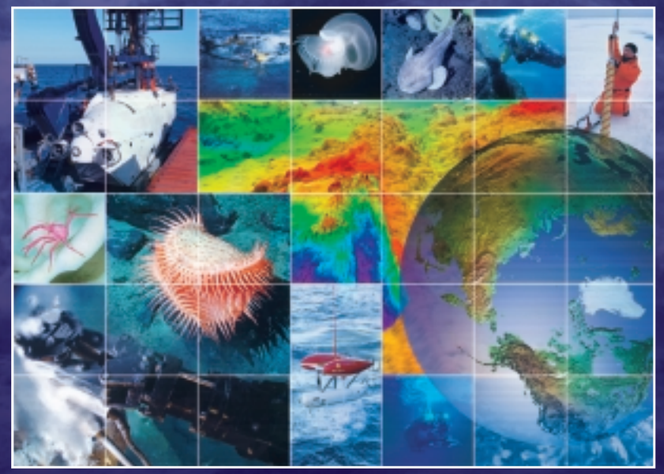
EXPLORE



NOAA OFFICE OF

OCEAN EXPLORATION

2002 ANNUAL REPORT

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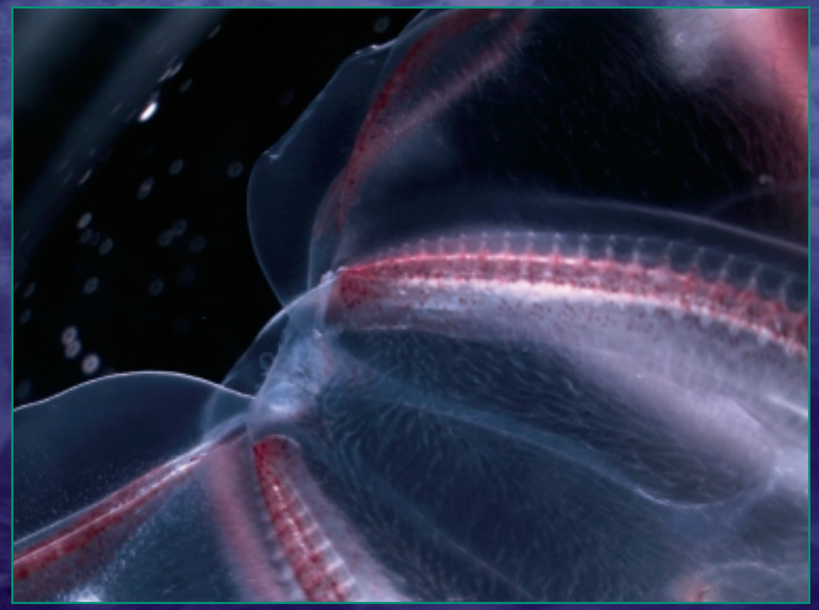


MESSAGE FROM UNDERSECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE AND NOAA ADMINISTRATOR

Welcome to the new era of exploration.

When most of us think of explorers, we envision historical figures from the Age of Sail to the "wild west." Notables like Ferdinand Magellan, Sir Francis Drake, Lewis and Clark, and others expanded our understanding of, and appreciation for, our planet. We mark human achievement with milestones in exploration: the date we landed on the moon; Columbus's discovery of the new world, and Charles Lindberg's Atlantic crossing. And while we celebrate the tremendous achievements gained through historical exploration, we realize that the greatest age of exploration has just begun: The exploration of Earth's oceans.

A little over two years ago a panel of leading ocean scientists, explorers, and educators developed a national strategy for ocean exploration. Their report, "Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration", opened the door to a new way of thinking about ocean exploration and inspired NOAA to embark on a mission to expand knowledge and appreciation of the oceans around us. Since the publication of their report, NOAA and partner organizations and institutions have made significant progress in exploring vast unknown ocean regions.

Having finished our second field season, I am proud to present the 2002 Annual Report for NOAA's Office of Ocean Exploration. Expeditions and projects undertaken this year built on our inaugural work in 2001 and set a precedent of high quality discovery based ocean research. Results from this year's work include new maps of previously unknown ocean areas, the discovery of new marine species, and volumes of new data for scientists, natural resource managers and decision makers. This year, we have seen the discovery of important shipwrecks, the creation of new research partnerships, and the development of new tools for educators so that explorers of all ages can join us in our discoveries.

Vice Admiral Conrad C. Lautenbacher, Jr., U.S. Navy (Ret.)

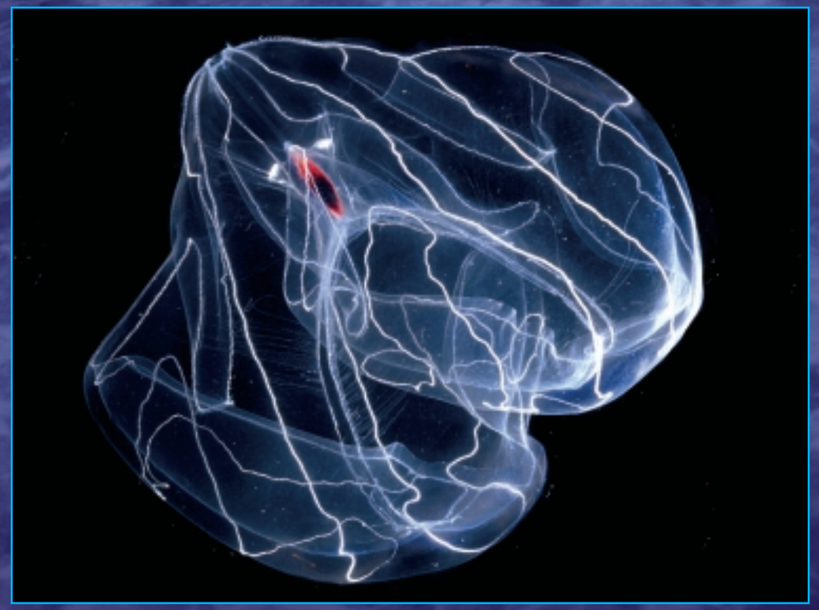
Undersecretary of Commerce for Oceans and Atmosphere and NOAA Administrator

ACKNOWLEDGEMENTS

THE NOAA OFFICE OF OCEAN EXPLORATION WISHES TO ACKNOWLEDGE AND THANK THE FOLLOWING EXPLORATION PARTNERS FOR THEIR CONTRIBUTIONS DURING THE 2002 FIELD SEASON.

The Alaska Native and Minority Student Internship Program, Aquarius, Brown University, Canadian Coast Guard, Canadian Institute for Marine Science, Canadian Scientific Submersible Facility, Carleton University, Charleston County (SC) School District, Chinese Arctic and Antarctic Administration, City of Newport News, Coastal Carolina University, College of Charleston, Dalhousie University, Darwin Research Station, Deep Sea Systems International, Inc., Department of Environment Puerto Rico, Department of Fisheries and Oceans Canada, DePaul University, East Carolina University, First Light Films, Florida Keys National Marine Sanctuary, Georgia Institute of Technology, Girl Scouts of the United States of America, Global Industries Inc., Government of Ecuador, Gray's Reef National Marine Sanctuary, Harbor Branch Oceanographic Institution, Hatfield Marine Science Center, Hawaii Undersea Research Laboratory, Hunter College at the City University of New York, Institute for Exploration, Institute for Genomic Research, Jacques Cousteau National Estuarine Research Reserve, Japan Marine Science and Technology, Kennedy Space Center, Laboratoire de Geosciences Marines, Lexington County (SC) School District, Louisiana State University, Manson Gulf Inc., Marine Conservation Biology Institute, Mariner's Museum, Massachusetts Institute of Technology, McGill University, Mill Street Elementary School, Miller Place School, Mobile Diving and Salvage Unit Two, Monitor National Marine Sanctuary, Monterey Bay Aquarium, Monterey Bay Aquarium Research Institute, Monterey Bay National Marine Sanctuary, Monterey Peninsula College, Moss Landing Marine Laboratories, National Aeronautics and Space Administration, National Geographic Society, National Park of the Galapagos, National Science Foundation, National Undersea Research Center at the University of North Carolina at Wilmington, National Undersea Research Program, Naval Sea Systems Command, NOAA Fisheries, NOAA Ocean Service, NOAA Office of Oceanic and Atmospheric Research, NOAA Pacific Marine Environmental Laboratory, North Carolina Division of Marine Fisheries, North Carolina National Estuarine Research Reserve, North Carolina State Museum of Natural Sciences, North Pacific Fisheries Observer Training Center, Northrop Grumman Newport News, Norwegian University of Science and Technology, Ocean Properties, Oregon Sea Grant, Oregon State University, Pennsylvania State University, Phoenix International Inc., Polar Institute of China, Portland State University, Rutgers University, Second Institute of Oceanography, China, Sci-Tek Communications, Smithsonian Institution, South Carolina Department of Natural Resources, Stanford University, Stennis-Scott Aquarium, Texas A & M University, Thunder Bay National Marine Sanctuary, U.S. Coast Guard, U.S. Naval Academy, U.S. Navy, U.S. Geological Survey, University of Alaska at Anchorage, University of Alaska at Fairbanks, University of California at Berkeley, University of California at Santa Cruz, University of Connecticut at Avery Point, University of Florida, University of Georgia, University of Hawaii, University of Lisbon, University of Maine, University of Maryland, University of Minnesota, University of Missouri, University of North Carolina at Wilmington, University of Oregon, University of Quebec at Montreal, University of the Algarve, University of the Azores, University of Toronto, University of Victoria, University of Virginia, University of Washington, University of Wisconsin at Green Bay, Washington State University, Western Washington University, and the Woods Hole Oceanographic Institution.

INTRODUCTION



THE MISSION

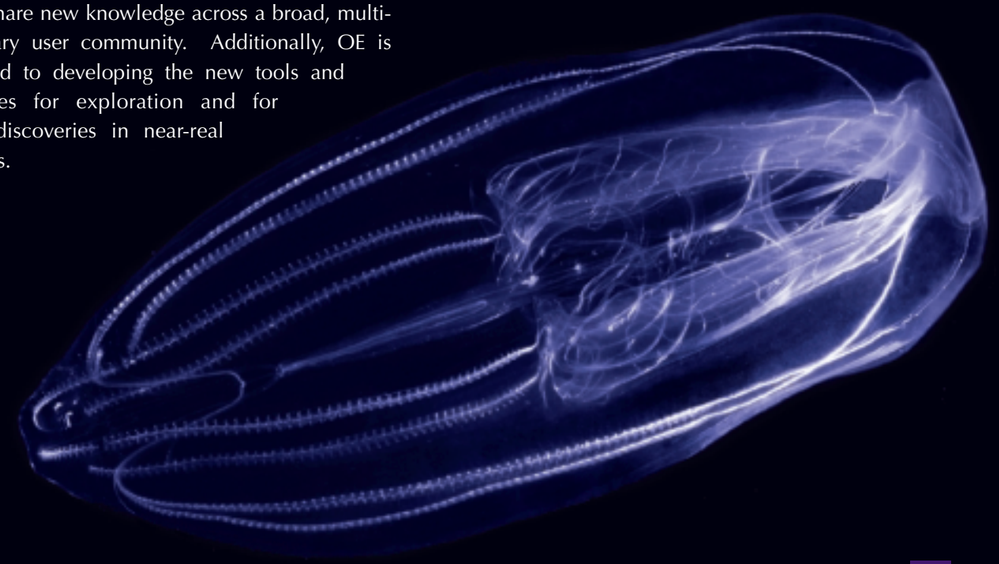
In August 2000, the Secretary of Commerce convened a U.S. panel of leading ocean scientists, explorers, and educators to create a National Strategy for Ocean Exploration. Their report, *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration,* (http://oceanpanel.nos.noaa.gov/panelreport/ocean_panel_report.html) represents the first comprehensive national plan for ocean exploration. In its final recommendations, the panel called for a new Ocean Exploration Program driven by the quest for discovery and the spirit of challenge. The result was the creation of a National Ocean Exploration Program to be lead by the nation's ocean agency, the National Oceanic and Atmospheric Administration (NOAA).

As a principal component of the national strategy contained in the panel's report, NOAA's Office of Ocean Exploration (OE) seeks to bring the best of the nation's scientists to the leading edges of ocean science and technology to (1) discover more about life and processes within the oceans, (2) learn more about maritime cultural resources and heritage, (3) provide a knowledge base that will help enable wise use of the ocean's biological and mineral resources and (4) share new knowledge across a broad, multi-disciplinary user community. Additionally, OE is committed to developing the new tools and techniques for exploration and for sharing discoveries in near-real time ways.

OE accomplishes many of these objectives through interdisciplinary expeditions to unknown, or poorly known, regions and through innovative experiments. The Program advocates discovery-based science and collaboration between multiple partners and disciplines. Education and outreach are priorities of NOAA's OE Program.

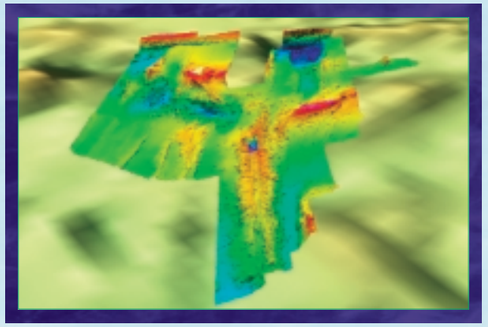
NOAA funded pioneering ocean exploration projects in 2002. Exploration projects are peer-reviewed with an approximate 75% of 2002 funds going to non-NOAA investigators. These projects and expeditions brought ocean scientists, outreach specialists and educators together to pursue exploration in the Arctic, Pacific and Atlantic Oceans, the Bering and Black Sea, the English Channel, the Great Lakes and the Gulf of Mexico. These expeditions brought NOAA to the ocean frontier while sharing the experience with millions of explorers across the Nation.

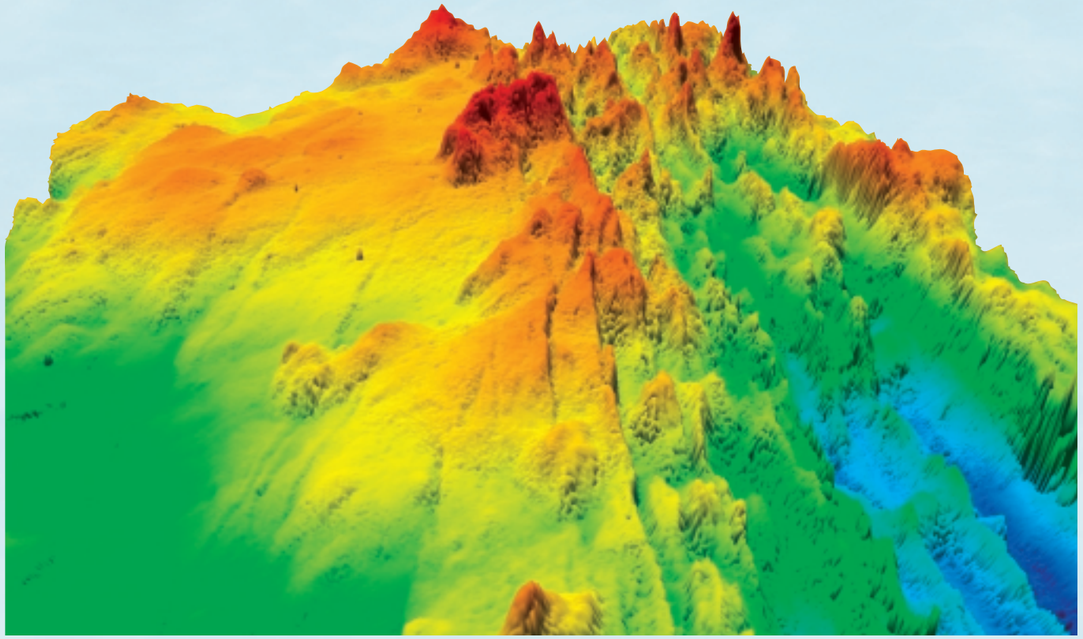
This report details NOAA's Office of Ocean Exploration accomplishments for 2002 and describes each major expedition and project undertaken during the program's second year. ■



SUMMARY OF ACCOMPLISHMENTS

The NOAA Ocean Exploration (OE) 2002 field season encompassed dozens of ocean science and outreach projects with benefits for natural resource managers, scientists, educators and students. OE conducts and supports exploratory activities in the ocean and shares these experiences with the public through various outreach and education activities. Its mission fits into four distinct areas as defined by the President's Panel on Ocean Exploration:

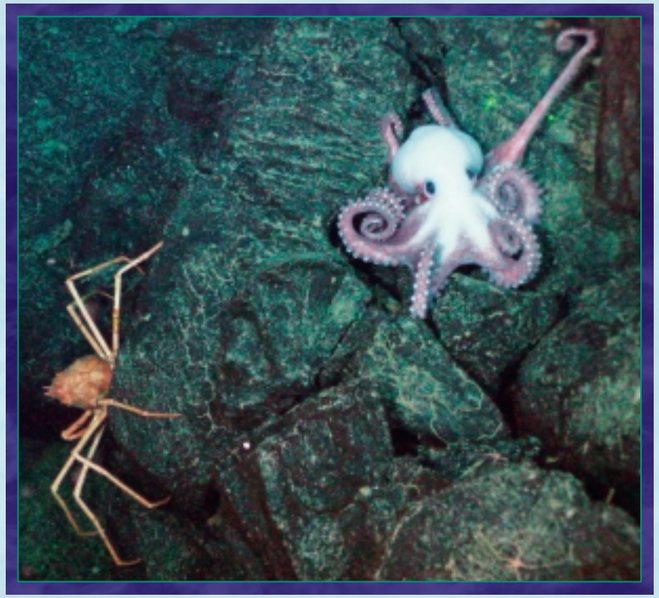




MAPPING THE OCEAN IN NEW WAYS

A primary product of exploration is new and improved maps. These maps differ from nautical charts by characterizing ocean regions and document more than the physical environment. OE's expedition teams collect data representing multiple facets of the ocean environment including bathymetry, biology, geology, chemistry, temperature, and even historic resources.

This year, nearly 30,000 square nautical miles were mapped using high-resolution tools (an area almost as large as South Carolina). These maps provide new definition of ocean regions and features. This information will serve as the foundation for new ocean science and exploration. Given the critical need for detailed maps of the ocean for ocean science, policy and management, OE places a high priority on new mapping endeavors.



UNDERSTANDING OCEAN INTERACTIONS

Documentation of ocean areas begins with descriptions of physical features of an ocean region, and then adds a variety of other environmental data to render a more complete picture of ocean ecosystems. After an initial account of the physical parameters of an area, the next step is to comprehend how the physical environment and its biological components fit together and relate to one another. Understanding an area's dynamic interactions is a vital component of exploration activities. Through discovery and observation of ocean organisms in the ocean systems they are a part of, ocean exploration is providing a new understanding of complex biological interactions and giving NOAA new baselines for understanding ocean ecosystems.

Advances in biological science have occurred this year. New marine species were discovered and the known habitat range of others has been extended. OE and its partners collected species from diverse ocean habitats, ranging from deep ocean vents to ice flows. Preliminary results indicate that several new marine organisms have been discovered, and many species, that were collected or documented, remain unidentified. Part of the species identification activity done in

Other important ocean interaction breakthroughs in 2002 include the discovery of new hydrothermal vents and the discovery that other vents have disappeared. While we are still far from attaining a comprehensive understanding of hydrothermal vent ecology, huge steps were made this year in our understanding of how geologic ocean conditions regulate deep ocean life.

A core ethic of NOAA Ocean Exploration program is data sharing. Giving access to OE data, sometimes in near real-time, to the broadest reaches of the ocean exploration and science community enriches all of science. This year, together with The Institute for Genomic Research, a collection of curated databases from organisms collected during OE missions, that includes DNA and protein sequence, gene expression, cellular role, protein family, and taxonomic data is now available. This data is provided to researchers as part of the Comprehensive Microbial Resource, a tool that allows researches to access all the bacterial genome sequences completed to date.

DEVELOPING NEW SENSORS AND TOOLS

Bringing science to ocean frontiers is one of OE's fundamental challenges. This year, OE logged more than 400 days at sea aboard many different research vessels. These ships ranged from 14-foot patrol boats to 274-foot Class I ocean research vessels. In addition, OE logged almost 1,000 hours underwater (over five weeks) in submersibles, Remotely Operated Vehicles (ROV), Autonomous Underwater Vehicles (AUV) and SCUBA diving.

Pushing the limits of existing technology and expanding the application of current tools puts NOAA on the leading edge of ocean technology. This year, new imaging systems were developed and

deployed, new sampling technology was tested for specimen collection, and a jointly sponsored symposium paired NASA's space explorers with NOAA's ocean explorers to plan advanced technology development and transfer.

The expense of utilization and development of ocean platforms and tools requires a sustained investment in exploration infrastructure. The U.S. Panel on Ocean Exploration envisioned a $75 million/year program with capital costs up to three times that amount. OE's current budget limits NOAA's ability to invest in technology development that would lead to regaining U.S. leadership in this field.

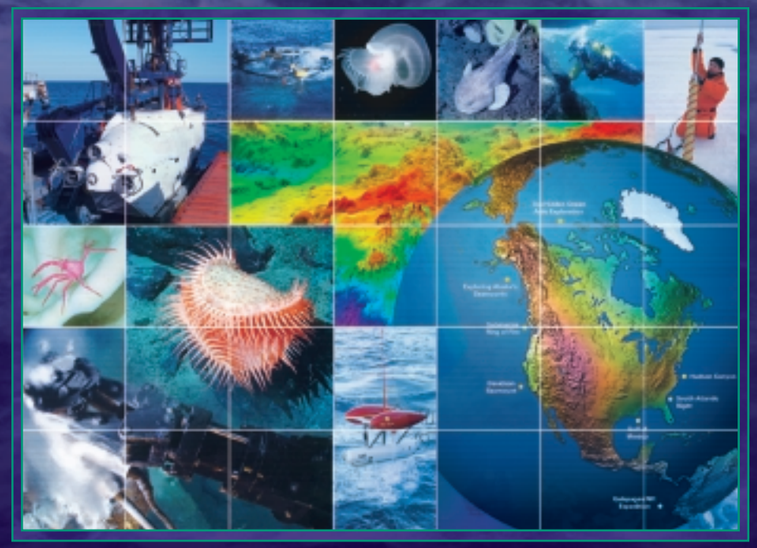
REACHING OUT IN NEW WAYS

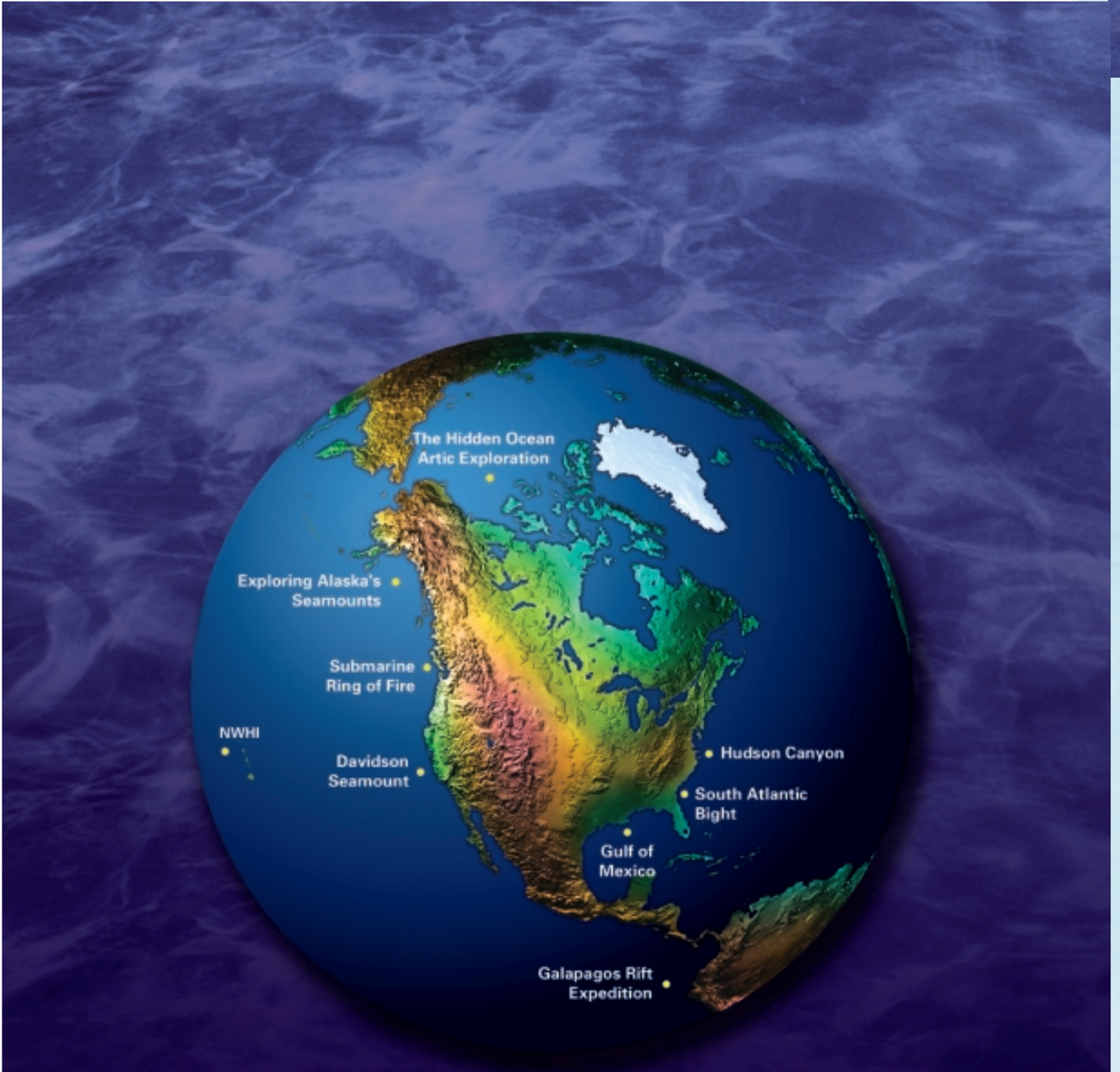
The Ocean Explorer web site (www.oceanexplorer.noaa.gov), is NOAA's primary outreach vehicle for exploration. The site grew from an average of 1,400 hits per day in 2001 to an average of over 4,000 hits per day in 2002. The site contains more than 3,500 pages of new information including 71 educational products developed this year. Other products for educators include an entire issue of the National Marine Educators Association's professional journal "Current, The Journal of Marine Education" dedicated to ocean exploration, professional development opportunities for educators, and the completion of a National Education Workshop to guide NOAA ocean exploration education activities.

Other outreach activities included eight regional ocean exploration workshops to collect information on regional exploration needs and priorities and to build new partnerships. NOAA also partnered with outreach collaborators including the Girl Scouts of the USA, the Smithsonian Associates, the National Geographic Society, and many others to improve and develop outreach efforts.

Finally, NOAA hosted Ocean Exploration port events in 2002 in Charleston South Carolina, New York City, and Kodiak Alaska. These port events gave the public, including a number of school groups, a chance to see the ships and technology used for exploration and visit with expedition science teams.

EXPEDITIONS AND PROJECTS

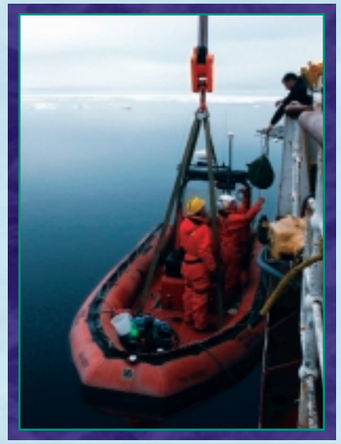




EXPEDITIONS AND PROJECTS

In collaboration with over 100 partners including universities, international, federal, state and tribal science agencies, private research and outreach organizations, civic groups, aquariums and museums, NOAA is expanding knowledge about our oceans. In 2002, NOAA engaged in nine major expeditions and sixteen projects around the world. This map highlights several NOAA missions from the 2002 field season. The following pages detail major expeditions to the Arctic, the Galapagos Rift, the Explorer Ridge, Hudson Canyon, the Gulf of Mexico, the Gulf of Alaska, Davidson Seamount, the South Atlantic Bight, and the Northwestern Hawaiian Islands.

Project descriptions articulate NOAA activities in ocean exploration smaller in scope than major expeditions, or where the NOAA Ocean Exploration component of work, accomplished in partnership with others, consisted of a small portion of the total effort.



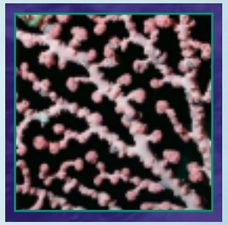
EXPLORATION AT DAVIDSON SEAMOUNT

The Davidson Seamount is an intriguing geologic feature, first mapped as a "sea mountain" in 1933. The seamount is an inactive volcano roughly as tall as the Sierra Mountains (2,300 m) and as wide as Monterey Bay (40 km), yet its summit is far below the ocean surface (1,300 m). This geologic feature is so impressive that it was the first to be called a "seamount" and is named after George Davidson, a marine scientist who's greatest work included making maps of the Pacific in the 1850's. Davidson was responsible for identifying the first accurate latitude and longitude positions of prominent points along the west coast and chose the sites for many of today's west coast lighthouses. The Davidson Seamount is located 120 km southwest of Monterey, California and despite the site's proximity to California's central coast, it has been subject to only a few brief scientific investigations. These early investigations provided scientists with glimpses of an area that appeared to be fascinating and unique, but too remote for systematic investigation. Today, technology allows us to visit and document the habitats and species on this remarkable submarine territory.

In May 2002, a team of NOAA, Monterey Bay Aquarium Research Institute (MBARI), Moss Landing Marine Laboratory and Monterey Bay Aquarium scientists and explorers spent eight days aboard MBARI's R/V *Western Flyer* exploring Davidson Seamount. Other team members included resource managers from the nearby Monterey Bay National Marine Sanctuary. MBARI's ROV *Tiburon* was used to make six dives to the seamount, for a total of 72 hours of bottom time. *Tiburon* was equipped with tools for sample collection, high definition imaging of the seamount environment, and sensors to measure environmental parameters.

The mission of Davidson Seamount Expedition was to more fully characterize the geological and biological aspects of the seamount and surrounding environment. Scientists documented new and rare species, collected samples, and described the unusual marine environment.

In geological terms, Davidson Seamount is young, having only celebrated it's 12 millionth birthday. Despite its youth, Davidson Seamount is host to remarkable biological communities, including large, dense patches of sponges and coral forests that appear to be over 100 years old, with individuals commonly reaching more than three meters in height. Rare species, such as the black-footed albatross and the federally listed endangered sperm whales have been sighted at the seamount.



The tremendous biodiversity of seamounts was confirmed by dives at Davidson. Assemblages of fish and invertebrates were surveyed by *Tiburon* through a quantitative video transect. This survey allowed rapid and detailed observations of benthic invertebrates, bottom fishes, and their habitats. The environments explored during this expedition are difficult to sample with traditional techniques such as bottom trawls and grabs. Comprehensive assessments and complete identification of fast moving or small animals from ROV videos were difficult, and in some cases, impossible. Since visual surveys may miss organisms that are cryptically colored, occupying hidden microhabitats, or avoiding camera and lighting systems, surveys were complemented with baited traps to identify those fishes and invertebrates that are attracted to bait but are not often seen by the ROV. Video collected during the expedition is expanding on MBARI's previous video surveys of bottom communities in the region.

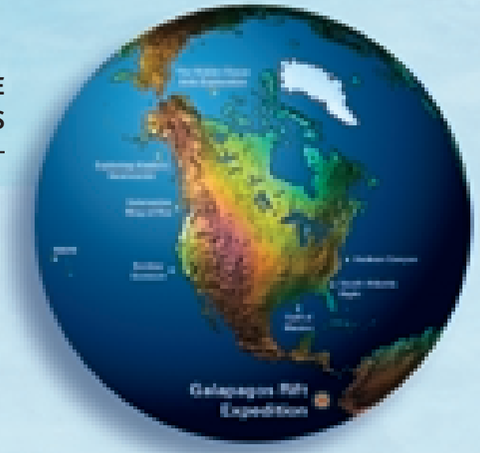
The unusual marine environment on Davidson Seamount includes volcanic rocks. When this undersea volcano erupted, its lavas were highly viscous (thick and pasty) and formed short, thick flows and steep-sided knobby structures at hydrothermal vents. The high viscosity of these lavas also likely inhibited the loss of gas bubbles, making the eruptions more explosive. When the seamount was being formed, erupting lavas contained coarsely crystallized fragments and rare rocks from deep inside the earth's mantle.

A potentially new species was found and four rare species of fish were sighted on the seamount.

More than 100 rock and 24 core samples were taken during the expedition and are giving scientists a new understanding of the geologic processes that form seamounts. Sperm whales were sighted at the seamount during the expedition, and the expedition team unsuccessfully attempted to take a tissue sample from a sperm whale using a special dart to collect genetic material to better understand broader population patterns among these marine mammals.

As the Monterey Bay National Marine Sanctuary Management Plan is being reviewed, one option is to include the Davidson Seamount within its boundaries. Resource managers and decision makers are using the findings from this expedition to help address the conservation and protection measures of the management plan. ■

RETURNING TO THE GALÁPAGOS RIFT: CELEBRATING THE 25TH ANNIVERSARY OF THE DISCOVERY OF LIFE AT HYDROTHERMAL VENTS



The discovery of deep-sea hydrothermal vents and associated biological communities on the Galápagos Rift in 1977 profoundly and permanently changed our view of life on earth. Revolutionizing our understanding of the requirements of life in the ocean, the discovery of chemosynthetic life thriving in what was considered the most inhospitable environment on earth is often noted as one of the most remarkable scientific discoveries of the last century. The discovery has allowed biologists, chemists, and geologists to better understand the complex interactions between hydrothermal, magmatic, and chemical processes at mid-ocean ridges.

The Galápagos Rift is an area where the seafloor is formed in a rift valley by continent-sized geologic plates that slowly move apart. As the plates move, magma from deep inside the Earth is pushed upward and is met by the pressure of a mile and a half of the Pacific Ocean bearing down upon it. This dynamic interchange between the earth and ocean creates an environment of extreme heat, pressure, and geologic, volcanic and chemical activity. If you can imagine the inside of a super-huge furnace at the bottom of the ocean, filled with toxic chemicals and the fury of volcanic heat, then you can begin to imagine the environment of hydrothermal vents. This environment is home to strange seafloor formations, and bizarre and undocumented forms of life. Superheated water surges out of the ocean floor, bringing with it a soup of microbial life that flourishes in this extreme environment.

In May-June 2002, NOAA joined with the Woods Hole Oceanographic Institution (WHOI) and a coordinated team of scientists for a return to the Galápagos Rift. The underlying mission for this return expedition was to reexamine vents in the ocean floor, where underwater hot springs release shimmering, mineral-rich fluids into the cold, dark depths, providing an integrated foundation for studies along the Galápagos Rift. Like the discovery made 25 years earlier, these vents were found to be brimming with extraordinary, unexpected life.

The Galápagos Rift expedition resulted in major discoveries at the site of the famous Rose Garden hydrothermal vent. The Rose Garden is one of the sites along the Rift where, 25 years ago, hydrothermal vents were first discovered and where chemosynthetic organisms were first seen. However, observations during the cruise strongly supported the possibility that the Rose Garden no longer exists. The vent field was covered by a lava flow, probably occurring within the past ten years. Although several dives were dedicated to finding the Rose Garden site, there appeared to be no trace of it. All of the Rose Garden vent fauna have apparently been obliterated. There was also no evidence of the many *Alvin* dive weights dropped in the vicinity of the Rose Garden vent over the past quarter century.

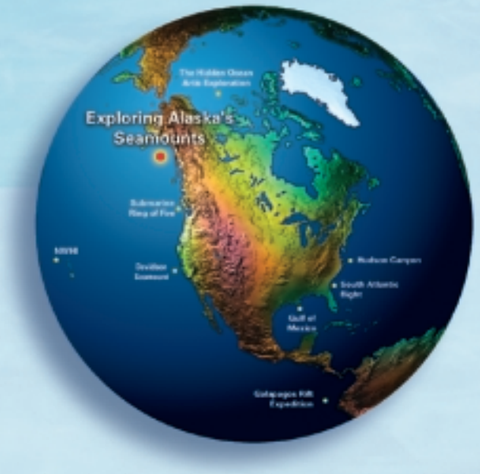
Throughout the expedition, a synergistic array of deep-ocean vehicles was used to collect data. *Alvin* and a new digital towed camera made seafloor observations, acquired digital imagery, and collected samples. The autonomous vehicle ABE (Autonomous Benthic Explorer) acquired meter-scale bathymetry, near-bottom magnetics, and bottom water properties in search of new active hydrothermal vents. Finally, water column profiles were taken using a CTD/rosette to explore for temperature plumes. A total of nine Alvin dives, seven ABE dives, five camera tows and six CTD casts were conducted.

As a primary tool for exploration in the area, and a product for future exploration and science, a new meter scale resolution map of the Galápagos Rift was created with a multibeam sonar on ABE. Together, 1,029 square nautical miles were mapped.

The study of hydrothermal vents and animals continues to yield significant new discoveries. One example is a seafloor microbial habitat where large quantities of microorganisms live in extreme conditions of heat and chemistry. These microorganisms could potentially be used in biotechnology and pharmaceutical applications.

One of the most significant findings made during this mission was the first-ever discovery of sponges at hydrothermal vents. These sponges, never before seen in association with vent ecosystems, seem to live in an unusual symbiotic relationship with vent resident snails. More information about this discovery will be available soon, as mission scientists are preparing journal publications and presentations. ■

EXPLORING ALASKA'S SEAMOUNTS



The cold, nutrient-rich waters of the Gulf of Alaska (GOA) support a diverse ecosystem that includes numerous species of fish and shellfish, as well as many marine mammals and large colonies of birds. Due to the high productivity of the region, large-scale fishing for several commercially important fisheries such as crab, shrimp, pollock, salmon, and halibut occur in the GOA. This geologically active region is also home to some of the largest glaciers on Earth and was the location of the second largest earthquake and resulting tsunami in recorded history. The geologic activity in the GOA has resulted in several volcanic seamount chains that have intrigued scientists from around the world. These deep-sea volcanoes contribute to the biological richness of the GOA and were the focus of NOAA's 2002 Exploring Alaska's Seamounts Expedition.

In June 2002, NOAA led an interdisciplinary team of scientists who spent 24 days aboard the Woods Hole Oceanographic Institution's research vessel Atlantis and used the manned submersible *Alvin* to explore and map five previously unexplored volcanic seamounts in the GOA. Due to their geographic isolation, seamounts are known to support unique ecosystems. Most seamounts in the GOA have never been explored scientifically so there was great potential for the discovery of unique and endemic species during this expedition.

The major objectives of this NOAA expedition were to characterize the unique biota and habitats of the seamounts and to determine how they were formed. *Alvin* was used at each seamount to collect samples and to develop a photographic inventory of benthic macrofauna. Depth transects were conducted with the *Alvin* to examine depth distribution, habitat utilization, and community structure of seamount organisms. A full-coverage swath bathymetric map of each seamount was produced to search for tectonic and volcanic structures, and rock exposures were sampled for age, duration, composition, and distribution of volcanic eruptions and for microbiological studies. Reef-building deep-sea corals and sclerosponges were collected to determine their age and their potential for providing information about climate-ecosystem variability in the GOA.

The genetic structure of deep-sea gorgonian corals was examined to determine whether seamount populations are genetically isolated units. The reproductive biology of some deep-sea coral samples was also studied. Species distribution and habitat utilization of deep-sea crabs was examined and live samples were collected to determine biological characteristics such as species, sex, and reproductive condition. A 'gentler' manipulator claw was developed and tested on the *Alvin*, which aided in the collection of live crabs. Observations were made at various depth ranges where particular crab species were most abundant to document reproductive or aggregative behaviors and interactions with other species.

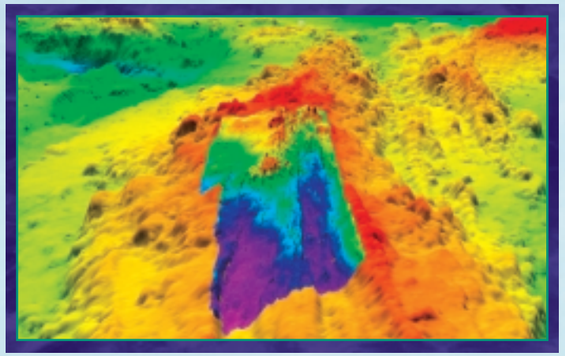
During the expedition, scientists discovered juvenile king crab habitat and found commensal amphipods on two crabs at depths deeper than previously recorded. The previously mentioned new manipulator claw was developed and tested through the initiatives of two cruise participants, and worked well in the collection of crabs. Eight different species of deep-sea crabs were collected, as were 15 to 20 different coral species, including several bamboo corals not previously known to the region. The known distribution of several families of deep-sea corals was also expanded through the findings of this expedition.

Through 13 successful *Alvin* dives, more than 160 hours of video footage was collected. This data demonstrated extraordinary biological diversity, and showed that original volcanic rocks remain well exposed on GOA seamounts with pillow basalts, lava conduits, and columnar jointing standing out in amazing detail. Over 700 square nautical miles of high-resolution multi-beam bathymetric maps were made of the five GOA seamounts, and a sixth seamount that had been mapped on a previous expedition was explored and sampled.

Not only were the seamounts mapped during this expedition, but their importance as essential habitat for many species of crabs and fishes, and other deep-water organisms was extensively documented as well. The last seamount explored during the GOA expedition was Warwick Seamount, which was so biologically rich and unique that it was referred to as 'The Garden of Eden.' Vast forests of hot pink paragorgia corals teeming with life were discovered, as were many other species of corals, crabs, fishes, brittle stars, and other invertebrates including enormous vase and elephant sponges, some as tall as the *Alvin*. This thriving community exists on a seamount that, at approximately seven million years old, is believed to be the youngest of those explored. ■

THE SUBMARINE RING OF FIRE EXPEDITION TO EXPLORER RIDGE

Submarine volcanic ridges lying as close as 60 nautical miles off the northwest U. S. and Canada are part of the mid-ocean ridge system of seafloor spreading centers encircling the entire planet. The mid-ocean ridge is the beginning of a giant conveyor belt. Here submarine volcanoes create new ocean floor and weld it to giant moving plates that are ultimately recycled at island arcs and deep-ocean trenches. Explorer Ridge, a largely unexplored segment of the Pacific basin mid-ocean



ridge system in the "Submarine Ring of Fire," is about 160 km (100 nautical miles) south of Vancouver Island. This area is home to submarine volcanoes, earthquakes and hydrothermal vents. It is a geologically dynamic place where new earth boils up in submarine eruptions and bizarre life thrives in sunless ecosystems. Explorer Ridge is located a mile-and-a-half underwater where strong Pacific weather systems and fast ocean currents make exploration difficult, yet it is also the site of exciting new ocean discoveries made last summer.

An interdisciplinary exploration team of NOAA and U.S. and Canadian university scientists explored the ridge in the summer of 2002 as part of a new "Submarine Ring of Fire Expedition." Using an array of new mapping and imaging tools, the seafloor has been brought to the surface for examination, discussion and analysis. The expedition team collected a remarkable amount of new information about the northeast Pacific "Submarine Ring of Fire," and these data will be disseminated to the broader scientific community for collective analyses and discovery in the months and years ahead.

This expedition was successful in being the first ever to use a multi-beam mapping unit aboard an *Autonomous Benthic Explorer (ABE)*, providing scientists mapping data with detail never seen before. An EM-300 multi-beam system, mounted on the University of Washington's R/V *Thomas G. Thompson*, imaged 1050 square nautical miles. When the highest priority sites were identified on the new map, the Woods Hole Oceanographic Institution's *ABE* was deployed for five square nautical miles of meter scale mapping. The maps will provide generations of scientists with newly available seafloor detail.

ABE was deployed on seven dives and spent 85 hours on the bottom. By pinpointing dive targets on the *ABE* maps mission, scientists were able to optimize the deployments of the Canadian Scientific Submersible Facility's *ROPOS* ROV. A total of eight *ROPOS* dives encompassing 88 hours of bottom time provided scientists and explorers significant opportunities to explore the ridge.

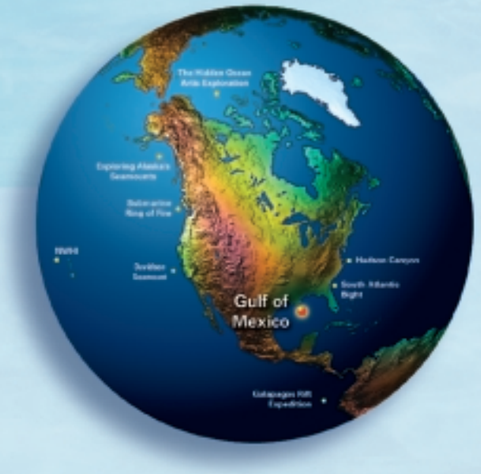
An important achievement of this expedition was the deployment of a recently developed high-resolution digital camera system on board the ROV ROPOS. This camera, the first of its kind, captured images with such clarity and detail, that scientists were often able to identify biological and geological features of the site only after reviewing images. At least 30 active vents were discovered, ranging in temperature from 20 degrees C to 311 degrees C. ■

DISCOVERY IN AMERICA'S SEA: THE 2002 MISSION TO THE GULF OF MEXICO

The discoveries of chemosynthetic ecosystems, such as those at hydrothermal vents and cold methane seeps, have been hailed as some of the most important findings of the past century. The discovery of tubeworms, ice worms and the array of associated fauna within these ecosystems has opened a new chapter in the history of life on Earth.

The Gulf of Mexico, home to extensive oil and gas lease tracts, has already been the site of numerous geologic studies and surveys. Due to this extensive background data, developed over five decades of geophysical surveys and piston coring, scientists have excellent information to use in planning new explorations. While much is known about the geologic foundation of the Gulf, surprisingly little is known about deep ecosystems and the associated biology in the region.

An interdisciplinary team of scientists used Harbor Branch Oceanographic Institution's (HBOI) research vessel *Seward Johnson* and the *Johnson Sea-Link* submersible in 2002 to explore the communities of animals found around deep-sea oil seeps in the Gulf of Mexico. The expedition team of ecologists, larval biologists, physiologists, microbiologists, geologists, geochemists, and oceanographers came from a variety of different academic institutions, as well as several foreign countries. Together, they explored several new sites in search of animal communities associated with oil and gas seepage, and carried out experiments and sample collections that have opened up new windows of understanding on the lush deep-sea Gulf communities that thrive in total absence of sunlight.



This expedition, using over two months of ship time, over 40 submersible days, and 60 hours of bottom time, resulted in one of the most interdisciplinary studies ever undertaken of the deep-sea life of the Gulf of Mexico. One of the most exciting findings of the expedition was the discovery of a new species of tubeworm. Another was the discovery of a large deep-coral reef associated with the carbonate rocks produced at one of the seep sites.

Cold-seep tubeworms (sometimes as long as 10 feet) are abundant at the cold seeps in the Gulf of Mexico. These worms are closely related to other giant tubeworms found around deep-sea hydrothermal vents. These bizarre worms have no mouth, gut, or digetive tract and obtain their food from special symbiotic bacteria that live inside their bodies in an organ called the trophosome, which is basically a cavity full of bacteria. These bacteria are chemosynthetic, using hydrogen sulfide present in cold-seeps and hydrothermal vents, as an energy source. By staining tubeworms and observing their growth over years, scientists have determined that the Gulf of Mexico cold-seep tubeworms are among the longest-lived animals known on Earth. They can easily live for more than 200 years.

One of the most unusual sites explored during the expedition was a site called the Brine Pool, which is a small hypersaline lake on the seafloor with a distinct surface and shoreline. It exists within the ocean because its water is so much denser than the surrounding seawater. The Gulf of Mexico contains brine lakes ranging from 1 m across to 20 km long. The Brine Pool was created by the dissolution of buried salt deposits formed during a time when the Gulf of Mexico was dry land. Now, broken into two large sheets, the movement of this salt sculpts the seafloor, and creates unique habitats.

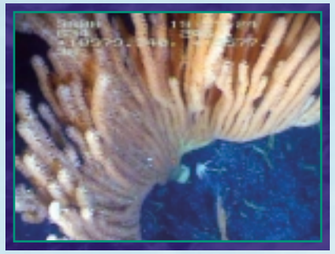
During the first leg of this expedition, the highest priority was to test equipment developed especially for exploration in the Gulf, and to initiate experiments that would be completed on later cruises, such as tubeworm age and growth studies, and a study on mussel settlement in brine pools. Several new cold-seep sites were also briefly explored and sampled before inclement weather forced the early termination of this leg. The main objectives for the second leg were to conduct submersible dives on methane hydrate sites to collect hydrates and sediments. During a third leg the scientists focused on reproductive biology studies of the seep animals and also explored and sampled several of the new cold-seep sites that were missed during the first leg.

Brine pools and microbial mats were also sampled, as were planktonic organisms. The ever-elusive ice worms were sought out and collected for physiological analysis. The preliminary examination of the collections suggests that at least three additional species that are new to science were collected with the tubeworms. Another facet of this expedition incorporated both ship and submersible operations and involved mapping the seafloor. Several potential new sites to be visited on subsequent missions were identified using this dual-sonar approach.

One of the major surprises of deep-sea biology in the past 50 years has been the discovery that many species living in deep cold waters breed during only one season of the year. Although seasonal breeding is common in shallow water, it is unexpected in the deep-sea, where seasonal changes are not obvious. The Gulf of Mexico expedition team studied the reproduction and embryology of seep animals, including mussels, clams, snails, crustaceans, tubeworms and several other kinds of worms. Dives were conducted to study the reproduction and embryology of these seep animals. The animals were collected for studies of feeding biology, community structure and diversity, and larval physiology and growth. Sediment was collected so that scientist could learn more about the unique microscopic animals that live between the sand grains in this extreme environment. ■

EXPLORING LIFE ON DEEP REEFS: DISCOVERY IN THE SOUTH ATLANTIC BIGHT

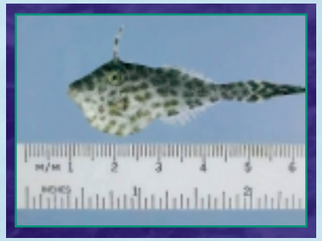
Since the mid-20th Century, NOAA and its predecessor agencies (e.g., the Bureau of Commercial Fisheries) have explored the habitats and resources off the coast of the south-eastern United States. The continental shelf and shelf edge from Cape Hatteras to Cape Canaveral, known as the South Atlantic Bight, has long been known by area fishermen to support large populations of fish in its submerged rocky reef habitat. Fishery research vessels have conducted fish population surveys in the area, beginning in the 1950's, using trawl nets towed along the bottom of the ocean floor. These early surveys found concentrations of snappers, groupers and other economically valuable fishes associated with rocky outcrops and other hard-bottom reefs on the continental shelf. However, scientists know that fish caught in a trawl net reveal little about the biological interactions, the habitat, the community structure and the overall ecology of the region. Populations of economically valuable reef fishes have been in decline for at least two decades in the South Atlantic Bight, leaving scientists with an urgent need to apply new tools and methods for understanding this vital ocean region.



In July and August of 2002, NOAA and an interdisciplinary group of investigators using Harbor Branch Oceanographic Institution's research vessel *Seward Johnson and the Johnson Sea-Link* submersible, explored deep reef habitats off the southeastern United States. These understudied habitats, peppered along the continental shelf and slope between North Carolina and Florida, are critical ecosystem links within the South Atlantic Bight region. This expedition extended exploration efforts into unexplored areas, and fostered collaboration on developing new ideas for habitat and resource protection.

Employing high-resolution sidescan sonar, 48 submersible dives totaling over 120 hours of bottom time, and traditional sampling techniques, the science team located and investigated deep-water reef and hard-bottom habitats. Scientists collected information to characterize these areas in terms of reef morphology, geology, biology, and ecology. Observers noted a transition in these communities based on latitude, depth, and the position of the reefs in relation to the Gulf Stream.

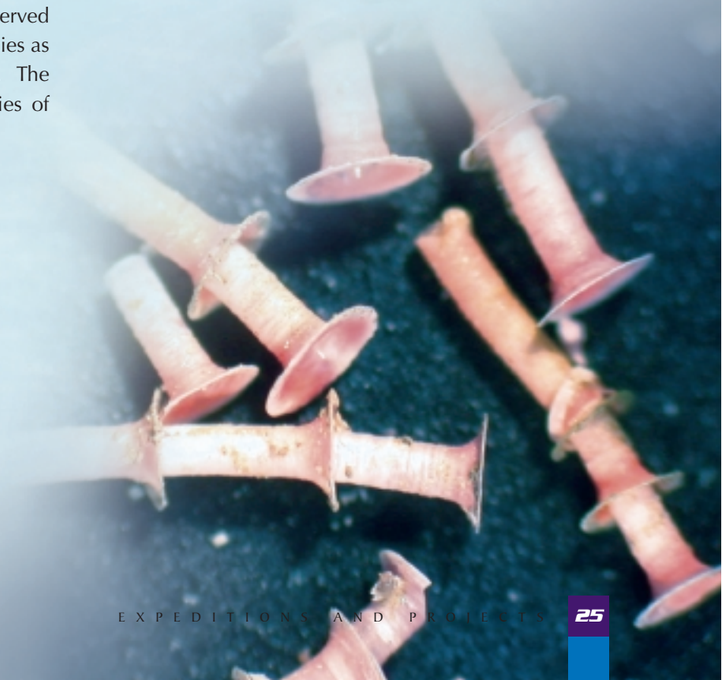
During the expedition, the team distinguished several discrete types of reef habitat and explored a series of reefs positioned along the edge of the



continental shelf, on the upper slope and on the Blake Plateau, approximately 80-100 km offshore at a depth of 1200 m. These reefs were found to contain a wide variety of deepwater coral species and associated biota. In even deeper water, researchers discovered monotypic stands of *Lophelia* and *Dendrophelia* corals. Observations made at two reefs separated by 100 km indicated that completely different communities were utilizing the same type of habitat. Further research on both of these habitat types is critical since little is known about them, their function, or their overall health. Researchers plan to use the information collected during this mission as a complement to historical data sets, providing natural resource managers with more information for making effective decisions.

With over 200 biological samples of deep-sea organisms collected at the site, researchers observed a richer abundance and higher diversity of species as compared to information in existing literature. The team also collected several unidentified species of sponges and octocorals.

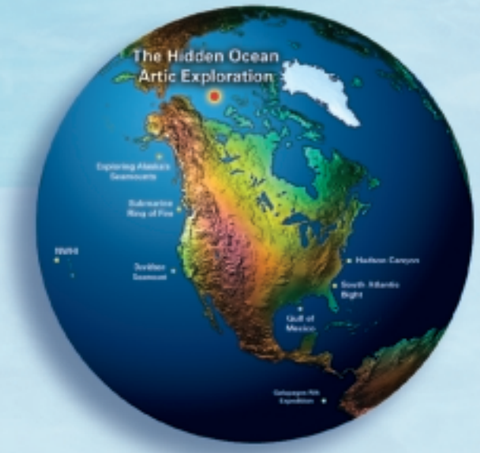
Scientists also witnessed sightings of the lionfish, *Pterios volitans*, a venomous invasive species native to western Pacific waters. This fish species had never been observed in waters this deep along the Atlantic coast until this year. The species appears to be numerous, widespread, and well established; its impact is unknown. ■



THE HIDDEN OCEAN: EXPLORATIONS UNDER THE ICE OF THE NORTH AMERICAN ARCTIC

Deep within the Arctic Ocean lies the isolated, more than two-mile deep Canada Basin, which reaches from Greenland and North America to Russia. Covered by ice and shrouded by total darkness during the winter, the Canada Basin has been left largely unexplored. What little is known about this area is limited to what the human eye can detect from a passing icebreaker or occasional satellite data. Limited efforts have been made to provide longer-term observations from such facilities as the drifting ice island T-3 and periodic Russian North Pole ice camps. Some data collected for national defense purposes are now available, and are providing a better picture of the bathymetry and circulation patterns of the Arctic Ocean. Still, the deeper portions of this northern ocean, and areas far from land-based facilities, remain largely unknown.

During the 2002 summer field season, NOAA Ocean Exploration participated in its first mission to a polar ocean. In August, an international team of 46 scientists from Canada, China, Japan and the United States participated in a collaborative effort to explore the frigid depths of the Canada Basin. The mission objectives were to take a first census of life from the sea ice surface down to the seafloor and measure the physical and geochemical properties in different regions of the basin. The physical oceanography of the Canada Basin is of interest because it is the last basin of the Arctic Ocean to receive warmer and fresher waters of Atlantic origin.



Inaccessibility due to severe ice conditions and extreme depth make the Canada Basin one of the Arctic Ocean's least known areas. Underwater mountain ranges border the western and northern fringes of the Basin. Waters in the depths remain at fairly constant temperatures, unfrozen year-round. Deep below the protective ice cover, there is a diversity of life, most of which has never been studied by researchers. Due to the remote and extreme physical environment, migration of life in and out of the area may be greatly limited. Consequently, some scientists believe the basin could be an 'Isolated Eden,' harboring undiscovered organisms, including extremophiles – novel microorganisms specially adapted to survive in the harsh Arctic environment.

NOAA scientists joined members of the Canada-Japan Joint Western Arctic Climate Study (JWACS) onboard the Canadian Coast Guard icebreaker, *Louis St. Laurent.* While JWACS studied the physical and chemical oceanography of the Canada Basin, United States scientists used an ecosystem approach to explore what lives in and under the sea ice, as well as in the mid-water and bottom habitats.

In nine ROV dives totaling over 50 hours under water of bottom time, combined with six SCUBA dives, scientists became polar explorers examining the hidden world of life in the Basin. From intricate microscopic organisms found in brine channels running through the ice to creatures that live on the sea bottom, the science team studied the relationships between pelagic and benthic communities. They investigated the manner in which food energy is transferred from the surface of the ice, through the water column, and to the bottom of this harsh environment. In addition, they will analyze bottom sediments to determine their chemical makeup, as well as help reconstruct the climatic history and paleo-ecological events that formed the region. Three long-term moorings were also successfully deployed. These instruments will relay information about the temporal changes in ice thickness, current speed and direction, temperature and salinity over a two-year period.

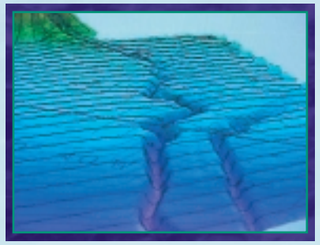
The international team looked at life throughout the entire water column. By combining these 'slices of life' with the physical and chemical research, scientists will have a look at the ecosystem structure of the basin. Preliminary findings include: the potential discovery of a new species of jellyfish; successful culturing of novel microorganisms; and raise new questions about the rates of reproduction in the Arctic. This exploration also provided a baseline for scientists to measure future effects of potential climate change.

The Arctic expedition also enabled the successful development and deployment of a highly portable remotely operated vehicle (ROV). Most deep submergence assets, though extraordinarily productive, still remain prohibitively expensive for scientists and other non-military or industrial groups. The only way to extend these capabilities to the wider community is to reduce their operation, transport and maintenance costs. The successful deployment of the Deep Sea Systems International, Inc. *Global Explorer* ROV to 3000 m during the Arctic expedition provides hope that the cost for these assets is declining.

Hundreds of live cultures of organisms collected during the mission are being assayed under a variety of extreme conditions. One newly discovered microorganism grows solely on hydrocarbons at –1 degree C. This microbe may be a significant organism for bioremediation at low-temperatures. Further studies will verify if this or other organisms collected during the mission are new to science. ■

HUDSON CANYON 2002

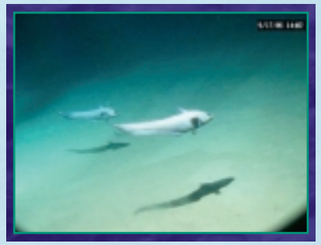
The Hudson Submarine Canyon is an ancient extension of the Hudson River Valley and is the largest submarine canyon on the eastern margin of North America. This unique region, extending over 400 nautical miles seaward from the New York/New Jersey Harbor and across the continental margin, connects the pulse of New York with the deep ocean. The Hudson Canyon is a pathway from land to sea in the heart of one of the largest metropolitan areas in the world. Scientists and resource managers have been curious about novel deep-sea creatures that could potentially live in the canyon and about how runoff from the major cities in New York and New Jersey may impact the deep Atlantic Ocean. In order to address important questions like these the Hudson Canyon must first be mapped in greater detail. High-resolution seismic and side-scan sonar systems have proven to be immensely important to scientists studying the deep-sea. But looking into the detailed profile of submarine canyon and trench walls is difficult, even for the advanced technology now available.



Using the largest vessel in the NOAA fleet, the *Ronald H. Brown*, and a high-resolution multibeam mapping system, investigators from NOAA, USGS, Rutgers, and Woods Hole Oceanographic Institution mapped a significant portion of the Hudson Canyon during the 2002 summer field season. In addition to the mapping efforts, a research group from New York University at Stony Brook is preparing to analyze water samples collected during the cruise in search of evidence of methane vents on the seafloor and gas hydrates buried beneath the sediments.

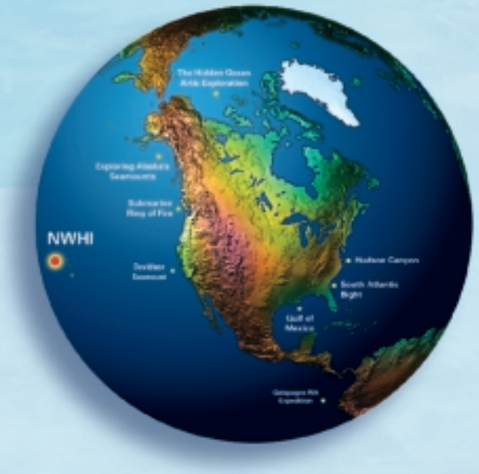
Until the evolution of modern underwater mapping tools, charts were made by lowering weighted lines into the water at successive individual points. Today, however, the seafloor is remotely mapped using sidescan-sonar and high resolution seismic-reflection profiling. Seafloor mapping surveys provide a sophisticated and highly detailed picture of the seafloor and even the underlying geology by transmitting a series of acoustic pulses that are reflected off the ocean bottom and subsurface layers. Thus, scientists make improved maps of the ocean by seeing what the ocean sounds like.

Another mapping tool now available to scientists is technology that is used to process, archive and develop the geographic information while at sea. Recent advances in swath bathymetry and sidescan sonar make it possible to create dynamic, three-dimensional maps at sea. For this expedition, multibeam sonar was used. This approach produced soundings not only along the ship's track, but also for significant distances perpendicular to it, thus providing a "swath" of soundings. This ability to collect side-scan sonar data at the same time as swath bathymetry and sub-bottom data has greatly improved a scientist's ability to interpret the seafloor geography. Using these tools in combination gives us a new set of technological "eyes" to see features in the ocean never before distinguished.



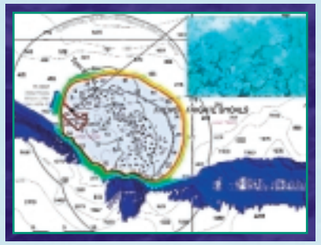
The main objective of this expedition was to map areas of the continental slope and rise to the east and west of the Hudson Canyon, and merge this data with existing multibeam coverage to produce the first coherent high-resolution bathymetric map of the Hudson Canyon region. This objective was met with the successful collection of data in a 6,600 square nautical mile area in the Canyon, contributing significantly to our understanding of this region. The second major objective of this expedition was to search for methane-venting zones through in-depth chemical analysis of water samples. Water samples are currently being analyzed to determine where and how widespread methane 'plumes' are in the Hudson Canyon, and to find the sources of methane in the area. The results of this expedition will be used to determine how long-term geological processes have shaped the Hudson Canyon, and this mapping effort will assist oceanographers in the future as they explore the deep ocean for new organisms, search for novel energy resources, and determine how our actions on land impact the deep sea. ■

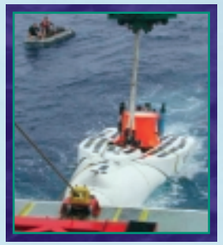
MAPPING AND EXPLORATION IN THE NORTHWESTERN HAWAIIAN ISLANDS



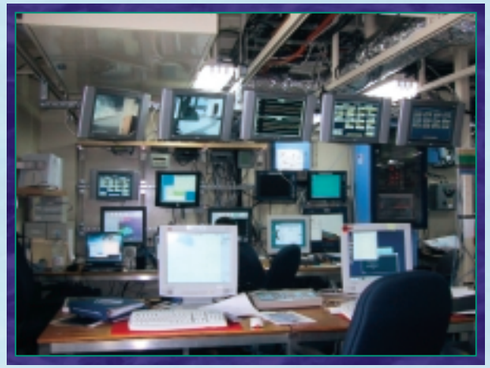
The Northwestern Hawaiian Islands (NWHI) extend 1,200 nautical miles to the northwest of the main Hawaiian Islands and cover an area longer than the State of California. This area has remained virtually unexplored as it is vast and remote. The recent establishment of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve requires accurate assessments of reefs and other submerged features existing in the NWHI ecosystem.

In 2002, the Northwestern Hawaiian Islands were the focus of two collaborative mapping missions involving scientists from NOAA and the University of Hawaii, Hawaii Undersea Research Laboratory (HURL). Both expeditions used research vessels home ported in Hawaii: the R/V *Ka'imikai-O-Kanaloa (K-O-K),* and the new coastal and deep-ocean mapping vessel, the R/V *Kilo Moana*. To the scientists studying this unexplored wonder it is critical to have updated nautical charts. While charts of the area exist, many of them are outdated. New technologies on this cruise provided positioning accuracy that allowed scientists to conduct detailed mapping of the area. During the first mission, NOAA led a multidisciplinary team to map and explore the slopes of the Northampton Seamounts. These submerged volcanic mountains support unexplored habitats and fish assemblages. Recent data from satellite tags deployed on monk seals indicate that for unknown reasons, seals make frequent visits to the slopes of both seamounts. Previous work utilizing seal tracking data in another area led scientists to discover new beds of deepwater corals. The seal tracking data from the Northampton area provide scientists with an excellent indicator of deepwater coral beds and other unique habitats that otherwise would have been difficult to find. The primary purpose for the second mission was to conduct detailed multi-beam mapping of banks and seamounts within the NWHI Coral Reef Ecosystem Reserve, specifically within the reserve preservation areas. This survey yielded detailed bathymetric maps of the ocean floor in areas where none existed.





A great deal of logistical and scientific planning preceded this expedition to make the cruise an overall success. The planning paid off as this expedition sparked several "first ever" accomplishments. This expedition deployed the first occupied submersible dive on the unexplored Northampton Seamounts. Scientists received their first view of this remote area through eight dives, totaling 29 hours of bottom time, in the University of Hawaii submersible, the *Pisces IV*. Also, five ROV dives, totaling 15 hours of bottom time, were made for observations and collections. Rare sharks were observed at the site including the first ever sighting of a spongehead catshark *(Apristurus spongiceps)*, and the first photo documentation of a smalltooth sand shark *(Odontaspis ferox)*. Other fish and shellfish were observed on many of the dives, and species were observed in depth ranges and on habitats never before seen. The spectacular *Grammatonotus macrophthalmus* is a colorful reef fish that had only been seen by scientists once previously, and 10 individuals were observed during the team's second dive. Profiles of coral communities that inhabit the seamounts at various depths were observed, and collections were taken for further laboratory analysis.



Deep-water habitat of the Hawaiian monk seal was also explored using the *Pisces IV* submersible. These dives allowed scientists to explore coral beds, study habitat characteristics, and see the deep ecosystem intact, rather than through pieces taken from trawl surveys. Using the ROV *RCV-150,* shallower coral beds and associated fauna were observed and sampled.

In addition to the many scientific discoveries of this mission, many scientists noted that an important piece of the expedition was the remarkable mapping capabilities of the *Kilo Moana*. An area of over 11,000 square nautical miles was mapped this year during the Northwestern Hawaiian Islands expedition. These maps give important details to resource managers and scientists to characterize habitat, accurately update nautical charts, and establish isobaths for the purpose of identifying boundaries. This high-resolution bathymetry also provides a basis of information for future exploration with occupied submersibles and ROVs.

This information provides a new baseline for ecosystem data in one of the world's least explored areas. ■

PROJECTS

THE AQUANAUTS PROGRAM

The Smithsonian Institution Summer Camp Program partnered with a NOAA exploration team and professional educators for a week of educating and inspiring young explorers in Washington, D.C. The 2002 Smithsonian Associates Summer Camp for Kids program, "The Aquanauts: Exploring the Ocean Depths," gave 10 to 13 year-olds the chance to learn about ocean technology, study marine life, and build a model of the seafloor. This project ran in conjunction with a NOAA expedition to the South Atlantic Bight and gave young explorers a chance to interact with chief scientists and submersible pilots at sea via satellite phone.

THE AQUARIUS PROJECT

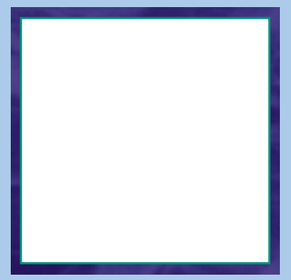
In August 2002, NOAA and the Girl Scouts of the USA (GSUSA) teamed up for The Aquarius Project, an intensive week of ocean science and discovery for a nationally selected group of Girl Scouts. This was the first partnership between NOAA and GSUSA bringing scientists and Girl Scouts together for ocean study and exploration. The National Undersea Research Center's (University of North Carolina at Wilmington) Key Largo, Florida field station, home to the world's only underwater laboratory, the Aquarius Habitat, hosted the project. The Scouts learned the fundamentals of exploration, oceanography, ocean technology, coral reef ecology, habitat preservation, and marine biology through hands-on experience and interaction with mentor scientists. These "aquanauts" dove to the Aquarius and visited current mission scientists at work in the habitat (and even delivered boxes of delicious Girl Scout Cookies). They worked alongside marine resource scientists to monitor fish communities on restored coral reef sites, and conducted an exploration of the Benwood wreck site in the Florida Keys National Marine Sanctuary. Each participating Girl Scout created an outreach plan to present what they learned to their schools, Girl Scout Councils and communities.

BLACK SEA

Supporting advancements in new ocean technology is a priority for NOAA's Office of Ocean Exploration. The latest expedition to the Black Sea, organized by Dr. Robert Ballard and supported by NOAA, used state-of-the-art technology to aid in the discovery of several shipwrecks, some of which appeared to be ancient, yet well preserved, off the coast of Bulgaria. One of the wrecks, a wooden ship about 40 feet long, was found July 30, when Ballard's Institute for Exploration team used a small manned submarine to dive on objects that were identified on an earlier mission.

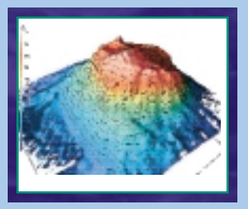
Another wreck, found August 1, appeared to be a Roman trade ship, and a third has not yet been identified. Ballard said an amphora, a tall jar used to transport commodities in the ancient world, was retrieved. Intact ancient wooden shipwrecks are extremely rare, however, in the Black Sea, organisms that commonly devour wooden ships in other bodies of water are not present below a depth of 450 feet, leaving most ships fully preserved. Ballard and his team plan to return to the Black Sea next year on a major expedition that will pioneer deepwater archaeological excavation.

BOTTOM TRAWLING RESEARCH AND RECONNAISSANCE SURVEYING IN BRISTOL BAY



Bottom trawling effects are being studied in a shallow, soft-bottom area of the eastern Bering Sea. In 2001, OE and the National Marine Fisheries Service (NMFS) partnered to map twelve 10-mile long research corridors, each surveyed before and after trawling with commercial gear. To investigate the recovery process, these same corridors were resampled in 2002 during a 21-day cruise aboard the chartered fishing vessel *Ocean Explorer.* Surface-living organisms (epifauna), surficial sediments, and organisms living in the sediments (infauna) were sampled using research trawls and van Veen grab samplers. A high-resolution side scan sonar system was also deployed to study possible changes in physical characteristics of the seafloor as a result of trawling. A multidisciplinary team of scientists, technicians, and fishers from government, university, military, and industry sectors are collaboratively working on the study.

CENSUS OF MARINE LIFE: BIODIVERSITY OF BEAR SEAMOUNT:



While the geology of the New England Seamounts and their effects on the Gulf Stream have been extensively studied, hardly any studies have looked at the communities of living organisms residing there. The first biological census ever undertaken at Bear Seamount, New England's most inshore seamount, was completed during this project. The objectives for this project were to explore the biodiversity in the vicinity of Bear Seamount by collecting organisms (especially fish and cephalopods) in bottom- and mid- water samples and to collect information on the distribution of cetaceans, particularly beaked whales and sperm whales, oceanographic features, and potential prey. Deep mid-water trawling at 20 different stations was very successful. Additionally, sets of mid-water

samples were successfully collected in three slope/canyon areas where aggregations of toothed whales were encountered. Preliminary identifications indicate that about 183 species of fishes, at least 33 species of cephalopods, and 152 other types of invertebrates were collected from Bear Seamount during this cruise, data that resource managers, scientists and decision-makers need for appropriate resource stewardship.

CENSUS OF MARINE LIFE: DISCOVERING LONG DISTANCE MIGRATIONS AND DEEP DIVING BEHAVIOR FOR LARGE PELAGICS IN THE CENTRAL PACIFIC

A new tool for tracking the movements of large ocean fish is the pop-up satellite archival tag. These tags turn oceanic sharks, tunas, and billfishes into explorers, and give scientists new information about the habitats of fish whose migrations are now known to cover thousands of kilometers. This year, 26 pop-up satellite archival tags were deployed on bigeye and albacore tunas, moonfish (locally known as opah), and short-fin mako sharks during two cruises utilizing commercial longline fishery vessels. While only preliminary results are known at this point, there are several exciting findings. One of the moonfish tagged near in May left Hawaii about two weeks after tagging and traveled over 1,000 km northward in 10 days to the northern edge of the subtropical gyre where it stayed for four months. It was discovered to be living at depths of 200-400 m. Until this work, very little was known about the movement of the moonfish. Tags deployed on large bigeye tunas southeast of Hawaii, reveal that although they are frequently found inhabiting depths of 300-400m, the tunas dive down to depths of 1,000 m, waters characterized by very low oxygen levels. It was previously thought that low oxygen waters were not a habitat for bigeye tunas, however our data suggest that while they can not stay in this low oxygen water for long periods, they can recover from the resultant oxygen deficit with frequent excursions to shallower depths.

CONTINUING THE LEWIS AND CLARK LEGACY

Complementing work done by OE in 2001, explorers spent four days off the coast of Oregon aboard the R/V *Thomas Thompson* to create a new, and highly detailed map of an area greater than 550 square nautical miles. The new map includes details of the submerged paleo-shoreline located southwest of Newport, Oregon, that has never been seen before. One exciting observation from the new view of this ancient coastline is the apparent location of what would have been the mouth of the present-day Yaquina River Estuary, during the last glaciation (ca. 17,000 YBP). Seaward of the estuary is a wave-cut platform possibly representing the paleo-continental shelf. During the present day, the Yaquina River Estuary is one of the larger Oregon estuaries, and the location of a major commercial fishing port, Newport. Could this estuary have been the home of some of the first North Americans?

HUNLEY

Friends of the Hunley is a non-profit organization dedicated to helping the *H.L. Hunley* complete her historic journey home. The goals of the Friends of the Hunley are to: recover the remains of the brave men who gave their lives and honor them with the proper burial they earned; solve the mystery of the first ever submarine attack in 1864; and conserve one of the greatest, most sought-after artifacts in the history of naval warfare. This year, NOAA partnered with the Friends of the Hunley for the development of new outreach and education materials.

THE LINK PROJECT

NOAA and NASA are investigating new opportunities for partnerships in exploration. Scientists, engineers, and explorers have much in common, and by crossing boundaries and working together, they can share solutions to some of sciences most important challenges. The Link Project 2002 captured the spirit of its namesake, renowned inventor Edwin Link, by convening an international symposium for ocean and space scientists and engineers in May 2002. This symposium, held at NASA's Kennedy Space Center, facilitated technology exchange between the ocean and space science and engineering communities through technical sessions. One season highlighted advancements in technology that may be of benefit to both ocean and space exploration. Another session described the role of

technology in deep sea and interplanetary exploration and its potential to answer fundamental questions about the origin and distribution of life. Proceedings from the symposium were published in the Marine Technology Society Journal in August 2002. The Link Symposium was also the focus of an article in the June 2002 issue of "Nature."

MAPPING THE PUERTO RICO TRENCH

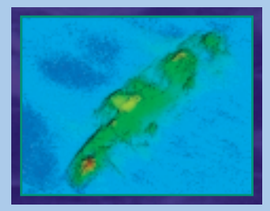
In September 2002, NOAA teamed up with scientists from USGS, and the University of New Hampshire's Center for Coastal and Ocean Mapping on board the NOAA R/V *Ronald H. Brown* to map a portion of the Puerto Rico trench. The Puerto Rico trench is associated with the most negative gravity anomaly on earth, and comprises the deepest region in the Atlantic Ocean with depths reaching more than 8400 meters. Yet, the bathymetry of the trench

is known only in general terms, and the tectonic setting of the trench is not thoroughly understood. This lack of knowledge is a major problem for Puerto Rico and the Virgin Islands, as tectonically active regions, potentially generating tsunamis, are located very close to their coastlines. The major objective of this project was to develop the first coherent high-resolution bathymetric map of the Puerto Rico trench to be used as a platform for future studies of this unique and poorly understood region. This six-day survey resulted in the acquisition of 7,475 square nautical miles of multibeam data, work which will continue in February 2003, with approximately 15 more days of surveying. Several new landslides and an active fault system were discovered through the high-resolution data acquired during the cruise.

MATE

NOAA partnered with the Marine Advanced Technology Education Center (MATE) and the ROV Committee of the Marine Technology Society (MTS) to co-host the first annual national student ROV competition. The competition is part of a national effort to introduce students to marine science and technology and help them develop the technical, problem solving, and teamwork skills needed in the marine technology workplace. Twenty-two high school, community college and university teams from ten states and Canada participated in an underwater competition of ROV design and capacity. Thirty-three organizations donated funds, equipment, supplies and facilities to ensure the success of this exciting event, while contributing to a growing pool of tomorrow's leaders in ocean technology.

NORMANDY



NOAA is proud of its role in supporting the Navy and the Naval Historical Center (NHC) in a historic survey of the waters adjacent to the beaches of Normandy. The NHC sought to obtain information on U.S. Navy losses during Operation Neptune, the Allied naval invasion on France's Normandy coast on June 6, 1944 (D-Day). Remote sensing and ROV instruments were used to locate and confirm the existence of U.S. Navy ships, vehicles and German beachhead structures. The areas were mapped using magnetometer and shallow water multibeam sonar technologies. The resulting discovery of more than 2,000 magnetic anomalies and over 800 sonar targets were integrated into a GIS database. The ROV phase of the project documented thirty-three targets deemed potentially significant to the interpretation of naval support in the American landing sectors, including the large transport vessel, *Susan B. Anthony.*

NORTHWEST GULF OF MEXICO HIGH RESOLUTION MAPPING

NOAA collaborated with the Minerals Management Service (MMS) and the U.S. Geological Survey (USGS) to map the northwest Gulf of Mexico using a high-resolution multibeam system. The data were acquired by the USGS using C&C Technologies' *R/V Ocean Surveyor,* and processed by USGS and the University of New Brunswick. Unique places such as Alderdice Bank, which has

two basalt spires characterizing it as the Gulf's only known volcanic area, were fully surveyed. The survey resulted in detailed bathymetric maps of several geological areas including 12 formerly unknown features. NOAA's Flower Gardens National Marine Sanctuary used the mapping data to support submersible work the following month. By overlaying the submersible track lines over the bathymetric charts, the team dramatically increased the efficiency of their dives. They were able to use newer technology to explore several new areas and revisit old sites.

SIRENA

Seismic Investigation by REcording of acoustic waves in the North Atlantic (SIRENA) On May 17, 2002, NOAA teamed with scientists from both sides of the Atlantic on board the French research vessel *Le Suroit.* They sailed from Ponta Delgada, in the Portugese Azores, to deploy an array of six continuously recording hydrophones around the Mid-Atlantic Ridge north of the Azores. The acoustic data was not available in real time, but the instruments will be recovered in the summer 2003. The onboard data and resulting analyses will constitute an "acoustic exploration" of this important region of the global ocean. Anticipated acoustic activity includes earthquakes, and possibly volcanic activity, from the Mid-Atlantic Ridge and Iceland, large whale calls, especially blue whales and humpback whales, and new measurements of the noise impact of oil exploration around the Atlantic Basin. Some new phenomena that could be present in the data include landslides along the massive continental slopes around the North Atlantic or the sound of catastrophic release of submarine methane hydrates from these margins. Also, the array will be within range of permanent glaciers on Greenland and may be able to detect sounds associated with ice processes in that region.

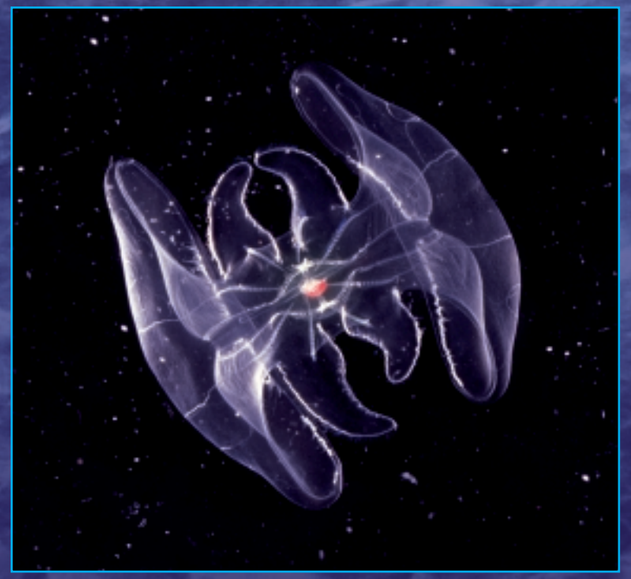
THUNDER BAY

The Thunder Bay National Marine Sanctuary was designated to help preserve an important part of America's maritime heritage. This is the second year of a partnership between NOAA and Dr. Robert Ballard's Institute for Exploration (IFE) to investigate shipwrecks at the site. The goal of this year's project was to use digital underwater video mounted on two remotely operated vehicles (ROV) to investigate shipwrecks and geological features the team located last year; the results were astounding. High definition digital video data were acquired on almost two-dozen wrecks, ranging from wooden schooners of the 1850's to 20th century steel freighters. The video data recorded detailed images of shipwright craftsmanship from an age when Great Lakes maritime commerce and trade were at their fullest. The ROVs also searched sinkholes and several other geologic features for evidence of human habitation prior to the refilling of the lake following the last Ice Age.

USS MONITOR

On August 6, 2002, after spending 140 years on the ocean floor, the turret of the USS *Monitor* was successfully raised by NOAA and the U.S. Navy. The turret was transported by barge to The Mariner's Museum in Newport News, Virginia for conservation and further excavation. The interior of the turret, filled with silt and coal, yielded many historical findings including two large Dahlgren cannons, a fully intact lantern, and a well-preserved leather boot. The remains of two sailors were also discovered, and were carefully transported to the U.S. Army's Central Identification Laboratory in Hawaii for proper treatment.

OUTREACH



REACHING OUT IN NEW WAYS

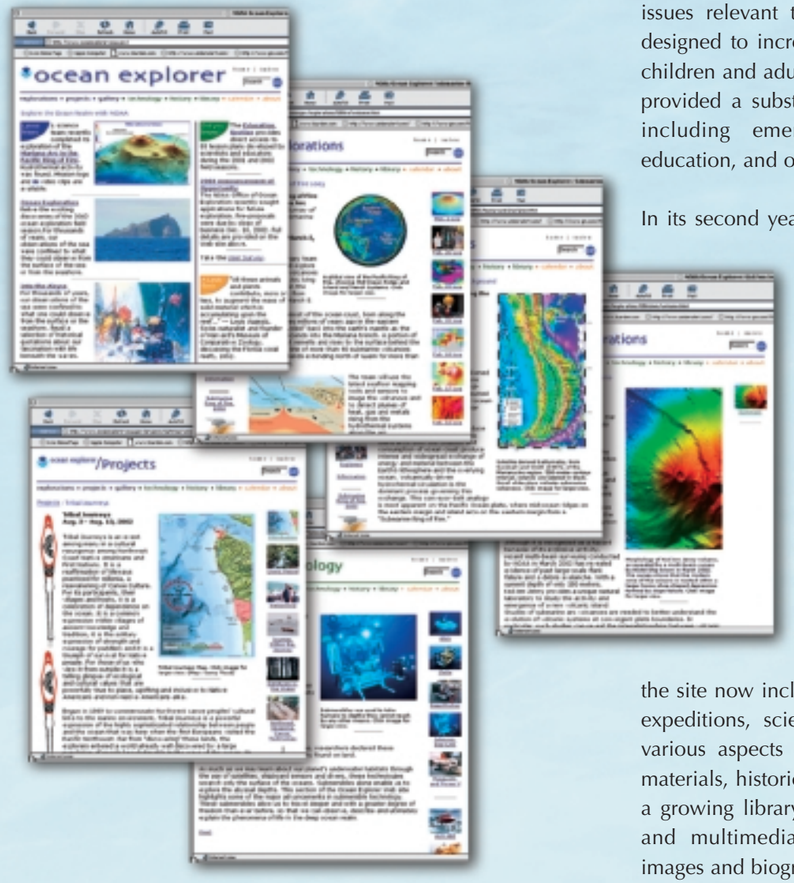
The oceans are the lifeblood of Earth. They cover 70% of the planet's surface, drive its weather, cleanse its atmosphere and ultimately fuel all living creatures. The increasing awareness that human existence on Earth is bound to the ocean, is directly related to our expanding knowledge of ocean regions and processes. As cornerstones of the Ocean Exploration program and with 10% of its overall annual budget dedicated to education and outreach activities, OE strives to engage the broadest possible audiences in order to raise America's environmental literacy.

Engaging this expanding audience is not without challenges. In 2002, NOAA organized regional workshops to solicit the needs and concerns of ocean constituents around the country. These workshops provided valuable guidance about regional ocean exploration and science needs, and inspired a number of new exploration partnerships.

OE's program signals a turning point for this Nation's ocean exploration efforts and represents a bold and innovative approach. It infuses teams of multidisciplinary scientist-explorers with a "Lewis and Clark" spirit of discovery, and then equips them with the latest exploration tools. OE has made a commitment to share these 21st century explorations with millions of interested people. Through OE's website and other outreach activities such as radio shows and port calls, everyone can become an ocean explorer.

In 2002, port calls were held in New York City, Kodiak, Alaska, and Charleston, South Carolina. These events gave students, educators, and the media opportunities to visit the vessels and submersibles and talk to mission scientists about the expedition and the contributions they have made to a greater understanding of the ocean regions.

Another successful outreach venue was through OE's partnership with *Our Ocean World,* a 90-second daily radio program. This show is the only one of its kind that focuses on the issues and splendors of the ocean and airs on over one hundred radio stations around the world. The show presents solutions to shared problems and suggestions on how listeners can help preserve our most vital natural resource.



In June 2002, OE successfully participated in Capitol Hill Oceans Week (CHOW) 2002, a bi-partisan series of educational meetings and events highlighting our oceans and coasts. CHOW brought together a wide range of stakeholders to discuss issues relevant to the ocean. An action agenda designed to increase ocean awareness among both children and adults was also highlighted. The event provided a substantive focus on key ocean issues, including emerging ocean technologies and education, and ocean literacy.

In its second year of existence, the Ocean Explorer web site (oceanexplorer.noaa.gov) was recognized as a flagship NOAA offering. With more than 4,000 visitors per day, it is one of NOAA's most popular web sites. This growing public profile prompted further improvements to the site. External contributors in 2002 were more familiar with the site and its mission, and eagerly offered their submissions to support the growth and impact of the website.

With over 3,500 pages of content, the site now includes near real-time daily logs from expeditions, scientific background information on various aspects of ocean exploration, educational materials, historical information on exploration, and a growing library of science publication references and multimedia products including video, still images and biographical sketches of explorers.

Site statistics continue to show a growing audience, including six million visits in August 2002. The average visitor to Ocean Explorer spent almost five minutes surfing during each visit. Many major media

outlets featured NOAA Ocean Explorer this year, including CNN.com, LA Times, Yahoo, AP wire, Wall Street Journal, ABCnews.com, NY Times/Herald, Baltimore Sun, and the San Jose Mercury News; it was also the lead story on the NOAA homepage for several explorations.

Other outreach projects included a partnership between NOAA and the Girl Scouts of the USA to increase opportunities for young women in ocean science. This project brought six nationally selected Girl Scouts to the Aquarius underwater habitat field shore station in Key Largo, Florida for an intensive week of ocean study. The "expedition" included the exploration of a shipwreck in the Florida Keys National Marine Sanctuary, a visit to a restored coral reef site, lessons in fish identification, and an introduction to the tools of ocean science.

The Smithsonian Institution and NOAA partnered for the 2002 Smithsonian Associates Summer Camp for Kids. "The Aquanauts: Exploring the Ocean Depths" gave 10 to 13 year-olds a chance to learn about ocean technology, study marine life, and build a model of the seafloor. This project ran in conjunction with a NOAA expedition to the South Atlantic Bight and gave young explorers a chance to interact with chief scientists and submersible pilots at sea via satellite phone.

EDUCATION

"NOAA helped me connect my oceanography students to authentic exercises and information using the internet."
Teacher participant in NOAA's exploration on-line curriculum and professional development workshop

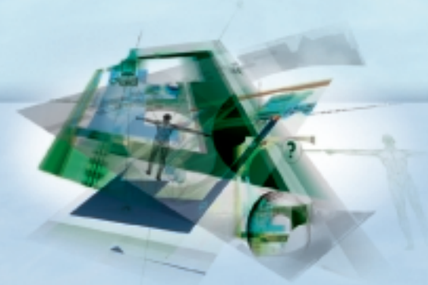
Achieving increased American environmental literacy requires collaboration between ocean explorers and America's teachers. Working to achieve this goal, new products for educators developed in 2002 included 71 new ocean science and exploration lesson plans for students in grades 5 through 12.

NOAA's Ocean Exploration lesson plans bring entire classrooms "on board" for exploration and discovery using web-based education materials. These lesson plans, developed through partnerships with educators and scientists around the Nation, correspond with OE missions and recently received distinguished recognition from the National Science Teachers Association. Given the NSTA "Scilink" award, these lesson plans have been called exemplary teaching materials by America's largest association of science educators.

In addition to developing lesson plans in conjunction with educators that are correlated to the National Science Education Standards, NOAA provided a number of other significant services to students and teachers. The creation of a professional development program for teachers in four states gave educators access to senior-level ocean scientists and updated their understanding of state-of-the-art ocean technology, research and exploration. NOAA also organized a National Ocean Exploration Education Workshop, bringing together a blue-ribbon panel of more than 50 educators and scientists to guide NOAA's exploration education efforts for maximum effect.

To reach out to educators, the Office published excerpts from the President's Panel Report entitled, *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*, in an issue of *Current, the Journal of Marine Education*. Current is the premier publication of the National Marine Educators Association. It reaches over 1,200 educators located throughout the country, including the Hawaiian and Caribbean Islands. Activities for teachers and students focusing on ocean exploration were also included in the publication.

OE was also represented through presentations at annual meetings of the National Science Teachers Association, the National Marine Educators Association, the South Carolina Marine Educators Association, the American Geophysical Union, the Marine Technology Society and NOAA's OAR Outreach Workshop. ■



ADDITIONAL EDUCATION "PRODUCTS" AND ACCOMPLISHMENTS

- Education and outreach materials for eight voyages of discovery
- Coordinated web development for educational offerings with NOS
- Professional Development Institutes in four states
- Three activity booklets
- Formed partnership with Building a Presence for Science, an NSTA dissemination network
- MATE ROV competition
- MATE SeaLab support
- Representation on various advisory boards and committees, both regional and national
- Appointed to NOAA Education Council
- Presentations at national and regional conferences
- Partnered with NSF RIDGE Program for joint education workshop
- Partnered with NGS to begin planning of Classroom Exploration of the Ocean, a virtual teacher workshop
- Smithsonian Associates Aquanaut Camp
- Correlated NOAA education posters to NSES
- Stephen Low Productions partnership in education
- National Education Workshop
- Port days
- Involved in development of NOAA Education Strategic Plan and provided input into NOAA Draft Strategic Plan
- National workshop after regional workshops held to lead up to Forum
- White paper on ocean science education involvement
- RI Sea Grant Topical Advisory Team for Education
- Mote Marine Laboratory Blue Ribbon Committee
- SECOSEE partnership in three state region in SE
- Hawaii educator partnership in conjunction with NWHI expedition

PHOTO CREDITS

For more information, contact:

The NOAA Office of Ocean Exploration
1315 East West Highway, 10th Floor
Silver Spring, Maryland 20910
Tel: 301-713-9444
http://oceanexplorer.noaa.gov

U.S. Department of Commerce/National Oceanic and Atmospheric Administration