics
Graham M. Kent, IGPP, Geophysics
John F. Kerridge, CSI, Crystallography
Jochen Kinkle, PORD, Physics
John A. Knauss, PORD, Oceanography
Nancy Knowlton, MBRD, Zoology
Robert A. Knox, PORD/SOMTS/DD, Oceanography
Antonius Koppers, IGPP, Isotope Geochronology
Gerald L. Kooymans, CMBB, Geophysics
Julia Kubanek, MRD, Chemistry
William A. Kuperman, MPL, Marine Acoustics
Claudia Lainscsek, MPL, Physics
Devendra Lal, GRD, Nuclear Geophysics
Carina B. Lange, GRD, Marine Diatoms
John L. Largier, MLRG/CGC, Coastal and Estuarine Hydrodynamics
M. Gabrielle Laske, IGPP, Geophysics
Michael Latz, MBRD/CMBB, Marine Biology
Carol Lee, MBRD, Marine Biology
Alvo Lepland, MRD, Geology
Alan R. Levander, IGPP, Geophysics
Lisa A. Levin, MLRG, Marine Population and Community Ecology
Ralph A. Lewin, MBRD/CMBB, Marine Biology
Baosheng Li, IGPP, Geosciences
Leonard N. Liebmann, Physics/MPL, Physics
Thomas C. Lippmann, CCS, Nearshore Oceanography
Jurgen Lobert, CAS, Atmospheric Chemistry
Hubert Loisel, MPL, Environmental Sciences
Michael S. Longuet-Higgins, D-SIO/INLS, Applied Mathematics
Peter F. Lonsdale, MPL, Geology
Ralph Lovberg, PHY, Physics
Carl D. Lowenstein, MPL, Marine Physics
Dan Lubin, CAS/CSI, Atmospheric Physics
Timothy J. Lueker, MBRD, Oceanography
Gunter W. Lugmair, GRD, Geochemistry
Christine Anderson received the Claude E. ZoBell Fellowship for 2000–2001.

Kay D. Bidel won the 1999 Edward A. Frieman Director's Prize for the research paper "Accelerated Dissolution of Diatom Silica by Marine Bacterial Assemblages."

Russ Davis won the Henry Stommel Medal in Oceanography from the Woods Hole Oceanographic Institution for development of the Autonomous Lagrangian Circulation Explorer.

Paul Dayton, Mia J. Tegner, Peter Edwards, and Kristin Riser won the William S. Cooper Award of the Ecological Society of America for their study "Temporal and Spatial Scales of Kelp Demography: The Role of Oceanographic Climate."

Paul J. Schaefer was honored as a 1999 Headliner of the Year by the San Diego Press Club.

Joe Reid received the 2000 Maurice Ewing Medal from the American Geophysical Union.

Rob Rhew received the Edward A. Frieman Director Prize for Excellence in Graduate Student Research for his submitted paper in Nature.

Bill Schmidt received the Marine Technology Society Scholarship Award for 2000 for his "outstanding individual accomplishments in academics and participation in extracurricular activities."

Jeff Severinghaus received a David and Lucille Packard Foundation Fellowship to pursue his research in rapid climate change.

Richard J. Seymour was selected as a Marine Technology Society Fellow for his significant contributions to the society and in recognition of outstanding accomplishments in marine science and technology.

Richard C. J. Somerville received the Louis J. Battan Author's Award from the American Meteorological Society for his book The Forging Air: Understanding Environmental Change.

Fred N. Spiess won the Oliver Johnson Award for Distinguished Leadership in the Academic Senate from the University of California University-wide Academic Senate.

Mia J. Tegner was elected a Fellow in the American Association for the Advancement of Science "for research in marine ecology and fisheries science and for efforts to utilize science to improve public policy regarding the coastal environment and fisheries."

The Scripps Committee for Humanities and Public Service (ChiPS) received the Community Partnership Award by Diane Rose, mayor of Imperial Beach. The following Scripps staff, students, and friends were involved in ChiPS: Christine Salomon, Wendy Storms, Holger Michaelis, Scott Storms, Rob Rhew, Kevin Hardy, and Barbara Ransom.
"The Scripps fleet supported projects spanning the disciplines of ocean science for a wide range of principal investigators."

sio.ucsd.edu/supp_groups/shipsked
THE SCRIPPS FLEET EXPERIENCED a busy year. It supported projects spanning the disciplines of ocean science for a wide range of principal investigators, funded by an equally wide range of agencies. No single project stands out as more noteworthy than the rest. The noteworthy aspect is that the ships, the crews, and the technical support personnel have again demonstrated their remarkable capability to change from project to project, accommodating very different types of seagoing operations with minimal in-port times in which to transform one ship configuration into another.

Robert A. Knox
ASSOCIATE DIRECTOR, SHIP OPERATIONS
AND MARINE TECHNICAL SUPPORT

"The noteworthy aspect is that the ships, the crews, and the technical support personnel have again demonstrated their remarkable capability to change from project to project."

Seagoing REPORT
Operations
Ten chief scientists led 11 cruises to sites such as the Japan Sea, East China Sea, and waters off Russia. Scientific activities included hydrographic measurements and a gravity survey, SeaSoar operations, and ocean acoustics studies in the ASIAX project. Institutions conducting research aboard RV Roger Revelle included the U.S. Naval Oceanographic Office, the Naval Research Laboratory, Woods Hole Oceanographic Institution, the University of Hawaii, and the University of Rhode Island. Thomas Desjardins was captain. Christopher Curl and Morgan Turrell were relief captains.

**R/V Roger Revelle**

<table>
<thead>
<tr>
<th>Type</th>
<th>Oceanographic research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. Built</td>
<td>1996</td>
</tr>
<tr>
<td>Yr. Acquired by Scripps</td>
<td>1996</td>
</tr>
<tr>
<td>Owner</td>
<td>U.S. Navy</td>
</tr>
<tr>
<td>Length</td>
<td>275'</td>
</tr>
<tr>
<td>Beam</td>
<td>52.5'</td>
</tr>
<tr>
<td>Draft, full</td>
<td>17'</td>
</tr>
<tr>
<td>Displacement, full (tons)</td>
<td>3,350</td>
</tr>
<tr>
<td>Cruising Speed (knots)</td>
<td>12.5</td>
</tr>
<tr>
<td>Range (nautical miles)</td>
<td>13,000 @ 10 knots</td>
</tr>
<tr>
<td>Crew</td>
<td>22</td>
</tr>
<tr>
<td>Scientific Party</td>
<td>37</td>
</tr>
<tr>
<td>Total Distance Traveled</td>
<td>36,754 nautical miles</td>
</tr>
<tr>
<td>Operating Days</td>
<td>248</td>
</tr>
</tbody>
</table>

R/V Melville supported 13 expedition legs led by 13 chief scientists off the west coast of the United States and off the coasts of Mexico, Costa Rica, and Ecuador. Projects included seismicity studies, vertical line array and ATOC instrument recoveries, studies of gas hydrates and ocean acoustics, the gathering of radiometric data, and field testing of video and coring equipment. Other universities and agencies performing research included Oregon State University, U.S. Geological Survey, University of Washington, Naval Air Warfare Center, National Oceanic and Atmospheric Administration, Lamont-Doherty Earth Observatory, and the University of Hawaii. Eric Buck was captain. Christopher Curl and David Murline were relief captains.

**R/V Melville**

<table>
<thead>
<tr>
<th>Type</th>
<th>Oceanographic research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. Built</td>
<td>1969 (refitted, 1992)</td>
</tr>
<tr>
<td>Yr. Acquired by Scripps</td>
<td>1969</td>
</tr>
<tr>
<td>Owner</td>
<td>U.S. Navy</td>
</tr>
<tr>
<td>Length</td>
<td>278'10&quot;</td>
</tr>
<tr>
<td>Beam</td>
<td>46'</td>
</tr>
<tr>
<td>Draft, full</td>
<td>16.6'</td>
</tr>
<tr>
<td>Displacement, full (tons)</td>
<td>2,958</td>
</tr>
<tr>
<td>Cruising Speed (knots)</td>
<td>12</td>
</tr>
<tr>
<td>Range (nautical miles)</td>
<td>12,000 @ 10 knots</td>
</tr>
<tr>
<td>Crew</td>
<td>23</td>
</tr>
<tr>
<td>Scientific Party</td>
<td>38</td>
</tr>
<tr>
<td>Total Distance Traveled</td>
<td>34,336 nautical miles</td>
</tr>
<tr>
<td>Operating Days</td>
<td>248</td>
</tr>
</tbody>
</table>
RV New Horizon embarked 12 chief scientists on 14 cruises. Research included measurements of plate motion, ocean chemistry studies, CalCOFI data collection, copepod distribution surveys, a student cruise, ocean circulation charting, multibeam sonar survey, mooring equipment testing, and a marine mammal survey. The ship's destinations included several points off the coast of Oregon and California. Other institutions leading expeditions were Rutgers University, Naval Air Warfare Center, U.S. Naval Oceanographic Office, Naval Postgraduate School, and the National Oceanic and Atmospheric Administration. John Manion was captain. Relief captains were Christopher Curl and Albert Arsenault.

### RV Robert Gordon Sproul

RV Robert Gordon Sproul hosted 22 expedition legs led by 17 chief scientists with most of the activity taking place off California or the Columbia River estuary in Washington. Other universities and agencies conducting research on the ship included the University of Washington, the U.S. Geological Survey, UC Santa Cruz, Lawrence Livermore National Laboratory, and the University of South Carolina. Activities included sediment coring, estuary turbidity measurements, testing of instrumentation for air-sea interaction measurements, a biogeochemical survey, collection of benthic and pelagic life samples, observations of predator-prey relationships between shark and seals, mooring deployments, and field testing of seismometer sensors. Louis Zimm was captain. Roger Price and Christopher Curl were relief captains.

### R/P FLIP

R/P FLIP was towed to sea twice during the year. Chief scientists from Scripps led both expeditions in studies of ocean bubbles and ocean acoustics. Tom Golfinos was the officer in charge on FLIP throughout the year.

---

**Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Oceanographic research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. Built</td>
<td>1978</td>
</tr>
<tr>
<td>Yr. Acquired by Scripps</td>
<td>1978</td>
</tr>
<tr>
<td>Owner</td>
<td>University of California</td>
</tr>
<tr>
<td>Length</td>
<td>170'</td>
</tr>
<tr>
<td>Beam</td>
<td>36'</td>
</tr>
<tr>
<td>Draft, full</td>
<td>12'2.25&quot;</td>
</tr>
<tr>
<td>Displacement, full (tons)</td>
<td>1,007</td>
</tr>
<tr>
<td>Cruising Speed (knots)</td>
<td>10</td>
</tr>
<tr>
<td>Range (nautical miles)</td>
<td>9,600</td>
</tr>
<tr>
<td>Crew</td>
<td>12</td>
</tr>
<tr>
<td>Scientific Party</td>
<td>19</td>
</tr>
<tr>
<td>Total Distance Traveled</td>
<td>13,380 nautical miles</td>
</tr>
<tr>
<td>Operating Days</td>
<td>131</td>
</tr>
</tbody>
</table>

---

**Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Oceanographic research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. Built</td>
<td>1981</td>
</tr>
<tr>
<td>Yr. Acquired by Scripps</td>
<td>1984</td>
</tr>
<tr>
<td>Owner</td>
<td>University of California</td>
</tr>
<tr>
<td>Length</td>
<td>125'</td>
</tr>
<tr>
<td>Beam</td>
<td>32'</td>
</tr>
<tr>
<td>Draft, full</td>
<td>9'6&quot;</td>
</tr>
<tr>
<td>Displacement, full (tons)</td>
<td>696</td>
</tr>
<tr>
<td>Cruising Speed (knots)</td>
<td>9</td>
</tr>
<tr>
<td>Range (nautical miles)</td>
<td>3,250</td>
</tr>
<tr>
<td>Crew</td>
<td>5</td>
</tr>
<tr>
<td>Scientific Party</td>
<td>12</td>
</tr>
<tr>
<td>Total Distance Traveled</td>
<td>8,190 nautical miles</td>
</tr>
<tr>
<td>Operating Days</td>
<td>105</td>
</tr>
</tbody>
</table>

---

**Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Floating instrument platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr. Built</td>
<td>1962</td>
</tr>
<tr>
<td>Yr. Acquired by Scripps</td>
<td>1962</td>
</tr>
<tr>
<td>Owner</td>
<td>U.S. Navy</td>
</tr>
<tr>
<td>Length</td>
<td>355'</td>
</tr>
<tr>
<td>Beam</td>
<td>20'</td>
</tr>
<tr>
<td>Draft, full</td>
<td>12'</td>
</tr>
<tr>
<td>Displacement, full (tons)</td>
<td>varies*</td>
</tr>
<tr>
<td>Cruising Speed (knots)</td>
<td>varies*</td>
</tr>
<tr>
<td>Range (nautical miles)</td>
<td>varies*</td>
</tr>
<tr>
<td>Crew</td>
<td>4 in port, 5 underway</td>
</tr>
<tr>
<td>Scientific Party</td>
<td>11</td>
</tr>
<tr>
<td>Total Distance Towed</td>
<td>1,240 miles</td>
</tr>
<tr>
<td>Operating Days</td>
<td>40</td>
</tr>
</tbody>
</table>

* Dictated by the towing vessel.
"Friends of the institution gave roughly $5.4 million in pledges, gifts, grants, and gifts-in-kind."

sio.ucsd.edu
SCIPP S INSTITUTE OF OCEANOGRAPHY

was the beneficiary of unprecedented generosity in fiscal year 2000. Friends of the institution gave roughly $5.4 million in pledges, gifts, grants, and gifts-in-kind from individuals, corporations, foundations, and organizations. The total number of gifts received in fiscal year 2000 was 2,170, breaking the previous record for a single fiscal year of 2,020 set in fiscal year 1999.

Scripps Institution of Oceanography depends on private support for new buildings and equipment, new faculty positions, new fellowships, seed funding for new research projects, and much more. The gifts received help fund projects aimed at protecting marine life and marine ecosystems, create technology breakthroughs in ocean science, and establish an understanding of major changes taking place in our global environment. These gifts make it possible to connect research efforts by the world's leading oceanographic institutions, to provide access to education for students who would not otherwise be able to pursue careers in oceanography, and to inform the public regarding scientific discoveries.

Research support remained the major focus for giving at Scripps with a combination of continuing contributions and new gifts. Among them was an $850,000 grant from the G. Unger Vetlesen Foundation, which is funding global change research at Scripps for the twelfth consecutive year. The Cecil H. and Ida M. Green Foundation for Earth Sciences continued its support for the Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics with gifts valued at more than $325,000. The Andrew Mellon Foundation continued its support for beach research by awarding a grant of $436,000, and the Tinker Foundation gave $120,000 for additional marine life research in the Sea of Cortés.

William and Patricia Todd gave an additional charitable remainder trust valued at $540,000. This brings their planned gift total to more than $170,000 during the past two years. The Joan Irvine Smith and Athalie R. Clarke Foundation continued their support of Scripps through a $50,000 grant to support research on kelp forests and marine protected areas.

Notable new gifts included support from Scripps alumnus and professor Walter Munk. After Munk won the Kyoto Prize in 1999, he and his wife Judith donated the prize money ($423,000) to establish the Kyoto-Munk Fund, an endowment to support daring research. The Rockefeller Brothers Fund, the Surdna Foundation, the Richard Lounsbery Foundation, and the Alfred P. Sloan Foundation contributed a total of $329,250 in support of the Partnership for Observation of the Global Oceans (POGO), an international group of oceanographic institutions. The Seaver Institute gave $100,000 to fund development of a towed fiber-optic sensor array.

In the area of graduate education, the Los Angeles and San Diego Chapters of the ARCS Foundation continued their steadfast support for fellowships at Scripps; several individuals also demonstrated their commitments to students. For instance, Jean ZoBell established the Claude E. ZoBell Endowed Fellowship in honor of her late husband, the noted Scripps marine microbiologist. Albert Boyer made a planned gift of $30,000 toward endowed fellowships for first-year students. This brings his total to more than $100,000 in planned gifts for first-year fellowships.

Boyter's gift, along with several others during the year, helped to complete the $300,000 challenge from the Henry L. and Grace Doherty Charitable Foundation for endowed first-year fellowships. Also part of the Doherty match, the Masserini Charitable Trust contributed $50,000 to endow the Maurice J. Masserini Fellowship. In addition, Ellis Wyer, a member of the Scripps family, provided support to fund a full fellowship for a first-year student.

Support for outreach included funding from several sources for the Robert Paine Scripps Center, a new facility to host meetings for scientists and policy makers. Children and grandchildren of Robert Paine Scripps contributed $650,000. Scripps Director's Cabinet members Maurice Kaplan and Shelia Davis issued challenges for the project of $100,000 and $250,000, respectively. Former Scripps staff member Frances Parker gave $50,000 to establish a program in public education in earth sciences.

The Fish Ball, co-chaired by community volunteers Jane Trevor Fetter and Noreen Muliken, was a great success with more than 450 people in attendance. It brought in more than $280,000 in underwriting and ticket sales, with the net proceeds supporting a new seahorse exhibit at the Birch Aquarium at Scripps. Other aquarium gifts came from Pearl Collett Black, an artist and longtime friend, who provided $50,000 through her estate and the Kenneth T. and Eileen L. Norris Foundation, which gave a $50,000 grant to enhance the Birch Aquarium's kelp forest exhibit.

We thank these donors and all those who, through their contributions of money and time, continue to make Scripps a world-class institution. On the following pages, a list of Scripps donors appears.

R. Lawrance Bailey
DIRECTOR OF DEVELOPMENT
# Financial Support for 7/1/99 – 6/30/00

## Federal, State, and City Agencies

**United States**  
Defense, Department of  
Air Force  
Defense Special Weapons Agency  
Navy, Department of the  
Naval Research Laboratory  
Office of Naval Research  
Space & Naval Warfare Systems Center  
Energy, Department of  
Health and Human Services, Department of  
National Institutes of Health  
Institute of Museum Services  
Interior, Department of the  
Minerals Management Service  
U.S. Forest Service  
U.S. Geological Survey  
National Aeronautics and Space Administration  
National Oceanic and Atmospheric Administration  
National Science Foundation  

**California, State of**  
The Resources Agency of California  
Department of Boating and Waterways  
Department of Water Resources  

**San Diego, City of**  

## Corporations/Foundations/Organizations

- AGIP Petroleum  
- AirBob  
- Allied Signal Foundation Inc.  
- Amaryllis Foundation  
- Anthony's Fish Grotto, Inc.  
- ARCS Foundation, Los Angeles Chapter  
- ARCS Foundation, San Diego Chapter  
- Barbara L. and Richard C. Barrett Family Foundation  
- Battelle Pacific Northwest Laboratory  
- The Beyster Family Foundation  
- Bidland.com  
- British Petroleum  
- Bureau of Rural Sciences  
- The Burnham Foundation  
- California Institute of Technology  
- The Casner Family Foundation  
- Chevron Petroleum Technology Company  
- Chicken of the Sea International, Inc.  
- Clearwater Instrumentation, Inc.  
- William Clewes Technical Services, Inc.  
- Comprehensive Test Ban Treaty Organization  
- Conoco, Inc.  
- The Corporate Service Group, LTD.  
- Cubic Corporation  
- Bob Davis Camera Shop, Inc.  
- Del Mar Union Foundation Trust  
- Delagnes, Mitchell & Linder  
- Delawie, Wilkes, Rodrigues, Barker & Bretton AIA  
- Deutscher Wetter Dienst  
- Diverse Corporation  
- Dole Food Company, Inc.  
- Dow Chemical Company  
- Electric Magnetic Instruments, Inc.  
- The Events Group, Inc.  
- ExxonMobile  
- Willis and Jane Fletcher Foundation  
- Gaia Day Spa  
- Golden State Flying Club  
- Cecil H. and Ida M. Green Foundation for Earth Sciences  
- Harvard University  
- Haygood Associates, Inc.  
- The William & Flora Hewlett Foundation  
- Hillyer & Irwin, TTEES  
- Homer Productions  
- Hyatt Regency La Jolla  
- IAI, Brazil  
- Incorporated Research Institutions for Seismology  
- Incredible Journeys, Inc.  
- Invitrogen  
- Isis Pharmaceuticals, Inc.  
- ITLA Capital Corp.  
- Ives Hardwood Flooring  
- Jet Propulsion Laboratories  
- Joint Oceanographic Institutions  
- KPMG Foundation  
- Lawrence Livermore National Laboratory  
- Los Alamos National Laboratories  
- Louisiana State University  
- Richard Lounsbery Foundation, Inc.  
- Donald A. Madden Consulting, Inc.  
- Mankoff Family Foundation  
- Massachusetts Institute of Technology  
- Maurice J. Masseinix, Charitable Trust  
- Maxwell Technologies  
- McCarthy Family Foundation  
- The Andrew W. Mellon Foundation  
- Metocean Data Systems Limited  
- Miramar & Company  
- Mitchell Energy & Development Corporation  
- Monsanto Company  
- Moore Family Foundation  
- NASDA  
- Neurus  
- Kenneth T. & Eileen L. Norris Foundation  
- NVL, Inc.  
- Permanent Solutions, Inc.  
- Pew Charitable Trusts  
- The Pittsburgh Foundation  
- Planet Fitness  
- The Ponagansett Foundation, Inc.  
- Princeton University  
- Promote La Jolla, Inc.  
- RACAL NCS, Inc.  
- Rancho Bernardo Inn  
- Raphael Industries  
- The Resort Group, Inc.  
- Robins Family Foundation  
- Rockefeller Brothers Fund, Inc.  
- Joseph Rosen Foundation  
- Sandia National Laboratories  
- The San Diego Foundation  
- San Diego Mission Valley East Rotary Club Charities  
- San Diego National Bank  
- Walter Schirra Enterprises  
- David Schwartz Foundation Inc.  
- Science Applications International Corporation (SAIC)  
- Ellen Browning Scripps Foundation  
- Scubapro Marketing Department  
- SDG&E  
- The Seaver Institute  
- Shell EP International Ventures Inc.  
- Shell Oil Company  
- Shin-etsu, Inc.  
- Alfred P. Sloan Foundation  
- The SHR Foundation  
- SMH Entertainment, Inc.  
- Joan Irvine Smith and Athalie R. Clarke Foundation  
- Space.com, Inc.  
- The Spencer Law Firm  
- Star & Crescent Boat Company  
- Surdna Foundation, Inc.  
- Székely Family Foundation  
- Tahoe Baikal Institute  
- Herman P. and Sophia Taubman Foundation  
- Tenet Healthcare Corporation  
- Texas AAM Research Foundation  
- Texas A&M University  
- Tiffany and Company  
- The Tinker Foundation, Inc.  
- TSKA, Inc.  
- Union Bank of California, N.A.  
- United Nations University  
- Universities Space Research Associates  
- University of Alaska  
- University of California, Berkeley  
- University of California, Davis  
- University of California, Santa Barbara  
- University of Delaware  
- University of Oklahoma  
- University of Southern California  
- University of Washington  
- G. Unger Vetlesen Foundation  
- Waitt Family Foundation  
- Wells Fargo & Company  
- Wildlife Computers, Inc.  
- Willow Designs & Interiors  
- Woods Hole Oceanographic Institution

## Individuals

- Mr. and Mrs. Richard M. Abney  
- Ms. Therese Ades-George  
- Mr. and Mrs. Joseph S. Albin, TTEES  
- Ms. Trish Alessio
Mr. and Mrs. Rand L. Alexander
Mr. and Mrs. Charles Allen, Jr.
Mr. and Mrs. Willis M. Allen
Ms. Marty Allenby
Muriel B. Alpen
Mr. and Mrs. Pat Amendola
Mr. and Mrs. Walter A. Andersen
Dr. Edward Anderson and
Ms. Joan Parsons
Mr. and Mrs. George C. Anderson
Mr. and Mrs. Mark G. Anderson
Mr. and Mrs. Victor Anderson
Dr. and Mrs. Craig Andreiko
Mr. and Mrs. Bryan Andrus
Anonymous
Mr. and Mrs. Stephen A. Antoniuk
Mrs. Joy A. Ari
Mr. and Mrs. Stanford L. Asato
Mr. and Mrs. Wilton L. Atkinson
Mr. David W. Ault and
Ms. Linda S. Robinson
Ms. Patricia Austin
Dr. and Mrs. Jim Backhaus
Mrs. Anna L. Baiza
Mr. Leon Baginski
Mr. and Mrs. R. Lawrence Bailey
Dr. and Mrs. Robert H. Baker
Mr. and Mrs. D. A. Baldwin
Mr. and Mrs. Gene Barduson
Mr. and Mrs. Eugene Barnyak
Mr. and Mrs. Richard C. Barrett
Dr. Elizabeth L. Barrett-Connor
Mrs. Ina Bartell
Mr. and Mrs. Stephen J. Bartram
Mr. and Mrs. Robert J. Basila
Mr. Ralph P. Baty
Ms. Marie E. Baxter
Mr. and Mrs. Jeffrey I. Becker
Mr. and Mrs. James R. Beeler
Mr. John R. Beers
Mr. and Mrs. Jim Belasco
Dr. Gerald A. Belkin
Mr. and Mrs. Roy M. Bell
Ms. Barbara Bennett
Mr. Douglass Bennett
Ms. Jacklyn R. Bennett
Dr. and Mrs. Andrew A. Benson
Mr. and Mrs. Roger S. Benson
Mr. Brian Bertler
Mr. Carl A. Bergard
Dr. and Mrs. Wolfgang Berger
Mr. and Mrs. Robert Bernard
Ms. Joan J. Bernstein
Mrs. Margery M. Berthard
Mr. and Mrs. Merle J. Bevis, Jr.
Ms. Lonsdakey Beyer
Dr. and Mrs. J. Robert Beyster
Mr. and Mrs. William D. Bickel
Lois B. Biddle Trust
Mr. and Mrs. Lyle G. Bien
Ms. Pearl Collett Black
Mr. and Mrs. Carl Blackwell
Mr. Craig Blackwood and
Ms. Mary Kalra
Mr. and Mrs. Thomas B. Blair, II
Mr. C. W. Blake
Dr. and Mrs. Gene Blickenstaff
Barbara W. Blomgren Trust
Ms. Barbara W. Blomgren
Dr. and Mrs. Colin M. Bloom
Mr. and Mrs. David C. Boattwright
Mr. and Mrs. Jack Bodfewes
Ms. Susan J. Bohlin
Mrs. and Mr. Carolyn S. Bolline
Mr. and Mrs. Charles A. Bollinger
Mr. and Mrs. James A. Bondoux
Mr. Gaylyn N. Boone
Ms. Jean Booth
Ms. Ginger Boss
Dr. James L. Bowers
Mr. Peter Bowers
Mr. Albert Boyer
Dr. Bruce Braciszewski
Ms. Jill A. Bradburn
Mr. Dan Bradley
Dr. and Mrs. Hugh Bradner
Mr. and Mrs. Turner G. Brashare
Dr. Andrew Breiterman
Dr. and Mrs. James Bright
Mr. William Bristol
Mr. and Mrs. Anthony P. Broad
Mr. and Mrs. Arthur Brody
Ms. Susan C. Brody
Mr. and Mrs. Paul and Joyce Brooks
Mr. and Mrs. Douglas Brown
Mr. and Mrs. Fowler M. S. Brown
Mr. and Mrs. Hal W. Brown
Mrs. Ilana S. Brown
Mr. Joseph P. Brown
Ms. Lillian E. Brown
Mr. and Mrs. Richard George Brown
Dr. and Mrs. William H. Browning
Mrs. Stuart Bruder
Mr. Terrance J. Bruggeman
Ms. Elizabeth Brummitt
Mr. and Mrs. Edward O. Buchanan
Mr. Bruce C. Burgener and
Ms. Gloria J. Hoff
Mr. John Davis Burky
Mrs. Esther J. Burnham
Mr. and Mrs. Malin Burnham
Mr. Dennis P. Burton
Mr. and Mrs. Philip Burton
Ms. Shirley Busch
Mr. Robert A. Buzzelli
Mr. Charles C. Byer
Mr. and Mrs. Ben J. Cagle
Mr. James L. Cainis
Mr. and Mrs. Jeff Calcarra
Mr. and Mrs. Alexander Ones Calhou
Ms. Lane Campbell
Mr. and Mrs. Robert R. Campbell
Mr. and Mrs. Sam Campbell
Ms. Janelle Cannon
Mr. Martin J. Capdevilla and
Ms. Wendy Gillespie
Mr. and Mrs. Robert Carley
Mr. and Mrs. James H. Carmel
Dr. Nancy M. Carmichael
Mr. Jerry Carola
Mr. and Mrs. Gordon Carter
Mr. and Mrs. Hugh Carter
Ms. Jolie Cartier
Drs. Marjorie and Frederick Caserio
Mr. and Mrs. Francis A. Casserto
Ms. Mary Louise Castagnola
Mr. and Mrs. John W. Chamberlain
Ms. Ruth H. Chambers
Dr. and Mrs. Jeffrey Chang
Dr. and Mrs. Gregory Chapelle
Mr. Thomas H. Chapman
Mr. Roger A. Chastain
Ms. Shirley M. Chervin
Mr. and Mrs. Andrew J. Chitiea
Mr. and Mrs. Larry Christensen
Mr. and Mrs. James V. Cimino
Mrs. Lauraett W. Cipra
Mr. David Clapp and
Ms. Gayle Barsaman
Mr. and Mrs. J. Dallas Clark
Ms. Bunny Clews
Mr. Tom Cloffetter
Dr. Mark W. Cocalis
Mrs. Bettie P. Cody
Mr. George S. Cohen, II
Mr. and Mrs. George N. Coleman
Mr. and Mrs. Jack I. Coleman
Mr. and Mrs. John Coleman
Mr. and Mrs. Lawrence W. Coleman
Mr. and Mrs. Tom Collins
Mr. and Mrs. Brian Conkie
Dr. Alan J. Conrad
Mr. and Mrs. G. A. "Coop" Cooprider
Mr. and Mrs. Dempsey D. Copeland
Mr. and Mrs. Michael C. Copley
Dr. and Mrs. Steven N. Copp
Mr. and Mrs. Joseph Corduan
Ms. Henriette Corwin
Ms. and Mrs. Milton H. Convin
Mr. and Mrs. George L. Cory
Mrs. Judy Courtemanche
Dr. and Mrs. Gary K. Cowell
Mr. and Mrs. Edward W. Cox
Dr. and Mrs. Harmon Craig
Mr. and Mrs. Sid Craig
Mr. and Mrs. Steven M. Craig
Mr. and Mrs. William R. Cramer
Mr. and Mrs. Perry J. S. Crampton
Mr. Walter Crampton
Mr. and Mrs. Allen A. Crane
Mr. Jose R. Criad
Mr. and Mrs. Albert Cristian
Mr. Thomas H. Critchlow
Ms. Deborah Law Cross
Ms. Alice C. Crosser
Mr. and Mrs. Kim C. Crosser
Mr. and Mrs. Thomas L. Crow
Mr. Joseph H. Currie
Ms. Jamie L. Curtis
Mrs. Joyce Cutter Shaw and
Mr. Jerome Shaw
Mr. Ronald A. Dahlin
Mrs. Lynn Dailey-Vondracek and
Mr. John E. Vondracek
Dr. Donald J. Dalesio and
Ms. Leanne Hull MacDoughall
Mr. and Mrs. James E. Daly
Mr. and Mrs. Frederick L. D’Ambrosi
Mr. Stanley Dashaw
Davis Family Trust
Mr. and Mrs. Hudson P. Davis
Mr. and Mrs. Joe Davis
Mr. and Mrs. Peter Q. Davis
Ms. Ruth F. Davis
Ms. Barbara Dawson
Ms. Elizabeth W. Dawson
Mr. Julian Day and Ms. Kathleen Healy
Mr. and Mrs. James E. De Lano
Ms. Maude De Schauensee
Mr. and Mrs. Charles William Dealy, Jr.
Mr. and Mrs. Alex Debakcy
Mr. and Mrs. Eugene A. Defalco
Mr. and Mrs. Jon D. Demorest
Dr. Dale Dennis
Dr. Edward A. and Martha G. Dennis
Mr. and Mrs. Victor S. Dennis
Mr. and Mrs. Kelly K. DePorte
Mr. and Mrs. Joseph Wayne Derrinet
Mr. and Mrs. Michael H. Dessart
Mr. and Mrs. George DeVries
Mr. William H. Disher
Mr. and Mrs. Donald Dinsley
Ms. Nancy Dodds
Mr. and Mrs. Stephen Doering
Mr. Patrick A. Doherty
Mr. and Mrs. William B. Doherty
Mr. and Mrs. John G. Dolan
Mr. Richard G. Dooley
Mr. and Mrs. James E. Doolittle
Mr. and Mrs. J. S. Dorobek, II
Mr. and Mrs. Joe Dottore
Dr. and Mrs. Glen P. Dougherty
Ms. Frances Dufresne
Ms. Patty A. Duncan
Mr. and Mrs. Steve M. Dunn
Ms. Carol A. Durst
Mr. and Mrs. Robert H. Dyre, Jr.
Mr. and Mrs. Burland B. East
Mr. and Mrs. Paul Ecke
Mr. Bernard Eckler
Mr. and Mrs. Frank Eckert
Ms. Joyce Edgar
Mr. and Mrs. Mark Edmead
Mr. Thomas A. Edwards
Mr. and Mrs. Michael B. Effie
Mr. and Mrs. Stuart Ehrenreich
Mr. and Mrs. William W. Eigner
Ms. Paula Eisenhart
Mr. and Mrs. Scott S. Eiler
Mr. Donn G. Ellerbrock
Mr. Michael S. Ellison, II
Mr. and Mrs. Joseph Engebretson
Ms. Donna M. Engel
Mr. Harry C. Engle
Ms. Jeanne Engler
BIRCH AQUARIUM GROUPERS
Ms. Meg Adams and Mr. Enidio Del Conte
Mr. and Mrs. Roy Bell
Mr. and Mrs. James Cimino
Mr. David Boyle and Ms. Anne Taubman
Mr. Marty Capdevila and Ms. Wendy Gilespie
Mr. Julian Day and Ms. Kathleen Healy
Mr. and Mrs. Bill Elgin
Mr. and Mrs. Charlie Ewell, Jr.
Mr. and Mrs. Thompson Fetter
Mr. Marvin Gerst
Mr. and Mrs. Rick Gulley
Ms. Kathryn Harr
Mr. Robert Horsman and Ms. Katherine Kennedy
Ms. Joanne Huffman
Mr. Ian Gil and Ms. Gail Stoorza
Mr. John McGlynn and Ms. Robin Young
Mr. and Mrs. David Mulliken
Mr. and Mrs. Tom Reed
Mr. and Mrs. Wil Roult
Dr. and Mrs. Ned Smith
Ms. Lori J. Steele
Mr. and Mrs. Sean Welsh
Dr. and Mrs. David Wolf

BIRCH AQUARIUM CORPORATE PARTNERS
A Catered Affair
Carriage Trade Catering
Catering by Design
Certified Folder Display Service, Inc.
City Channel
Cloud 9 Shuttle
Crown Point Catering, Inc.
Culinary Concepts
Delawie Wilkes, Inc.
Shuttle Concepts
Sandicast, Inc.
 KPBS Public Broadcasting
 La Jolla Beach and Tennis Club, Inc.
 Sea Lodge Hotel
 The Shores Restaurant at the Sea Lodge
 Marine Room Restaurant
 Ocean Enterprises
 Peartrees Catering, Inc.
 Robert F. Driver Co., Inc.
 Sandicast, Inc.
 San Diego Gas & Electric
 San Diego Marriott Hotel and Marina
 San Diego National Bank
 San Diego This Week, Inc.
 Science Applications International Corporation (SAIC)

Scripps Oceanographic Society Members
Special thanks to our 6,500 members whose dues help to support the Birch Aquarium and Scripps operations. We also thank SOS lifetime members Mr. Adam C. Brover, Mr. and Mrs. Leo Rotter, and Mr. Sam Stein for their continued support.

(h) denotes honorary member
(I) denotes lifetime member
The results of Scripps research are published in many different forms. These publications range from short contractual reports to long taxonomic descriptions. A listing of recent Scripps publications follows. Information on the availability of each series is included.

sio.ucsd.edu/supp_groups/techpubs


OTHER WORKS
This section contains books, articles, and other materials published by Scripps faculty and staff during the 2000 fiscal year. Works listed have been submitted by the authors and may cover any subject matter of interest to the general Scripps community.


Scripps Institution of Oceanography Reference Series

The Scripps Institution of Oceanography Reference Series includes data reports, preliminary research reports, historical reports, and contractual reports distributed mainly under government contracts. There is no mailing list for this series. For inquiries about the reference series and requests for free copies of the yearly and multiyear bibliographies, please write to:

University of California San Diego
Scripps Institution of Oceanography
Naga Reports
9500 Gilman Drive Dept 0210
La Jolla CA 92030-0210.


99-4 Canceled


99-15 Canceled


SEA GRANT PUBLICATIONS

The publications listed below can be obtained by writing to:

California Sea Grant College System
University of California San Diego
9500 Gilman Drive Dept 0232
La Jolla CA 92039-0232

REFERENCE SERIES


TECHNICAL SERIES


MARINE EXTENSION PUBLICATIONS


Johnson, L. T. Make every day a clean boating day: Here's what you can do! 1998. Poster.
Financial programming has been modified to more accurately reflect expenditures within all Scripps divisions. Previous programming allowed some forms of revenue to offset expenditures, resulting in an understatement of expenses. New financial programming utilized by Scripps captures this revenue as income, rather than as a reduction in expenditures. New programming also recognizes the impact on expenditures of transferring funds to other universities or UC campuses.

This statement does not purport to present all annual expenditures associated with operating the institution. Many services provided by campus departments outside Scripps are not reflected in Scripps annual expenditures. Examples of campus provided services include building construction and maintenance, parking lot and road maintenance, utilities, seawater utilities, custodial services, landscaping and grounds maintenance, accounting, payroll, and personnel services.

Tom Collins
Deputy Director

<table>
<thead>
<tr>
<th>FEDERAL FUNDS</th>
<th>PREVIOUS PROGRAMMING EXPENDITURES</th>
<th>% of Total</th>
<th>NEW PROGRAMMING EXPENDITURES</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Science Foundation</td>
<td>$29,240,706.97</td>
<td>25.48</td>
<td>$28,897,337.80</td>
<td>20.89</td>
</tr>
<tr>
<td>Department of the Navy</td>
<td>$16,702,813.81</td>
<td>14.55</td>
<td>$16,702,846.91</td>
<td>12.07</td>
</tr>
<tr>
<td>National Aeronautics and Space Administration</td>
<td>$17,772,128.25</td>
<td>15.49</td>
<td>$17,667,033.74</td>
<td>12.77</td>
</tr>
<tr>
<td>National Oceanic and Atmospheric Administration</td>
<td>$10,517,857.72</td>
<td>9.17</td>
<td>$10,616,220.19</td>
<td>7.67</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>$1,268,403.71</td>
<td>1.11</td>
<td>$1,261,390.85</td>
<td>0.91</td>
</tr>
<tr>
<td>Other Federal</td>
<td>$3,233,950.17</td>
<td>2.82</td>
<td>$3,446,320.85</td>
<td>2.49</td>
</tr>
<tr>
<td>Other Department of Defense</td>
<td>$621,303.00</td>
<td>0.54</td>
<td>$591,356.00</td>
<td>0.43</td>
</tr>
<tr>
<td>Federal Flowthru</td>
<td>$3,659,120.91</td>
<td>3.19</td>
<td>$3,721,693.28</td>
<td>2.69</td>
</tr>
</tbody>
</table>

| TOTAL Federal | $83,016,284.54 | 72.34 | $82,904,199.62 | 59.92 |

<table>
<thead>
<tr>
<th>OTHER</th>
<th>PREVIOUS PROGRAMMING EXPENDITURES</th>
<th>% of Total</th>
<th>NEW PROGRAMMING EXPENDITURES</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>State General Funds</td>
<td>$21,242,783.91</td>
<td>18.51</td>
<td>$21,274,629.66</td>
<td>15.38</td>
</tr>
<tr>
<td>Private Gifts and Grants</td>
<td>$3,458,130.39</td>
<td>3.01</td>
<td>$3,561,115.96</td>
<td>2.57</td>
</tr>
<tr>
<td>University Funds</td>
<td>$1,904,505.85</td>
<td>1.66</td>
<td>$2,232,914.95</td>
<td>1.61</td>
</tr>
<tr>
<td>State of California</td>
<td>$1,622,911.54</td>
<td>1.41</td>
<td>$1,622,911.54</td>
<td>1.17</td>
</tr>
<tr>
<td>Endowments</td>
<td>$1,019,617.49</td>
<td>0.89</td>
<td>$1,048,559.36</td>
<td>0.76</td>
</tr>
<tr>
<td>Other</td>
<td>$2,493,193.04</td>
<td>2.17</td>
<td>$25,713,842.76</td>
<td>18.58</td>
</tr>
</tbody>
</table>

| TOTAL Other | $31,741,142.22 | 27.66 | $55,453,974.23 | 40.08 |

| TOTAL EXPENDITURES | $114,757,426.76 | 100.00 | $138,358,173.85 | 100.00 |

Scripps Institution of Oceanography
1999 Census / 1,698 Total
ORGANIZATION
FOR 7/1/99-6/30/00

Chancellor
Robert C. Dynes

OFFICE OF THE DIRECTOR
Director, Vice Chancellor Marine Sciences & Dean of Marine Sciences
Charles F. Kennel

Deputy Director, Scientific Affairs & Associate Vice Chancellor of Marine Sciences
William S. Hodgkiss

Executive Assistant to the Director
Doug Bennett

Director, International Relations
Lisa R. Shaffer

Associate Director, Ship Operations & Marine Technical Support
Robert A. Knox

Associate Dean, Marine Sciences
Ray F. Weiss

Deputy Director, Administrative Affairs
Tom Collins

Director, Government Relations
Kathleen E. Ritzman

Executive Director, Birch Aquarium at Scripps
Ned A. Smith

INSTRUCTION SPECIAL RESEARCH UNITS RESEARCH DIVISIONS LABORATORIES UC INSTITUTES
SIO Graduate Department
Chair
W. K. Melville
Vice Chair
Guy Masters

CAS
V. Ramanathan
CCS
R. T. Guza
MLRG
M. M. Mullin

CRD
D. R. Cayan
GRD
Jeremy Jackson
MBRD
R. R. Hessler
MRD
J. M. Gieskes
PORD
D. P. Rogers

CMBB
W. H. Fenical
MPL
W. A. Kuperman

CAS
Center for Atmospheric Sciences
CCS
Center for Coastal Studies
CMBB
Center for Marine Biotechnology and Biomedicine
CRD
Climate Research Division
GRD
Geosciences Research Division
IGPP
Institute of Geophysics and Planetary Physics
MBRD
Marine Biology Research Division
MLRG
Marine Life Research Group
MPL
Marine Physical Laboratory
MRD
Marine Research Division
PORD
Physical Oceanography Research Division

CURRICULAR GROUPS
Applied Ocean Science
Biological Oceanography
Climate Sciences
Geological Sciences
Geophysics
Marine Biology
Marine Chemistry & Geochemistry
Physical Oceanography

CALSPACE
California Space Institute

D. Lubin

J. A. Orcutt

W. H. Fenical

W. A. Kuperman
SIO COUNCIL
Joseph Coors
Shelia Marie Davis
Sandra Faber
Edward Frieman
Robert Frosch
David Gardner
George Mitchell
Gordon Moore
Clyde Ostler
William Owens
Frank Press
Louis Simpson
J. Craig Venter
A. Thomas Young

DIRECTOR'S CABINET
Fred Borrelli
Malin Burnham
James Cimino
Kathleen Healy
Art Engel
Anne Evans
Edgar M. Gillenwaters
Maurice C. Kaplan
Herb Klein
David Malcolm
William Nelson
Tom Page
Russell S. Penman IV
Charles Robins
Linda Robinson
William H. Scripps
Alex Szekely
Julie Meier-Wright

Ex Officio Members
Lawrence Bailey
Cindy Clark
Charles F. Kennel
James Langley
(UCSD ex officio member)
W. Kendall Melville
Ned Smith
In Memoriam

Easter Ellen Cupp
August 1999
Easter Ellen Cupp was the first woman in the United States to receive a doctorate in oceanography. In 1934, she received a Ph.D. in biological oceanography from Scripps. She went on to research plankton, and her 1943 book Marine Plankton is still used by researchers today.

Arthur Datus Raff
August 1999
Arthur Datus Raff joined the newly established Marine Physical Laboratory shortly after World War II. With colleague Ronald Mason, he was the first engineer to illustrate lines of magnetic stripes on the ocean floor. He was on the Capricorn Expedition in 1952-1953.

John Lawrence McHugh
August 1999
John Lawrence McHugh received his Ph.D. from Scripps and was a professor of marine resources at the State University of New York, Stony Brook for 14 years. Prior to that, he was chief of biological research at the Federal Bureau of Commercial Fisheries and former director of the Virginia Fisheries Laboratory at the Virginia Institute of Marine Science of William & Mary College.

Thyra Fleming
September 1999
Thyra Fleming worked at Scripps for almost 24 years serving in various administrative capacities in MLRG, IMR, Sea Grant, MRD, CRD, CSI, JIMO, and the director's office. She was the management services officer for the Institute of Marine Resources and later for the Marine Research Division. Thyra was noted for her integrity, spirituality, and great sense of humor.

Bob Snodgrass
October 1999
Former senior aquarist and lifelong friend of Scripps, Bob Snodgrass began his career at the old Scripps Aquarium as a Junior Oceanographer. His tenure at the aquarium as a full-time employee spanned two decades. He helped design and outfit the Birch Aquarium. He retired in 1998.

Seibert Q. Duntley
October 1999
Seibert Q. Duntley was director of the Visibility Laboratory at Scripps from 1952 to 1975, ushering it through many achievements. He also led the lab through controversial times, most notably the student protests against its partial CIA funding. Duntley's awards included the Army-Navy Certificate of Appreciation and the Frederic Ives Medal, the highest honor of the Optical Society of America.

James Edward Rupert
November 1999
James Edward Rupert joined Scripps in 1952 after having served as a U.S. Navy photographer during World War II and at the Naval Electronics Laboratory in San Diego. He was head of the Photo Laboratory here at Scripps before retiring in 1987.

John Francis Spanbauer
December 1999
John Francis Spanbauer was a crew member on several Scripps research vessels including the Oconostota, Argo, Alpha Helix, Thomas Washington, and Alexander Agassiz from 1967 to his retirement in 1991.

Robert Karl Johnson
May 2000
Robert Karl Johnson received his Ph.D. in 1972 from Scripps and became an established authority on deep-sea fishes. Johnson began his career at the Chesapeake Biological Laboratory of the University of Maryland Center. He later worked at the Field Museum of Natural History in Chicago and at the Grice Marine Laboratory in Charleston, South Carolina.

Harry Grow
June 2000
Harry Grow began his career at Scripps as a laboratory technician and went on to become the management services officer for the Scripps Graduate Department. He retired after working at Scripps for nearly 30 years. Grow also was a dedicated volunteer, especially with the Boy Scouts of America.

Willard Bascom
September 2000
Willard Bascom was a preeminent ocean engineer who pioneered the use of scuba for scientific diving on Scripps's Capricorn Expedition. A friend of author John Steinbeck and marine biologist Ed Ricketts, Bascom was also president of Ocean Science and Engineering, Inc. and director of the Southern California Coastal Water Research Project.

William A. Nierenberg
September 2000
William A. Nierenberg served as Scripps's seventh and longest serving director. Before leading Scripps, he had distinguished himself in several fields of underwater research and warfare in addition to his distinguished career as a physicist. Nierenberg was active in science policy and had been a consultant to several government agencies. He retired in 1996, after receiving numerous honors.

Mildred Rogers
September 2000
Mildred Rogers began her career at Scripps as secretary to Dr. Roger Revelle in July 1952. She retired 25 years later after having also worked with Drs. Fred Spiess and George Shor.

Wendell Gayman
December 2000
Wendell Gayman received his Ph.D. from Scripps in October 2000, 30 years after defending his thesis. As a young scientist in 1970, Gayman could not afford to have his thesis professionally typewritten, so he put aside his degree, for a time and worked as a marine mining and environmental consultant. When diagnosed with a grave illness he became Scripps's oldest Ph.D. recipient.

Michael Mahlon Mullin
December 2000
As a researcher, Michael Mahlon Mullin studied the dynamics of phytoplankton, zooplankton, and larval fish in the ocean food web. As an administrator, he served as chairman of the Scripps Graduate Department, director of the Marine Life Research Group, and associate dean for academic affairs.