

## OCEANS TO CLASSROOMS WITH NATIONAL MARINE SANCTUARIES

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**Abstract** - The National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program serves as the trustee for a system of fourteen marine protected areas, encompassing over 150,000 square miles of ocean and Great Lakes waters from Washington State to the Florida Keys, and from Lake Huron to the Hawaiian Islands. Since passage of the National Marine Sanctuary Act in 1972, the sanctuary program has worked cooperatively with the public and its partners to protect and manage sanctuaries and enhance public awareness, understanding and appreciation of the ocean environment. In partnership with the JASON Foundation for Education and Institute for Exploration, we have established an educational and technological framework to bring the excitement of the nation's underwater ecosystems to students by linking telepresence activities with system-wide oceanographic monitoring programs. This initiative, which will be featured on an internet-based Ocean Science Education Portal, will integrate live video camera feeds with data streams as diverse as student-collected observations, satellite records, and measurements collected by monitoring stations in the National Marine Sanctuaries.

## I. INTRODUCTION

The National Oceanic and Atmospheric Administration's National Marine Sanctuary Program has established an innovative educational and technological framework to bring the excitement of the nation's underwater ecosystems to the American public by linking telepresence activities with system-wide oceanographic monitoring programs. This initiative will revolutionize oceanographic information dissemination by integrating live video camera feeds with data streams as diverse as observations collected by citizen-scientists, satellite records, and measurements collected by monitoring stations in the marine sanctuaries. Integration is achieved through distributed data

systems and protocols that enable unified Internet access to information collected at multiple sites through multiple observing systems.

Developed in partnership with the JASON Foundation for Education, the Institute for Exploration, and MOTE Marine Lab, NOAA's framework allows individuals living far from the coastal zone to experience up-close the wonders of these special marine areas without even getting their feet wet.

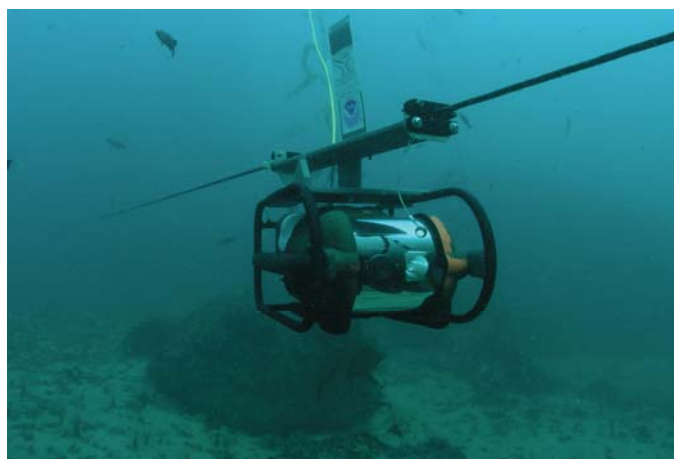
A successful telepresence pilot began operating in Monterey Bay National Marine Sanctuary, allowing visitors to the Mystic (Connecticut) Aquarium's "Immersion Theater" to view and operate, in real time, a remotely operated vehicle tethered near a kelp forest. The

popular exhibit has introduced thousands of visitors to the underwater wonders of the Monterey Bay ecosystem.

## II. SANCTUARIES “LIVE” IN THE CLASSROOM

This innovative and growing program uses a technology called “Telepresence.” The National Marine Sanctuary Program, the Sea Research Foundation (SRF)—the parent of Mystic Aquarium and Institute for Exploration, and the JASON Foundation for Education teamed together to meet the challenge of raising public awareness and appreciation of our national marine sanctuaries. This goal can be met by bringing ocean ecosystems to public places and increasing everyone’s understanding of the marine environment through live video feeds directly from the resource. This is a highly challenging task. However, the SRF was up to the task and instrumental in developing telepresence technology to help bring real-time images of our national marine sanctuaries to the public.

Telepresence uses the latest in wireless and video technology and works through the eyes of underwater cameras and scientific equipment wired beneath the waves. Then, using very fast Internet2<sup>1</sup> connections, telepresence can provide live, broadcast quality, interactive video, and pre-recorded content to distance learning programs, exhibits in aquaria, after-school programs, and a new web-based Telepresence Education Web Portal.



Tethered remotely operated vehicle that beams back live “telepresence” images of the Monterey Bay National Marine Sanctuary to pin sites across the country. (Photo credit : Philip Powell)

There is currently a pilot telepresence system in Monterey Bay National Marine Sanctuary in California. A remotely operated vehicle (ROV) and other cameras operate at a depth of 60 feet of water near a productive sanctuary kelp forest, just offshore the fabled Cannery Row. Video footage from the underwater cameras, as well as above-water cameras focused on a seabird rookery and a sea lion haul-out, is transmitted via fiber optic cable and Internet2 to Mystic Aquarium’s Immersion Institute. There, visitors can control the ROV and cameras as trained specialists interpret the live video. Approximately 100,000 people per year have experienced the live feeds from Monterey Bay since the system came online in summer 2001. With new ROV technology installed and tested this year, a telepresence site now has the capability to send live video and audio from an underwater diver. This exciting element was successfully demonstrated from Monterey in fall of 2004 at an Internet2 conference and again to several locations across the nation, allowing three cross-country groups to view the live feed simultaneously and converse with the diver and the participants at the other locations.

<sup>1</sup> Internet2 is a consortium being led by 207 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow’s Internet. Internet2 is powered by the Abilene network which has a cross-country backbone of 10 gigabits per second, with the goal of offering 100 megabits per second of connectivity between every Abilene connected desktop. Using a simple analogy, if the internet is the information highway, Internet2 is the express superhighway.

The National Marine Sanctuary Program and SRF are expanding the telepresence system to other national marine sanctuaries. Efforts are underway to install cameras and a ROV in Florida Keys National Marine Sanctuary. We anticipate this will be complete in the winter of 2005 and will feature images of coral reefs and a tropical marine protected area as well as footage from the Aquarius underwater habitat. In 2006, cameras are scheduled to be installed in Channel Islands National Marine Sanctuary off of southern California, followed by several additional sanctuary sites including a 19th century shipwreck in Thunder Bay National Marine Sanctuary and Underwater Preserve in Lake Huron, and Hawaiian Islands Humpback Whale National Marine Sanctuary off Maui, Hawaii.



Diver with remotely operated vehicle during telepresence "live dive" in Monterey Bay National Marine Sanctuary. (Photo credit: Phillip Powell.)

Everyone cannot experience the program from Mystic, Connecticut. So, the National Marine Sanctuary Program is working with local partners to develop visitor centers for the national marine sanctuaries. At each of these centers, we envision providing telepresence images from all available cameras. The program is also working with other institutions interested in offering the signal, extending the experience across the country, and

well as to international audiences. To date, partners who have expressed an interest in hosting the signal or who are currently hosting the signal include Pier Wisconsin in Milwaukee; The Aquarium of The Pacific in Long Beach, California; The Cleveland Museum in Ohio; Mote Marine Laboratory in southern Florida; and even the Acquario di Genova, in Genoa, Italy!

At each of the host sites, we anticipate being able to provide the ability to switch images between available camera signals and the opportunity to control the cameras throughout the day. Host sites will be able to develop their own educational materials and programming around the camera signals.

### III. TELEPRESENCE EDUCATION WEB PORTAL

Currently, Internet2 capabilities are out of reach for most people. In fact, it is tremendously expensive, and is currently only hosted at colleges, universities and a handful of other institutions. Thus, the National Marine Sanctuary Program has been working with the JASON Foundation for Education and SRF to bring this imagery and programming to all audiences through the Telepresence Education Web Portal (currently titled "Oceans Live") on the regular internet. The Telepresence Portal is designed to not only provide the live camera feeds from Monterey Bay, but also to provide content and promote ocean literacy and conservation through activities, curricula, live and recorded footage, images and more. While this site will appeal to explorers of all ages, the curriculum offerings will be targeted to grades 4 - 9. The JASON Foundation for Education is revising some of their popular educational materials for use on the site.

As a public resource, the portal will be the gateway to marine science for all audiences, allowing the public to virtually visit underwater habitats, providing live and pre-recorded sight and sound experiences. Beyond the technology-driven ocean education and outreach material, the site will also provide access to other aspects of marine science, exploration, interactive programs and projects.

Currently there are five primary content areas identified for the Telepresence Portal:

- **Life in the Ocean:** Content focused on the origins and evolution of life in the ocean and on our planet; biodiversity; and, biologically changing populations, habitats, and ecosystems.
- **The Physical Ocean:** Content focused on the characteristics of the ocean as a dynamic interconnected system; description of the ocean from a geological, chemical, and physical standpoint; understanding how the ocean works; and the oceans as a global engine.
- **Discoveries and Technology:** Content focused on early exploration of the ocean; technologies used for exploration and research; mysteries of the ocean and current ocean exploration; and, new ocean discoveries, including uses and benefits of the ocean.
- **Conservation and Preservation:** Content focused on human interaction with the oceans; the health and future of ocean conservation; and, environmental stewardship.
- **Maritime Heritage:** Content focused on understanding and appreciating our maritime past and our deep connections to the ocean.

The Telepresence Portal will integrate the live and pre-recorded video feed from the telepresence sites in an interactive and exciting way to teach these five primary content areas. It will provide the educational framework to complement the live opportunity to explore our national underwater treasures! One could envision a classroom in Texas, having just completed a unit on “Life in the Oceans” on coral reefs, watching live coral spawning in Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico with a diver providing interpretation and answering questions in real-time.

As an education tool, the Telepresence Portal is being designed with children (primarily in grades 4-9) and educators in mind. However, as the mechanism to bring national marine sanctuaries into homes across the world, the portal will also be designed for users outside the formal and informal education systems.

In addition to the live video feeds from cameras and ROVs, one of the unique design features of the Telepresence Portal that will help ensure its widespread use and value is a fun capability to access and record “best of” images from telepresence sites. The Telepresence Portal will feature a “best of” gallery of images (still and video) captured from telepresence cameras and provide users the ability to shoot and capture their own “best of” images that they can then use to make their own ocean gallery or submit to the Telepresence Portal for inclusion in the online gallery.

Another exciting capability that will be offered on the Portal is the ability to manipulate telepresence cameras. According to a schedule, users will be able to rotate the cameras and zoom in and out to change perspectives. This feature

will allow users the flexibility to control what they want to see and how to see it. If there is a sea otter playing in the far left field of view, instead of hoping that the otter will swim to the right, the user can rotate the camera to capture the full antics of the otter.

Another feature of the Telepresence Portal will be a broadcast schedule that informs users of special events. The teacher in Texas would know months in advance that on a certain day a diver will provide live interpretation of a coral spawning event or when is the best time to watch humpback whales through the Maui camera.

The Telepresence Portal is currently under development, and a prototype will be available in late 2005. The complete portal will take a couple of years with ample opportunity to pilot and refine individual components prior to full-scale development and implementation. We are currently seeking additional classrooms, teachers, and partners willing and able to pilot this technology and provide crucial feedback. Be sure to visit the National Marine Sanctuary Program's education website to sign up for announcements and other sanctuary education opportunities at <http://sanctuaries.noaa.gov/education/>.

#### IV. CONCLUSION

NOAA's National Marine Sanctuary Program is partnering with aquaria, research institutions, and a variety of private and federal partners to expand this exciting technology to the Channel Islands, Florida Keys and Thunder Bay sanctuaries over the next two years. The vision is to eventually establish a telepresence and monitoring capability at all thirteen national marine sanctuaries and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve and to provide the public the ability to analyze the

movement of satellite-tagged loggerhead turtles in the South Atlantic Bight, observe sea otters in the Monterey Bay kelp forest, listen to the songs of the Hawaiian Islands humpback whales, and interact with this information in its broader context to address current environmental and social challenges. By linking telepresence with system-wide monitoring, this initiative promises to excite and educate millions by bringing the National Marine Sanctuaries and their vibrant ecosystems right into the homes of audience members worldwide.