

## Research Vessels *Fulmar* and *R4107* 2020 Accomplishments Summary in Cordell Bank, Greater Farallones, and Monterey Bay National Marine Sanctuaries



Captain Rayon Carruthers departs Monterey harbor at the helm of the NOAA R/V *Fulmar*. Photo Credit: B.Kaiser, WCRO

NOAA's Office of National Marine Sanctuaries (ONMS) operates a fleet of small boats to support mission-critical programs in national marine sanctuaries. The research vessels *Fulmar* and *R4107* are based in Monterey, California and are operated by the West Coast Region Office (WCRO) in support of Cordell Bank (CBNMS), Greater 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 area encompassed by the three central and northern California national marine sanctuaries which covers more than 10,000 square miles. During 2020, the vessels spent 52 days at sea and successfully completed 32 missions.

### ***Fulmar* and *R4107* Summary –**

Support area: 10,675 square miles

Projects supported: 18

Missions completed: 32

Days at sea: 52

Total participants: 210

Number of dives: 11



NOAA R/V *R4107* hauled out at Monterey Boatyard for a hull inspection and cleaning. Photo Credit: B.Kaiser, WCRO

The three national marine sanctuaries of northern and central California are some of our nation's most spectacular marine protected areas and offer some of the best marine wildlife viewing in the world. Because of this, they have been dubbed the "Serengeti of the Sea". Focused along the California coastline from Pt. Arena to Cambria, these sanctuaries include pristine shorelines, lush kelp forests, steep canyons, offshore islands, banks and seamounts, all teeming with life —from microscopic plankton to the giant blue whale.

The history of California's coast is predominantly a maritime one, with hundreds of shipwrecks laying on the seafloor. Part of the mandate of the ONMS System is to inventory and to research these archaeological sites and provide public education about them.

The *Fulmar* and *R4107* are specially designed and equipped to complete projects that fulfill the Office of National Marine Sanctuaries' mission. The vessels support a wide variety of missions and provide access to offshore sites and extensive stretches of the coastline that cannot be reached by land. Resource protection and management are at the core of the projects supported by the vessels.

GREATER FARALLONES, CORDELL BANK, & MONTEREY BAY NATIONAL MARINE SANCTUARIES



The three national marine sanctuaries of central and northern California are a biological hot spot and have a rich maritime heritage.

With 39 days at sea, the *Fulmar* continues to be the WCRO flagship. The *R4107* had 13 days at sea, but the vessel operations team continued to apply significant attention and efforts to much needed vessel maintenance. Research missions accounted for 64% of the day at seas, while resource protection missions accounted for 21%. Most of the research projects were designed to provide data needed for resource managers to make informed management decisions. The California national marine sanctuaries maintain site specific research projects that contribute to long-term monitoring data sets in order to meet management plan needs. Details about the research designs, methods, and results of the monitoring projects can be found on the Sanctuary Integrated Monitoring Network (SIMoN) website [www.sanctuariesimon.org](http://www.sanctuariesimon.org). Although education and outreach are a priority for the WCRO vessels, these types of missions were cancelled due to the COVID-19 pandemic.





Safety is a top priority for all operations, and the WCRO operations team strives to meet or exceed NOAA Small Boat standards and procedure. Even so the pandemic limited operations and dramatically reduced the number of missions planned for 2020, the vessel team continued to keep the vessels mission ready. Fifteen percent days at sea were devoted to crew proficiency, drills and sea trials.

Starting March 16, as a result of the coronavirus pandemic onset, the WCRO vessel team began to implement protocols to minimize the risk of exposure to COVID-19, and limited field operations to time sensitive, essential and emergency missions. Warm lay-up missions were established and agreed upon by ONMS leadership to ensure vessels are functioning properly and able to commence an operation at any time. The primary objectives of these missions are to run engines at cruise speed and full speed to fully heat the engines and circulate engine oil, check transmission and gears from each station, remove growth from hull bottom underway ablating, and test the vessel systems underway. It is recommended that these types of mission occur every two to four weeks when the vessels are not otherwise run. To take advantage of the vessels being at sea, ancillary missions were incorporated into the warm lay-up, as long as they did not significantly increase the risk of exposure to COVID-19. Examples of ancillary missions included crew proficiency training, emergency drills, and marine resources surveys.

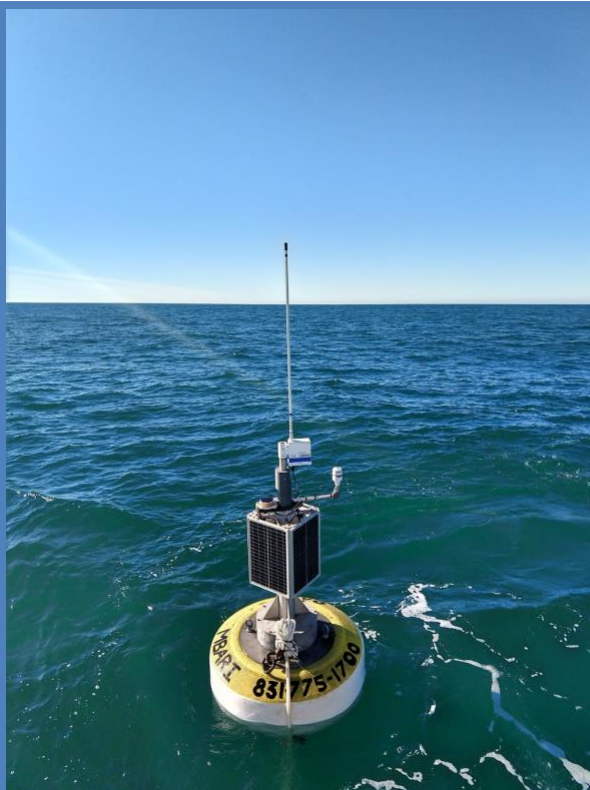
## RESEARCH HIGHLIGHTS

### Tracking an Apex Predator in Monterey Bay National Marine Sanctuary

White sharks occur in all West Coast national marine sanctuaries. Although there is uncertainty among scientists about the white shark population size off the California coast, the number of sub-adult (7-9 ft length) white shark sightings in Monterey Bay increased significantly over recent years. It is likely that the higher-than-normal temperatures recorded close to shore in Monterey Bay are an important factor for the increase in sub-adult white shark numbers. Channel Island National Marine Sanctuary science team collaborates with an academic partner to tag and track sharks in and near that sanctuary. Furthering this regionally significant work, the *Fulmar* team, in partnership with Stanford University's Hopkins marine station, deployed nine VR2w acoustic receivers in June to study white shark movement in Monterey Bay. Free divers attached the receivers to MBNMS boundary marker buoys for motorized personal watercraft zones. Buoys and moorings can be an entanglement risk for whales and a navigational hazard. Attaching receivers to existing buoys – ones that have never been involved in an entanglement with whales over 25 years – is an inventive way to expand the deployment of acoustic receivers without increasing risks for entanglement or vessel collision. The data records from the receivers will be downloaded and analyzed after they are recovered in a mission planned for early 2021.



Ronan, a large white shark, inspects the Stanford University tag boat at Año Nuevo. Photo Credit: Stanford University



Oceanographic buoy at Año Nuevo equipped with an acoustic receiver that can transmit live data.  
Photo credit: C.Wahl, MBARI

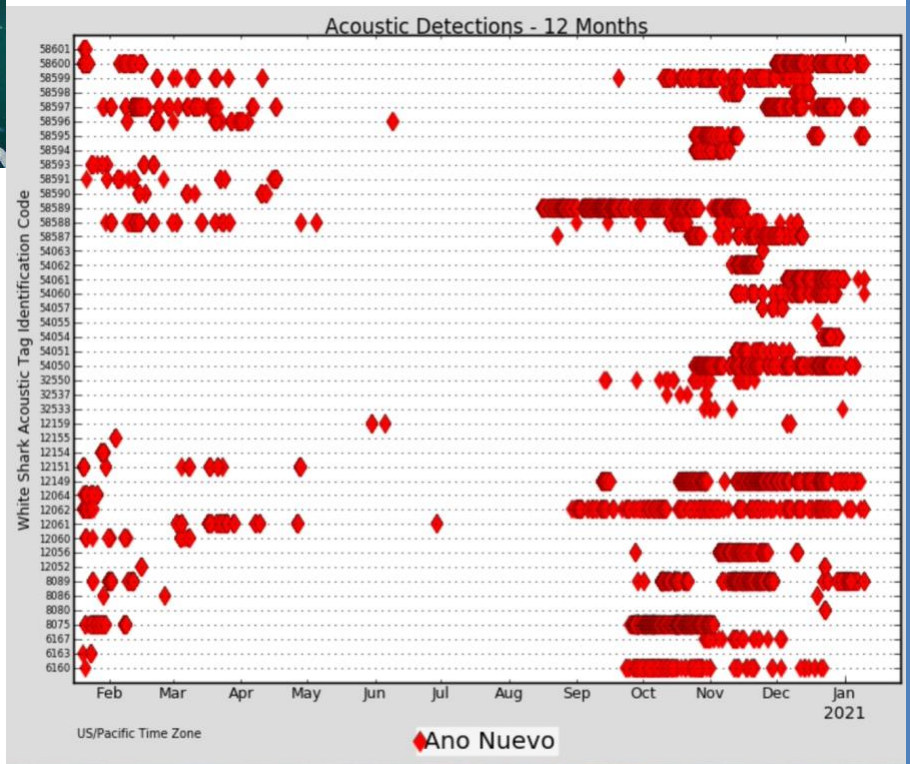
### Monterey Bay Time Series

In November and December, scientists from the Monterey Bay Aquarium Research Institute (MBARI) deployed a CTD and a rosette of water sampling bottles from the *Fulmar* and used the vessel's echo sounder and thermosalinograph to collect oceanographic data in support the Monterey Bay Time Series (MBTS), a long-term monitoring project in its 31<sup>st</sup> year. The MBTS project collects oceanographic data using research vessels and autonomous platforms, including moorings, autonomous underwater vehicles (AUV), wave gliders, and satellites, to study the effects of natural and man-induced climate change upon ocean ecology. MBTS effort focuses on monitoring physical, chemical and biological conditions with a particular attention to primary production by characterizing the origins and fate of water, nutrients and phytoplankton upwelled off Monterey. A warming event was observed in November with decreased chlorophyll concentrations and lower salinity, and was followed by an upwelling event in December, which conversely changed all concentrations.

The data collected by this project has been instrumental in understanding the complicated and interrelated relationship between climate change, both natural and man-made, and also upon cyclical ocean conditions that can vary from year to year, and oceanographic periods. While many

In August, the *Fulmar* re-deployed an oceanographic buoy equipped with an acoustic receiver that can transmit live data at Año Nuevo, a hot spot for larger white sharks. As of the end of 2020, 32 different tagged sharks were recorded in the vicinity of the buoy since its re-deployment. Most of the sharks arrive at Año Nuevo in the Fall, a time when elephant seals, a favored white shark prey, are abundant in that area.

Studying white shark movement, behavior and biology is essential to understand the role of this apex predator in the sanctuaries' ecosystem. It may also provide valuable information that could augment public awareness and risk management.



Acoustic detections of tagged white sharks recorded at Año Nuevo during 2020.



consequences of these dramatic events have been described, some of the physical drivers still remain largely enigmatic - as do their connections to climate change. These large climate fluctuations alter livelihoods and economies, yet their origins, drivers and how they will play out in the future remain largely a mystery.

In addition to tracking environmental change through time, the MBTS project provides a contextual setting, data and infrastructure that support new ideas and process studies that use Monterey Bay as a natural laboratory for sensor and platform

### Chasing Midwaters Jellies in Monterey Canyon

Midwater communities are poorly documented and mostly uncharacterized throughout the world's ocean. As an important ecosystem that houses diverse organisms, vertical migrators, and many economically important fisheries, understanding the players and drivers in midwater communities are essential to effective stewardship. The *Fulmar* served as a support vessel to test a mini ROV system developed by MBARI that was specially equipped with machine learning for real-time classification, identification, and to track and collect midwater invertebrates. By mining



The miniROV setup on the deck of the *Fulmar* Photo credit: MBA/MBARI



An undescrbed jellyfish (*Annatiara* spp.) found in Monterey Bay. Photo credit: MBA/MBARI

MBARI's annotated video database, and training machine learning models to classify targets of interest in real-time, scientists are moving closer towards fully automated exploration and characterization of communities throughout the ocean's midwaters.

The team collected live specimens for an upcoming Monterey Bay Aquarium exhibit about marine life and ecosystems of the deep ocean. The samples collected included an undescrbed jellyfish (*Annatiara* spp.), which may be new to science and certainly a new species for MBNMS. The exhibit will introduce nearly two million visitors a year to the variety and complexity of deep-sea ecosystems in MBNMS and the new discoveries being made about life and ecosystem processes in this poorly understood environment. The Aquarium plans on addressing the direct and indirect threats facing these communities and share these stories, including the science conducted aboard the *Fulmar*, with its online audiences which includes 3,583,000 followers as well as another 3,000,000 on the web each year, making Aquarium-messaging extremely far reaching.

## Sanctuary Soundscape in Monterey Bay and Channel Islands National Marine Sanctuaries

NOAA and the U.S. Navy monitor underwater sounds across eight National Marine Sanctuaries and Monuments, including CINMS, MBNMS and Olympic Coast National Marine Sanctuaries on the West Coast. Standardized measurements assess sounds produced by marine animals, physical processes (e.g., wind and waves), and human activities. Collectively, this information will help NOAA and the Navy measure sound levels and baseline acoustic conditions in sanctuaries. In 2020, the *Fulmar* and *R4107* dedicated 10 days at sea to maintain nine different acoustic moorings in CINMS and MBNMS for the Sanctuary Soundscape Monitoring project. Of particular interest to MBNMS is the correlation between the use of seal bombs in fishing operations and the presence of harbor porpoise. The data from these moorings are critical and timely because they are collecting a time series of acoustic information that will document the effects of the COVID-19 on underwater sound during this unprecedented economic crisis.



Naval Postgraduate Schools scientists recovering a HARP mooring at Sur Ridge. Photo credit: WCRO



MBARI used the *Fulmar* to recover an autonomous profiling float. Photo credit: K.Johnson, MBARI

## Offshore Recovery

Developing sensors and instruments for improving ocean observations and understanding ocean health is one of MBARI's primary missions. On September 2<sup>nd</sup> the *Fulmar* travelled approximately 85 nm offshore from Monterey to recover a defective autonomous profiling float (drifting buoy). The pH and nitrate sensors that are part of this profiling float provide data to the core-Argo global array of profiling floats. NOAA has put a priority on supporting and prioritizing the data stream from this network of sensors. MBARI intends to refurbish and improve the sensors on the recovered profiling float and redeploy it in the California Current system for continued monitoring and observation of coastal biogeochemistry.



### Measuring the effect of Turbulences on Laser Communication

This past year, the Naval Postgraduate School (NPS) Physics Department has been conducting research on the effects of atmospheric turbulence on laser communication in the marine environment. This work is supported by the Office of Naval Research. It included a series of experiments over several months on the Coast Guard Pier where the WCRO vessels are berthed, and two underway experiments on the *Fulmar* and *R4107*. As part of a doctoral thesis, an NPS student collected over 100 hours of data using turbulence monitors deployed on the pier and the two WCRO vessels. The data collected in the field from the *Fulmar* are used to develop a machine-learning algorithm for predicting turbulence based on meteorological parameters.



NPS installed sensors on the *Fulmar's* bow to monitor atmospheric turbulence. Photo credit: NPS

### Unmanned Aircraft System Testing

In October, retired NOAA Corps officers Matt Pickett and Brian Taggart from Ocean Unmanned tested the feasibility of launching and recovering a newly acquired NOAA vertical take-off and landing (VTOL) Unmanned Aircraft System (UAS) from the *Fulmar* and *R4107*. This evaluation consisted of multiple steps including testing the system's ability to properly initialize internal GPS, magnetic compass, and navigation system while on the deck of research vessels. The VTOL will be used to meet coastal and habitat mapping requirements.



Retired NOAA Corps Officer Brian Taggart running system check for a fixed-wing UAS on the on back deck of the *R4107*.

Photo credit: M.Pickett, Ocean Unmanned

### RESOURCE PROTECTION HIGHLIGHTS

#### Underwater Survey of Golf Balls

On March 4, MBNMS divers conducted a SCUBA survey off the south side of the Monterey peninsula to assess efficacy of current golf ball collection sites and collection data and explore the cove for any additional natural aggregation sites. Dive operations were based of the *R4107*. The team recorded only two golf balls off Pescadero Rocks. The team collected 170 balls while replicating survey initially completed in June 2017 in Stillwater Cove. The 2020 surveys increased confidence with dive search results at these sites because of the lower density of seaweed and algae cover on the seafloor in March compared to June. The dive team suggested that



A dozen discarded golf balls in a small depression in Stillwater Cove. Photo credit: MBNMS

December through February should be the optimal window for SCUBA search efforts because the benthic flora density should be at its lowest. Information and data from the dives will be used to ground-truth ball collection data reported to MBNMS by a commercial contractor. The results of the dive surveys will also improve MBNMS general understanding of golf ball movement and deposition/dispersal patterns within Stillwater Cove, as influenced by currents and tides over time.

### Salvage Attempts of a Sunken Yacht

In September and October, MBNMS Resource Protection staff used the *R4107* to observe salvage and recovery efforts of the M/V *Going Coastal*, a 92 foot motor yacht that sank in MBNMS on April 30, 2020. After locating the vessel in 400' of water, the insurance company for the vessel owner hired Curtain Maritime to raise the 92' vessel and tow it to a dry dock in San Francisco Bay. The salvage plan approved by MBNMS and the US Coast Guard, included tugboats, a barge with a large crane and an ROV, and a team of commercial SCUBA divers. The vessel was supposed to be raised in September but the salvage team aborted operations due to weather. During the second attempt in October, the video image from the ROV revealed cracks in the hull of the vessel near the chocks where they had connected the harness to the vessel. Operations were suspended until a new plan is developed.

### Motorized Personal Watercraft (MPWC) Boundaries Marker Buoys Maintenance

Throughout the year, both the *Fulmar* and *R4107* were used to inspect the MPWC buoy in Monterey Bay. On March 9, NOAA divers dove to 100 ft to inspect the mooring line of MY-3 off Pacific Grove. In July *Fulmar* redeployed SC-3 off Santa Cruz. The buoy had broken loose of its mooring earlier in the Spring. These missions directly support regulatory enforcement responsibilities and obligations of the MBNMS by maintaining buoys that mark special use areas.



A large barge served as an operations platform to crane, ROV and dive teams to attempt salvaging of a sunken yacht of the Big Sur Coast. Photo Credit: B.Hoover, MBNMS

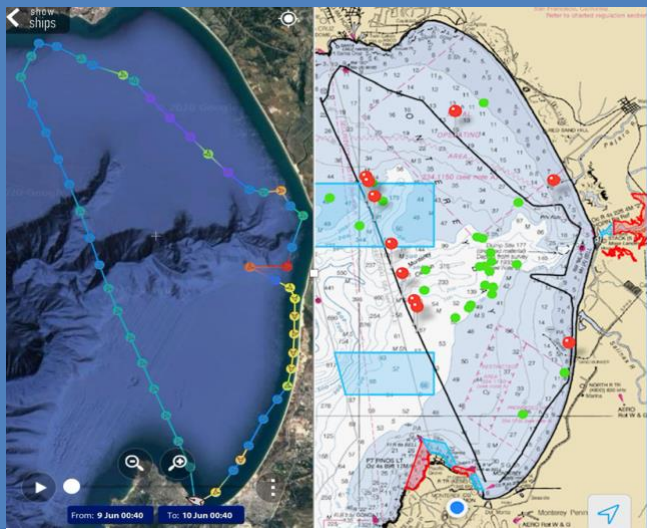


The M/V *Going Coastal* 400 ft below the surface off the coast of Big Sur. Photo credit: Curtain Maritime



A minke whale swims by NOAA divers during a buoy inspection. Photo credit: WCRO





Left - FULMAR AIS track from 9 June 2020.

Right - Ocean Alert Plot. Red dots are humpback whale and crab pot float observations recorded on 9 June 2020. Note that one dot may represent more than one individual of the same species or multiple floats. The green dots are previous whale observations conducted from other vessels. There was no overlap during the survey between float sightings that were shallow (all within 20 fathoms) and humpback whale sightings that were all off the continental shelf break.

### Whales and Crab Gear Surveys in Monterey Bay

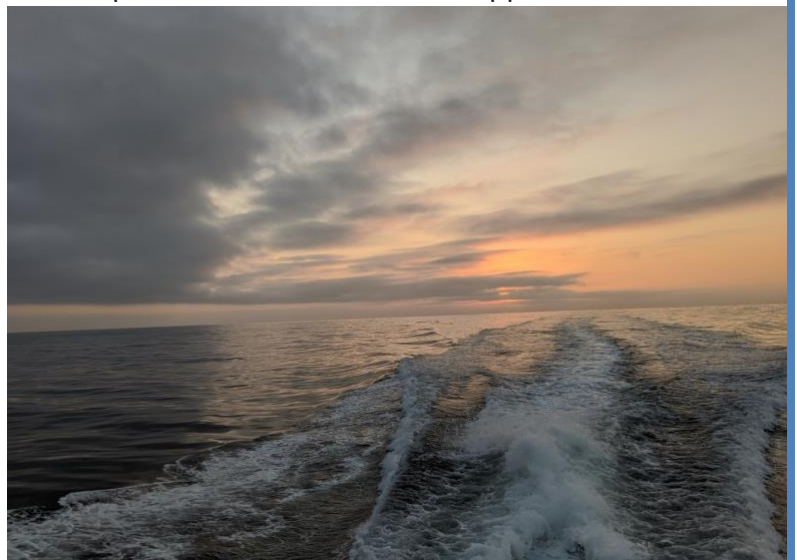
On May 7 and June 9, WCRO personnel tested the Ocean Alert App on the *Fulmar* for recording presence and absence of whales and Dungeness crab pots' floats on a pre-determined path. Over recent years Dungeness crab fishing gear has been associated with several whale entanglements. Whale entanglements are identified by the West Coast region's resource protection coordinators as a priority as the issue represents one of the major threats to large whales. During the first survey, 15 humpback whales were recorded likely feeding on fish near the Monterey Canyon head and eight trap floats were recorded in shallower water to the south. During the second survey, 10 humpback whales were recorded along the continental shelf break and four floats were recorded in shallow water closer to shore. There was no overlap between the whales and float distribution during the two surveys.

### Squid Fishing Fleet Monitoring

Between April and June, WCRO personnel and a NOAA Office of Law Enforcement officer conducted three surveys of the squid fishery fleet in Monterey, one from the *R4107* and two from the *Fulmar*. During the May survey 27 squid seiners were recorded within two nautical miles of Monterey harbor. MBNMS is interested in observing and monitoring the fleet operations to better understand their interaction with marine mammals, in particular Risso's dolphin which feed on squid and are most likely to be impacted by fishing operations. In 2018, a squid boat was observed harming dolphins and sea lions in squid nets and one of the incidents is still under investigation by NOAA enforcement. No violation or interaction with Risso's dolphins were recorded during the 2020 surveys.

### VALUABLE REGIONAL ASSETS

The *Fulmar* and *R4107* are 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 three northern and central California sanctuaries. The *Fulmar* crew has been essential to the success of ONMS mission. Investments in vessel operations enable the vessels to be ready to respond with minimal notice for a wide variety of missions. The emphasis on training, safety, customer service, and preventive maintenance contribute to making the *Fulmar* and *R4107* operation team a model among the NOAA Small Boat Program. The *Fulmar* remains an icon for sanctuary research.



*Fulmar* returning to port. Photo credit: K.Johnson, MBARI