

Research Vessels *Fulmar* and *R4107* Summary of 2011 and 2012 Accomplishments in Cordell Bank, Gulf of Farallones, and Monterey Bay National Marine Sanctuaries



NOAA's R/V *Fulmar*.

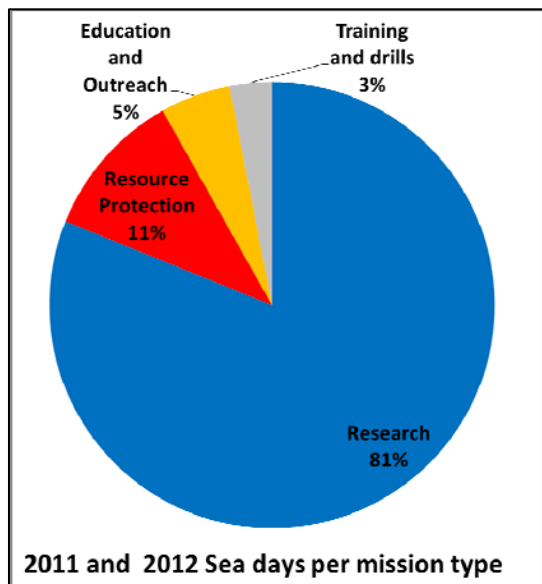
NOAA's Office of National Marine Sanctuaries operates a fleet of small boats to support mission-critical programs in sanctuaries. The research vessels *Fulmar* and *R4107* are based in Monterey, California and are operated by the West Coast Region Office on behalf of Cordell Bank (CBNMS), Gulf of Farallones (GFNMS) and Monterey Bay (MBNMS) National Marine Sanctuaries. These two vessels serve as platforms for research, resource protection, and education and outreach missions in the 8,000 square mile area encompassed by the three central California National Marine Sanctuaries. In 2011 and 2012 the vessels successfully completed 65 missions.

***Fulmar* and *R4107* Summary**

- Support area: 8,000 square miles
- Missions completed: 65
- Days at sea: 196
- Research participants: 894
- Education and outreach participants: 202
- Number of SCUBA dives: 321
- Combined SCUBA diver bottom time: 235 hours



NOAA R/V *R4107*. Photo credit: Bob Schwemmer.



The majority (81%) of sea days aboard the *Fulmar* and *R4107* are dedicated to conducting research. Each of the central California sanctuaries maintains site specific research projects that contribute to long-term monitoring data sets to meet management plan needs. Research design, methods, and results are reported on the Sanctuary Integrated Monitoring Network (SIMoN) web site at www.sanctuarysimon.org. Most of the research projects are designed to provide data needed for resource managers to make informed decisions. Only 5% of the sea days were allocated to education and outreach missions, but students and teachers had opportunities to participate in many of the research projects at sea, and were also involved in data analysis.

RESEARCH HIGHLIGHTS

Applied California Current Ecosystem Studies

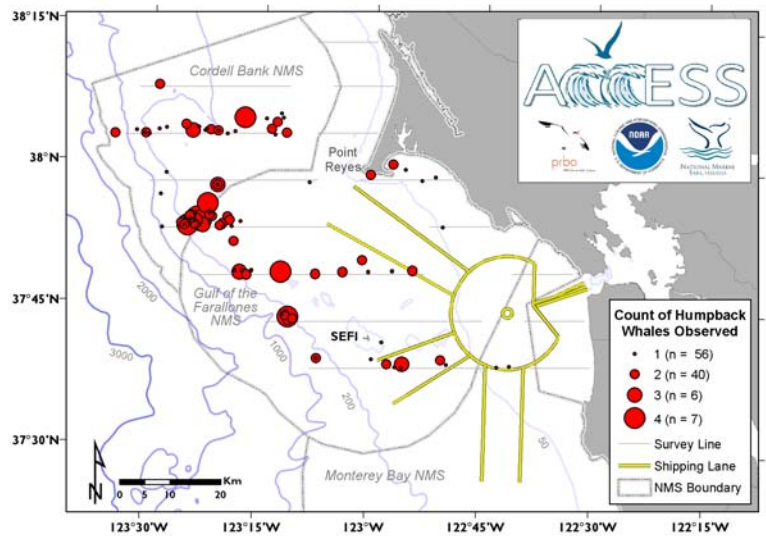
The Applied California Current Ecosystem Studies (ACCESS), a partnership with CBNMS, GFMNS and PRBO Conservation Science, continues to support integrated marine ecosystem research to advise management. The ACCESS team conducted five multi-day surveys to document how temporal changes in oceanographic conditions impact marine mammal and seabird abundance and spatial distribution in the three central California national marine sanctuaries.

In 2012, maps of baleen whale observations were produced to accompany a Local Notice to Mariners for the San Francisco Bay vessel traffic region advising mariners to use caution when transiting within the Sanctuaries to reduce potential vessel strikes to whales. Two high school teachers from NOAA's Teacher-at-Sea program participated in ACCESS cruises and carried this immersive experience to their classroom.

Foraging Ecology of Humpback and Blue Whales

A team of researchers led by Duke University examined the fine scale foraging of whales in Monterey Bay using digital acoustic recording tags and scientific echo sounders. One whale was tagged and it dove repeatedly down to 200 meters to feed on a dense krill layer. The *Fulmar's* hull-mounted EK-60 scientific echo sounder allowed sampling prey around the whale to be quick and efficient.

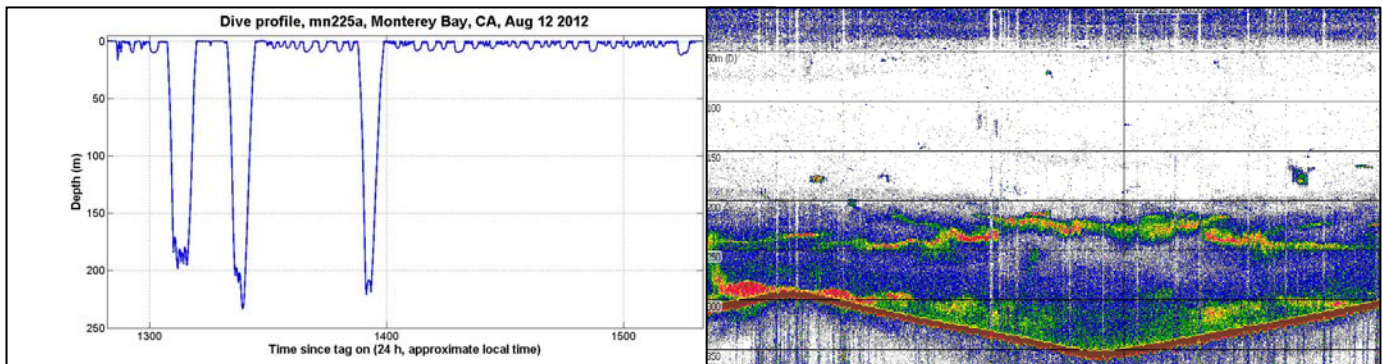
Humpback Whale Observations - 2012 ACCESS Cruises



Applied California Current Ecosystem Studies (ACCESS, www.accessoceans.org)



Lunge feeding humpback whales and shearwaters feasting on Pacific mackerel. Photo credit: Sophie Webb.



The echogram of acoustic backscatter is concurrent with the dive profile for a feeding whale. Layers of krill are seen between 200-250 m and 300-350 m. The tagged whale made three deep foraging dives to a dense krill layer, and then remained near the surface for the remainder of the tag deployment.



A Humboldt Squid is dissected on the deck of the *Fulmar*.

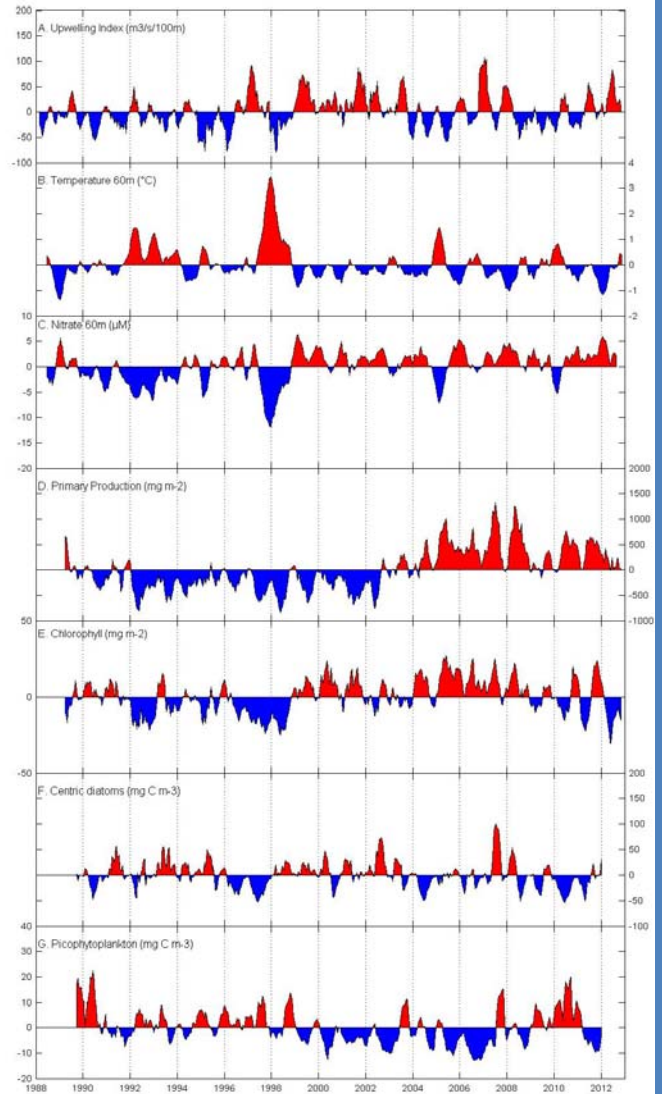
Humboldt Squid in Monterey Bay

Researchers from NOAA, Oregon State, Stony New York State, and Stanford Universities conducted acoustic surveys and captured Humboldt squid to study the distribution and biomass of this voracious predator in the Monterey Bay area.

Oceanographic Monitoring in Monterey Bay National Marine Sanctuary

Scientists from the Monterey Bay Aquarium Research Institute (MBARI) studied the ammonium maximum layer in Monterey Bay. This layer is thought to be created by the biological activity of plankton and bacteria, as well as by physical processes of advection and mixing. MBARI also used the *Fulmar* to collect data for their Monterey Bay Time Series project. Since 1989, MBARI monitors physical, chemical and biological conditions in Monterey Bay with a focus on phytoplankton production. The project has documented seasonal change, decadal change, El Niño and other oceanographic events.

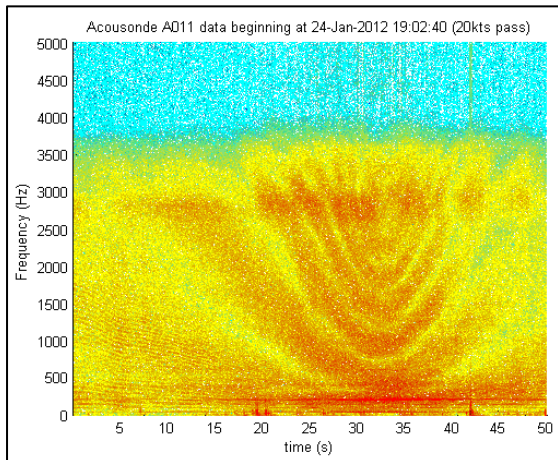
Researcher from Scripps Institution of Oceanography (SIO), MBARI and the Naval Postgraduate School (NPS) deployed and recovered arrays of moorings and buoys from both the *Fulmar* and *R4107*. SIO replaced wave-height monitoring buoy systems off Point Sur and in Monterey Bay for the Coastal Data Information Program (CDIP), an extensive network for monitoring waves and beaches along the coastlines of the United States. Since its inception in 1975, CDIP has produced a vast database of publicly-accessible environmental data for use by coastal engineers and planners, scientists, mariners, and marine enthusiasts. The program has also remained at the forefront of coastal monitoring, developing numerous innovations in instrumentation, system control and management, computer hardware and software, field equipment, and installation techniques.



Low (blue) and high (red) anomalies for a number of variables over the past 23 years. Since the 1997-98 El Niño, Monterey Bay has been in a cool productive state.



Naval Postgraduate School students deploying a sediment grab from the *Fulmar*.



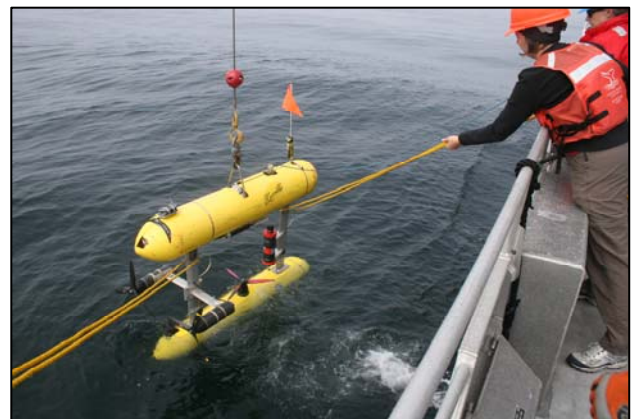
Fulmar noise signature during a 20 knots pass off a NPS mooring.

Researchers and students from NPS deployed acoustic moorings, and collected CTD data and sediment samples for a tactical oceanography class project that investigated underwater sound variability in a shallow water environment. Other NPS researchers and students used a variety of free floating wave buoys, including a prototype buoy, to make currents, waves and surf predictions along the southern Monterey Bay area.

SIO Whale Acoustics Laboratory deployed moorings with High Frequency Acoustic Recording Packages to acoustically monitor marine mammal activities in the southern part of MBNMS as part of a proposed study of the environmental impacts of offshore geophysical surveys planned near the Diablo Canyon Power Plant. The goal of the proposed acoustic monitoring is to provide insight on the impact of seismic noise on harbor porpoise, coastal bottlenose dolphins, endangered baleen whales (blue, fin and humpback), and other marine mammals in the region.

Exploration of Bodega Canyon in Cordell Bank National Marine Sanctuary

In collaboration with NOAA's Northwest Fisheries Science Center, CBNMS scientists operated the autonomous underwater vehicle (AUV), *Lucille*, off the *Fulmar* to collect the first underwater images of benthic communities in Bodega Canyon. *Lucille* surveyed to 500m on the sloping edges of this prominent underwater feature that reaches over a mile in depth. The new imagery revealed the Canyon's soft sediment and mud-draped bed rock habitat and a diverse array of fishes and invertebrates, including some deep-sea corals and sponges, highlighting the ecological importance of the Canyon's deep-water habitats.



Launching AUV *Lucille*. Photo Credit: Dale Roberts.



Vase shaped sponge and sea cucumber in Bodega Canyon.

Photo Credit: CBNMS.

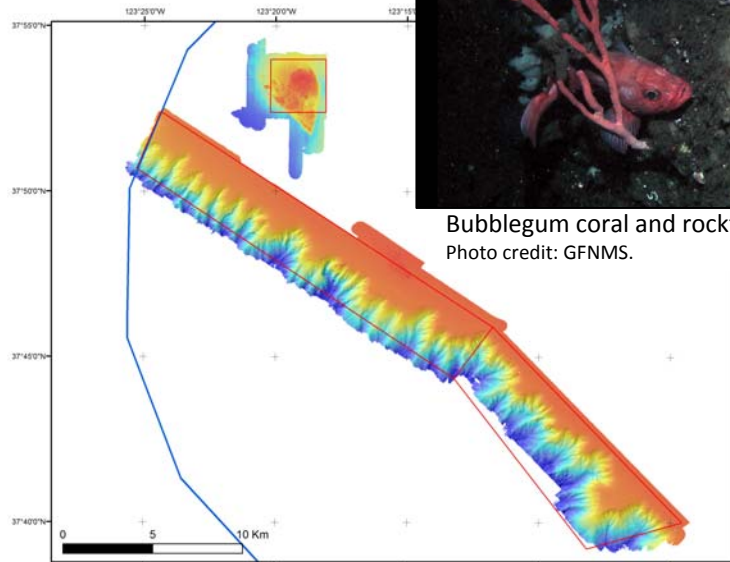
Deep-Sea Coral Survey in Gulf of Farallones National Marine Sanctuary

In 2011, the GFNMS, in collaboration with the United States Geological Survey (USGS) and NOAA's National Centers for Coastal Ocean Science (NCCOS), used a multibeam sonar to map the continental shelf and slope to identify suitable substrate for deep-sea corals in the Sanctuary. The map was used to select sites to conduct video surveys and collect specimens with the remotely operated vehicle (ROV), *Beagle*, operated by Marine Applied Research and Exploration (MARE) in 2012.

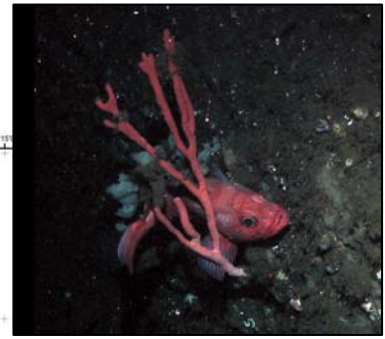
As part of this project selected invertebrates were collected for expert identification, their DNA is archived at the California Academy of Sciences, and video data are currently being analyzed at NCCOS. The goal of the ROV survey was to characterize deep-sea corals and sponges in the areas.



Gary Williams from California Academy of Sciences with a deep-sea coral specimen collected with the ROV in GFNMS. Photo credit: GFNMS.



Preliminary multibeam map of Rittenburg Bank and Farallon Escarpment created by Guy Cochrane (USCG).



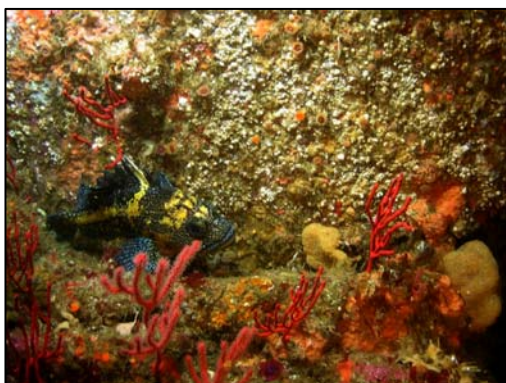
Bubblem gum coral and rockfish. Photo credit: GFNMS.

Deepwater Characterization in Monterey Bay National Marine Sanctuary

Scientists and students from MBNMS and California State University Monterey Bay (CSUMB) continued the video characterization effort of the Sanctuary’s continental shelf and slope. The 2011 research effort focused mostly on surveying previously unexplored areas of the continental shelf off the Big Sur “Lost Coast” using a tow camera sled. Additionally, surveys were conducted in the Piedras Blancas State Marine Conservation Area to augment baseline surveys conducted there in 2007 and 2008, when it was designated by the state as a marine conservation area.



Red octopus. Photo credit: MBNMS/CSUMB/MARE.



China rockfish and red gorgonian coral. Photo credit: MBNMS/CSUMB/MARE.

The 2012 research cruise focused on a sanctuary area of interest off the Monterey Peninsula using the ROV *Beagle* from depths ranging 30 to 500 meters.

The imagery collected on these cruises contributes to data on the Sanctuary’s Ecologically Significant Areas as well as contributes to the database of fishes and invertebrates throughout the MBNMS. Monitoring the deep seafloor in these areas provides invaluable information on benthic habitats, and associated fish and invertebrate assemblages.

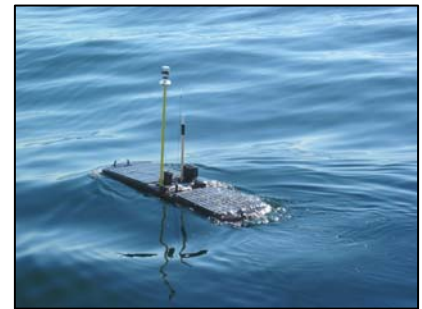
Lagrangian Camera Floats and Wave Gliders: Innovative Research at Cordell Bank and Monterey Bay National Marine Sanctuaries

Funded by a NOAA technology grant, Dr. Chris Roman from the University of Rhode Island, collaborating with Dr. Elizabeth Clark from NOAA Northwest Fisheries Science Center, partnered with CBNMS to successfully complete field trials of a recently developed shallow water camera float. The float was equipped with a high quality bottom imaging camera system that successfully sampled several high relief areas on Cordell Bank. Images were used to ground truth predictive coral models developed by the sanctuary and photo document recruitment of yelloweye rockfish, a species recovering from over fishing.



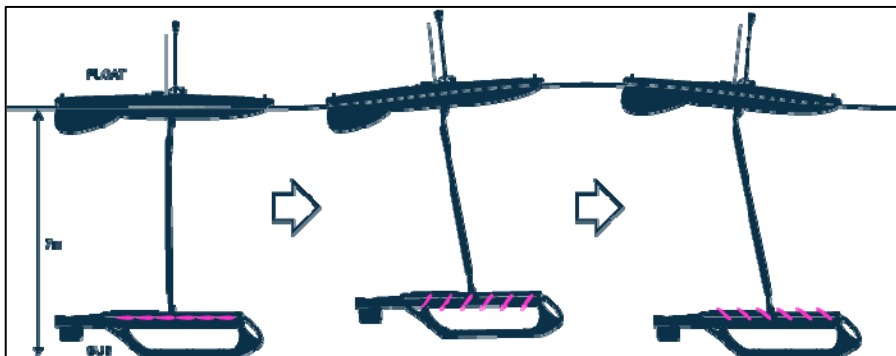
Lagrangian camera.
Photo credit: CBNMS.

A team from Liquid Robotics, Inc. used the *Fulmar* to recover two experimental Wave Gliders. The gliders were tested in Monterey Bay for comparison of two different hydrocarbon fluorometers. The tested sensors are designed to detect minute amounts of spilled oil for detecting or mapping oil spills. A high resolution digital camera on the Wave Glider float is triggered by the presence of hydrocarbons to take surface images of oil sheen. Meteorological and oceanographic data were collected via the solar powered weather station during the mission.



The Wave Glider is the first unmanned autonomous marine robot to use only the ocean's endless supply of wave energy for propulsion.

Photo credit: Lorraine Anglin.



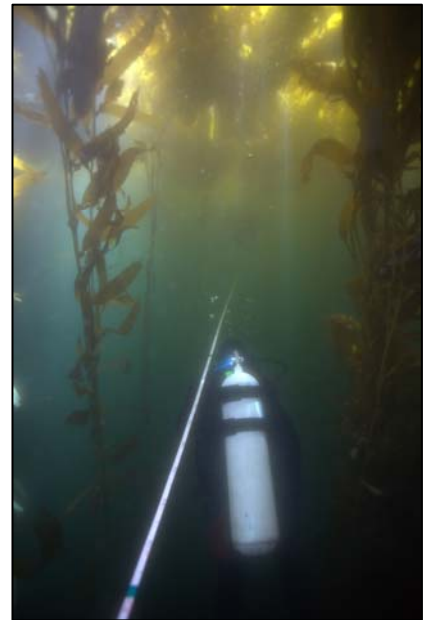
Wave motion is greatest at the water's surface, decreasing rapidly with increasing depth. The unique two-part architecture of Liquid Robotics' Wave Glider exploits this difference in motion to provide forward thrust.



Olive rockfish over rocky outcrop covered with kelp, hydrocoral and sponge off the Big Sur coast. Photo credit: Chad King.

Research Diving in Monterey Bay National Marine Sanctuary

MBNMS divers and partners continued the nearshore characterization and monitoring effort of the Big Sur coast aboard the *Fulmar* and *R4107*. The goal of the Nearshore Characterization project is to increase our first-hand knowledge of the marine resources and habitats along the coastline, particularly kelp forests. This long-term project provides data to directly inform sanctuary management actions and permitting processes. The work of MBNMS scientific divers in this area has established the sanctuary as a leader in ecosystem-based management of resources along the Big Sur coast. Surveys of fishes, invertebrates, and algae provided species richness data that complement those collected by the University of California Santa Cruz's Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and allow comparisons among subtidal sites along the coast. The *R4107* is used to deploy smaller dive teams. The *Fulmar* allows up to ten divers to work in remote sections of the coast for up to five days at a time without returning to port.



Kelp forest midwater survey. Photo credit: Chad King.



Kelp forest benthic survey. Photo credit: Chad King.

Divers from MBNMS and PISCO continued the Marine Protected Area (MPA) monitoring to determine the effectiveness of the MPAs established in 2007 by the state of California. The divers also conducted subtidal surveys at the Alder Creek land slide, which closed scenic Highway 1 in Big Sur for two months. These surveys will guide the design and implementation of a study that will assess the impact of the slide and subsequent engineering performed at the site.

MBNMS and other local NOAA divers participated in semi-annual dive safety training for divers aboard the *Fulmar*. Training exercises included a deep dive and practicing procedures to hoist unconscious divers from the ocean onto the *Fulmar* using a litter and the A-frame. This session increased safe diving practices and emergency situation preparation. NOAA and American Academy of Underwater Sciences (AAUS) dove together from the *Fulmar* to actively engage AAUS divers with the NOAA dive program and NOAA small boats.

Summary of *Fulmar* dive statistics for 2011 and 2012

	2011	2012
Number of dives conducted	169	130
Number of unique divers	24	26
Total bottom time	137 hr	85 hr
Average bottom time	49 min	39 min
Average depth	52 ft (+/- 20 sd)	61 ft (+/- 20 sd)
Enriched air Nitrox dives	84%	35%
Number of dive sites	25	27

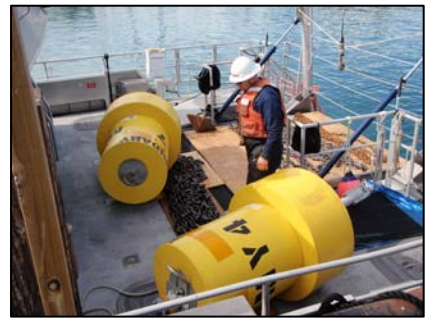


Invertebrates assemblage on a rocky reef off Big Sur. Photo credit: Chad King.

RESOURCE PROTECTION HIGHLIGHTS

Buoys Maintenance and Inspection

Sanctuary staff deployed buoys from the *Fulmar* to demarcate special zones within the National Marine Sanctuaries. Buoys around the Devil's Slide Rock are intended to inform boaters about a No-Access Zone to protect seabirds. Another buoy array in Monterey Bay marks marine boundary lines for a motorized personal watercraft (MPWC) zone within the sanctuary. The *Fulmar* is a safe and functional platform for deployment, whereas the *R4107* has been used to inspect MPWC buoys.



Fulmar Captain Dave Minard inspects MPWC buoys before deployment.

Photo credit: Scott Kathey.

Resource Protection Patrols

MBNMS conducted patrols aboard the *R4107* to inspect the shoreline for illegal construction below mean high tide in the sanctuary. In May 2012, the *R4107* was deployed to Santa Cruz to monitor human activity around a humpback whale that was swimming unusually close to shore. The *R4107* was also called upon to search for a whale that was reported to be entangled in fishing gear - in this case the whale was not found.

Deepwater Lost Fishing Gear Removal



The Sanctuary ROV is named *Edward Scissorhands*.

Photo credit: MBNMS.

Lost fishing gear can smother underlying benthic habitat, get caught on rocky reefs, or float in the water column to catch marine life or additional fishing gear. The majority of this lost gear does not decompose in seawater and can remain in the marine environment for years to decades. In 2011, MBNMS and partners conducted their third cruise, searching for gear at locations selected by the sanctuary after consulting with NOAA's Southwest Fisheries Science Center (SWFSC) and local fishermen. MBNMS, working closely with a number of partners (CBNMS, CSUMB, MARE, MATE, California Academy of Sciences, California Department of Fish and Wildlife, Steinhart Aquarium, UC Davis' SeaDoc Society and others) used an ROV to survey areas in and close to the Point Sur and Soquel Canyon State Marine Conservation Areas.

The team successfully retrieved a 75 x 25ft gillnet and a variety of crab pots and traps. They also located a 100ft longline and a Navy cable dump area. Biologists collected and catalogued specimens from the recovered gear and a CSUMB graduate student determined density of monofilament fishing line for her thesis. This three-year project reflects the importance partnerships with other agencies have on completing MBNMS led projects.



Floating trawl net found within the Portuguese Ledge State Marine Conservation Area.

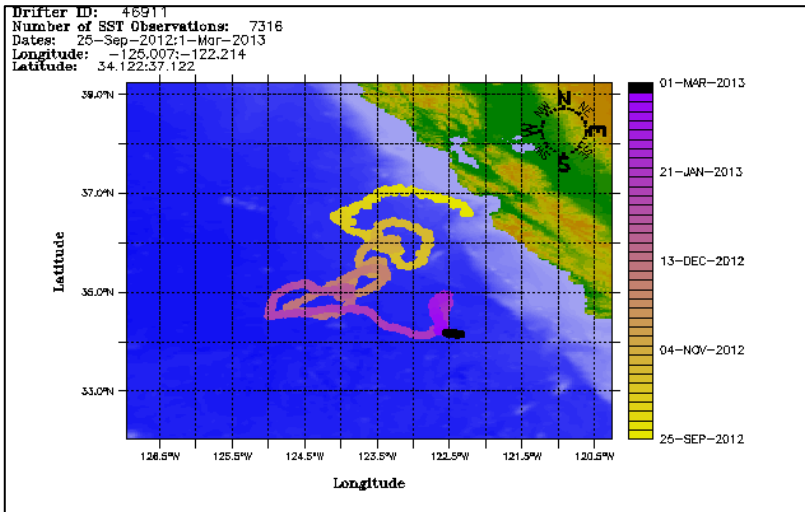


Part of the lost Fishing gear crew standing by the recovered trap. Photo credit: MBNMS.

OUTREACH AND EDUCATION HIGHLIGHTS

Adopt a Drifter

In fall 2012, students from Monterey's Santa Catalina High School deployed a drifter from the *Fulmar* as part of the NOAA Adopt a Drifter Program. The school co-"adopted" this drifter with students in Sicily, Italy. The 44-pound drifter will collect and transmit sea surface temperature and position data for up to approximately 400 days to teachers and students in the US and abroad.



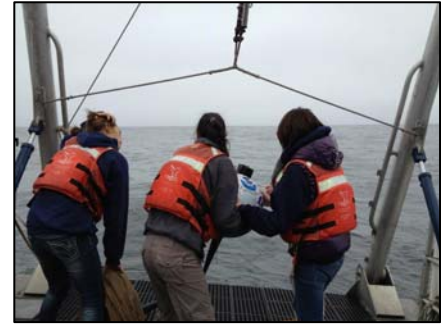
Additional dockside activities included students participating in tours of the *Fulmar*, simulated whale disentanglement demonstration and a discussion with Monterey Peninsula College's Marine Advanced Technology Center staff.

John Steinbeck: Voice of a Region, Voice for America

Educators from Stanford and San Jose State University led a group of twenty five high school teachers who were attending a National Endowment for the humanities-sponsored Summer Institute, "John Steinbeck: Voice of a Region, Voice for America". The group engaged in a day aboard the *Fulmar* searching for marine mammals and seabirds, conducting CTD casts, and jigging for squid. This three-week institute bridges humanities and science and includes one week devoted to Steinbeck's interest in marine biology with Ed Ricketts of Monterey. The cruise was extremely successful. For many of the teachers (from all over the U.S.), this was their first time at sea.

AMP Film Crew

A film crew from Access Monterey Peninsula Community Media Center worked with MBNMS staff aboard the *R4107* to film wildlife in Monterey Bay. The crew also filmed the new Sanctuary Exploration Center in Santa Cruz, and interviewed Charles Canfield, the owner of Santa Cruz Seaside Co. at the Santa Cruz Beach Boardwalk. The interview was broadcasted in the "Your Sanctuary" public access television program.



Three High School students who won the essay & arts contest deploy the drifter. Photo credit: MBNMS.



Photo credit: MBNMS.

Students from the Italian sister-school signed the NOAA sticker applied to the buoy before it was launched into the sea.

Together, they track this buoy as it travels along ocean currents, collecting important environmental data about the Pacific and the global climate.



First Mate Hans Bruning gives a tour of the *Fulmar*. Photo credit: MBNMS.

Volunteers at Sea

Education cruises for MBNMS volunteers conducted in 2011 and 2012 aboard the *Fulmar* allowed volunteers the chance to observe seabirds, whales, dolphins and other marine mammals in their pelagic habitats, which greatly enhance how volunteers provide interpretations to visitors. After each cruise, volunteers send images and emails thanking the sanctuary for their continued support of the volunteer programs. The volunteers appreciate the experience being on a research vessel and out on the sanctuary. These volunteers contribute close to 7,500 hours a year (a \$150,000 value) to MBNMS projects.



A Risso dolphin breaching in front of the *Fulmar*.



The Central California National Marine Sanctuaries are a biodiversity hotspot, the Serengiti of the sea.



A Northern Fulmar flying by the *Fulmar*.

VALUABLE REGIONAL ASSETS

The *Fulmar* and *R4107* were vital to maintaining important long-term monitoring projects with partners in addition to forging alliances to meet the needs of new partners and new outreach opportunities for the sanctuaries. The *Fulmar* has become an icon for sanctuary research in central California.



The Big Sur Coast viewed from the *Fulmar*. Photo credit: Chad King.