



COMMANDER, UNITED STATES PACIFIC FLEET MARINE SPECIES MONITORING PROGRAM

Protecting the Seas through Science





U.S. PACIFIC FLEET

Since 1775, the U.S. Navy has been operating on, over, and within the world's oceans to protect and defend the United States, its interests, allies, and the global commons. The Navy's U.S. Pacific Fleet, the world's largest naval command, has maintained and secured America's presence in the vast and vital Indo-Pacific region for nearly two centuries.

Navy Sailors must be ready to respond to many different situations, in varied settings, often under crisis conditions. Sailors must be fully trained and ready to perform various responsibilities and demanding duties at a moment's notice, from large-scale conflict to maritime security to humanitarian assistance and disaster relief.



Navy Sailors have a unique relationship with the oceans. Aboard ships for many months, traveling around the globe year-round to defend freedom, Sailors experience the power and beauty of the sea every day. Sailors have a great respect for the marine environment and view it as a valuable home worth protecting.

The skills needed to achieve military readiness are challenging to master and require constant practice. Training activities must be diverse and as realistic as possible to prepare Sailors for what they will experience in real-world situations to ensure their success and survival. The Navy uses simulators to provide early skill repetition at the basic operator level and enhance teamwork, but there is no substitute for live training in a real-world environment.

To promote military readiness, the Navy must train Sailors and test new technologies. Using active sonar or explosives during military readiness activities safely prepares Sailors for successful encounters with potential hostile threats in the real world, such as enemy submarines and underwater mines. Active sonar and in-water explosives used during training or when testing systems produce sound in the water and have the potential to affect marine species.

In its role as an environmental steward, the Navy strives to minimize the impacts its activities may have on the marine environment while still achieving its mission to train, equip, and maintain capable Sailors. The Navy funds research and collects data on the presence and behavior of marine species in areas where it trains and conducts monitoring to determine whether military readiness activities are impacting species and, if so, how.

The effects of underwater sound on marine species are complex, and science is still emerging after more than a decade of research. In coordination with the National Marine Fisheries Service (NMFS), the Navy uses the most current research and the best available science to analyze the potential impacts of its activities.



Photo provided by Brenda K. Rone, taken under NMFS permit no. 15330.





FUNDING MARINE SPECIES RESEARCH AND MONITORING

Although the Navy has been funding marine species research tool development and surveys for over three decades, the Marine Species Monitoring Program began in 2006 with the goal of understanding and increasing knowledge about marine species occurrence, exposure, response, and potential consequences in relation to military readiness activities. These efforts have contributed significantly to the greater scientific community.

The Navy is a world leader in marine mammal research, investing over \$20 million in research and monitoring each year. The Navy's research has generated approximately 800 scientific publications, posters, and technical reports and has helped the Navy develop more effective measures to protect marine species.

PROTECTING THE SEAS THROUGH SCIENCE: MARINE SPECIES RESEARCH AND MONITORING

LEADING THE WORLD IN MARINE SPECIES RESEARCH AND MONITORING

The Navy continues to be a world leader in marine species research and monitoring, funding marine research programs, surveys, and data collection efforts. The Navy partners with state and federal agencies, universities, research institutions, federal laboratories, and private researchers around the world to better understand marine species. Data and reports from scientific research and monitoring help environmental regulators, scientists, the public, and the Navy to:

- Better understand the abundance, distribution, foraging, reproduction, physiology, hearing and sound production, behavior, and ecology of marine species, which are needed to assess the effects on species from naval activities
- Refine methods used to detect and monitor marine species before, during, and after training activities
- Add to the understanding of the effects of underwater sound on marine species
- Develop improved tools to model and estimate potential effects of underwater sound



Photo provided by Cascadia Research Collective, taken under NMFS permit no. 15330 issued to Dr. Robin Baird.



NAVY-WIDE MARINE SPECIES RESEARCH AND MONITORING

Navy research and monitoring programs fund the design, development, and validation of data collection techniques and tools for government, academic, and commercial use in the field to gather robust scientifically defensible data. The Navy strives to incorporate the most accurate and reliable data and information in its environmental analysis and planning documents. All researchers are encouraged to have their work peer-reviewed and published. These publications support effects modeling, environmental planning documents, and consultations.

Within the Navy, there are three programs funding marine species research and monitoring:

- **Marine Mammals and Biology Program** (Office of Naval Research, basic research)
- **Living Marine Resources Program** (Chief of Naval Operations, applied research and validation)
- **Marine Species Monitoring Program** (Navy fleets and system commands, compliance monitoring)

Navy scientists work together to integrate information and maximize research dollars by building upon complementary efforts. For example, the Marine Mammals and Biology Program focuses on basic marine species research, and the Living Marine Resources Program focuses on demonstrating and validating new data collection techniques and tools for implementation under the Marine Species Monitoring Program.

Marine Mammals and Biology Program

The Office of Naval Research's Marine Mammals and Biology Program supports basic and applied research and developing technology related to understanding the effects of sound on marine mammals. Program efforts include:

- **Monitoring and detection** — Improve monitoring capabilities by developing and advancing technology, such as passive acoustics, infrared, and environmental DNA hardware and analysis methods.
- **Effects of sound on marine life** — Better understand and characterize the behavioral, physiological, and population-level consequences of sound exposure and the cumulative effects of multiple stressors on marine mammal populations.
- **Integrated ecosystem research** — Characterize the baseline measures of marine mammal behaviors and drivers of distribution relative to environmental features and prey fields. This topic includes the development and early stage testing of technology such as tag technology, passive acoustic and infrared hardware and software, and new analytical and modeling approaches.
- **Models and databases for environmental compliance** — Provide the tools to support environmental compliance efforts and decision-making related to how marine mammals are affected by manmade sounds.

For more information on the Office of Naval Research's Marine Mammals and Biology Program, visit:

<https://www.onr.navy.mil/Science-Technology/Departments/Code-32/All-Programs/Atmosphere-Research-322/Marine-Mammals-Biology>



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Living Marine Resources Program

The Living Marine Resources program’s fundamental mission is to support the Navy’s ability to conduct uninterrupted training and testing, which preserve core Navy readiness capabilities. The program meets its mission and responsibilities by:

- **Improving the best available science** regarding potential impacts on marine species from Navy activities, which is used in at-sea environmental compliance documents;
- **Demonstrating and validating basic research** projects that are ready for applied research investment; and
- **Broadening the use of or improving the technology and methods available** to the Marine Species Monitoring Program.

For more information on the Navy Living Marine Resources program, please visit: exwc.navfac.navy.mil/lmr



Photo provided by Cascadia Research Collective, taken under NMFS permit no. 16111 issued to John Calambokidis.

Marine Species Monitoring Program

The Navy is responsible for compliance with federal environmental laws and regulations that apply to marine mammals and other marine protected species, including the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). As part of the regulatory compliance process, the Navy is also responsible for meeting specific requirements for monitoring and reporting on military readiness activities involving active sonar and in-water explosives. The following sections of this brochure contain more information about the U.S. Pacific Fleet’s Marine Species Monitoring Program, which is instrumental in complying with these laws and regulations.

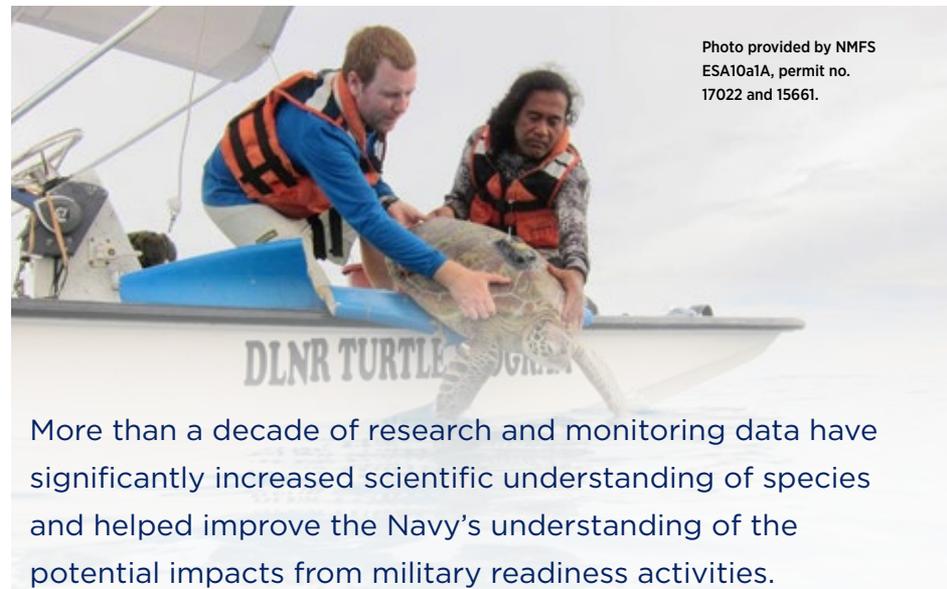


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More than a decade of research and monitoring data have significantly increased scientific understanding of species and helped improve the Navy’s understanding of the potential impacts from military readiness activities.

MARINE SPECIES MONITORING PROGRAM

The office of the Chief of Naval Operations, U.S. Pacific Fleet, and U.S. Fleet Forces Command established the Marine Species Monitoring Program to address monitoring requirements across all geographic regions and range complexes where the Navy trains and tests. The program centers on developing information on “*occurrence, exposure, response, and consequences*” as a progression of knowledge on marine species and their interaction with naval activities. Under the guidance of a Scientific Advisory Group, the Navy developed a Strategic Planning Process to establish guidelines necessary to develop, evaluate, and fund individual projects based on objective scientific study questions.

The Navy monitors marine species throughout the year, including before, during, and after select military readiness activities. The goal of the Navy’s Marine Species Monitoring Program is to improve the scientific community’s understanding of marine species’ occurrence in areas where the Navy conducts at-sea training and testing, their exposure to the activities, and the potential response of marine species when exposed to those activities. The monitoring program uses sophisticated underwater acoustic sensors, as well as more established field methods such as animal tagging, photo identification, passive acoustic technology, biopsy sampling and genetic analysis, and visual surveys. The Navy provides annual reports to NMFS with updates on monitoring goals, projects, field methods, and results. These reports are available to the public online on the Navy Marine Species Monitoring page (navymarinespeciesmonitoring.us).



The Navy partners with the National Marine Fisheries Service to adaptively manage the Marine Species Monitoring Program based on research results and program outcomes. The monitoring program has evolved and improved through the adaptive management review process as the knowledge base expands and new field methods and analysis technologies become available.



Photo provided by Roxanne Parker, taken under NMFS permit no. 14856 issued to Dr. Bruce Mate.

Marine Species Monitoring Program Notable Results

Below are some of the results from the U.S. Pacific Fleet's monitoring efforts.

Pacific Northwest and Gulf of Alaska

- Chinook salmon tagged in the Gulf of Alaska with pop-up satellite tags improved the understanding of ocean distribution and behavior of immature adult Chinook salmon.
- A genetics study of Chinook salmon captured at three northern Gulf of Alaska locations found they originated from southeast Alaska, British Columbia, Washington, and the Columbia River. A relatively small proportion of these fish included ESA-listed Chinook originating from the Columbia River.
- Navy funded genetic studies of fish potentially overlapping with the Navy's training and testing ranges. Studies were conducted by NMFS and the University of Alaska-Fairbanks and improved understanding of the relative proportion of ESA-listed populations compared to non-listed populations.
- Monitoring efforts for Southern Resident killer whales assisted NMFS with designation of critical habitat.
- Navy provided funding support for a Southern Resident killer whale scat survey to identify priority prey species and key populations of Chinook salmon.
- Acoustic receiver array on the Washington coast addressed the seasonal occurrence, distribution and habitat use of ESA-listed salmonids (particularly those considered primary food sources for the Southern Resident killer whale) within a Navy range. Receiver detections of acoustically tagged salmonids yielded a vast amount of data detailing specific population differences on coastal migration routes and timing.

- Acoustically tagged and tracked green sturgeon provided information about movement patterns, depth, and habitat use, allowing the Navy to identify ways to reduce the overlap with Navy ranges and adverse effects.
- Navy funded NMFS to conduct a review of Puget Sound and Strait of Juan de Fuca acoustic-receiver data collected from 2002 to 2019, which allowed for a thorough update of green sturgeon occurrence. Findings indicate there is little or no overlap of ESA-listed populations within Puget Sound Navy installations, and limited distribution within inland Washington waters.
- Surveys of Puget Sound produced density estimates for marine mammals, including the first harbor seal density estimates.
- Navy-funded sea lion tagging provided information on movement and predation, residence times at Navy installations, and differences in the dive profiles and prey base between inland waters and the outer coast of Washington.

Southern California

- Long-term acoustic studies of marine mammals and anthropogenic sounds provided presence/absence information and temporal patterns of occurrence and activity.
- Unique population studies over 15 years for Cuvier's beaked whales, a noise-sensitive species, documented a steady population occurring on a highly used Navy range.
- Blue, humpback, and fin whale tagging and photo identification found individual whales spend little time in Navy training areas and Biologically Important Areas.
- Surveys and tagging of ESA-listed Guadalupe fur seals resulted in updated population counts. Findings indicate they do not spend a large amount of time in Navy ranges, therefore minimizing impacts.

Hawaiian Islands

- Satellite tags deployed on toothed whales in Hawaii, along with photo identification, provided information about population structure, habitat use, and movement. These techniques were also used to examine effects of Navy activities, finding that some whales changed behavior.
- Minke whales found to be the most common baleen whale and Blainville's beaked whales found to be the most common beaked whale detected acoustically at the Pacific Missile Range Facility (Kauai). Important behavioral changes were observed when in proximity to active sonar.
- Cross Seamount beaked whales were detected acoustically, with foraging dives occurring only at night and dives increasing during new moon phases. Although yet to be quantified, foraging dives are reduced during multi-day Navy training activities.
- Fin whales tracked by hydrophones determined whales produce multiple song patterns in one area each season, possibly by the same population, and individuals may change their song pattern mid-song.
- The change in amplitude or frequency of a vocalization in areas with higher background noise were measured for humpback and minke whales, leading to findings of changes in vocal behavior during high-noise periods related to natural phenomenon, e.g., storms, and during Navy training.
- Data from humpback whales with satellite tags found movements and dive behaviors were different when animals were nearshore versus offshore in deep water. Humpback whales spent little time on the Navy range, therefore the likelihood of exposures to high levels of sonar is low.

Mariana Islands

- Over 100 tags were deployed on hawksbill and green sea turtles in the Mariana Islands, indicating most individuals did not transit through Navy underwater detonation training areas, thereby reducing potential risk of impacts. Results include mapping migrations, calculating home ranges, and evaluating dive parameters (i.e., time at depth, maximum dive depth, time at temperature, and dive duration).
- Humpback whale surveys in the Mariana Archipelago determined they belong in the Endangered Western North Pacific Distinct Population Segment. Therefore, the Navy agreed during ESA consultation to limit training in some areas used for reproductive behavior to reduce impacts on this endangered population.

Multiple Locations

- A Pacific basin-wide multi-year study of humpback whales migrating between Hawaii, Alaska, Washington, Oregon, and California used a variety of survey techniques including satellite tags, biopsy, photo identification, and historical telemetry analysis to comprehensively summarize migratory movements, population structure, and habitat use.
- The *Pacific Marine Assessment Program for Protected Species* conducts surveys of marine mammals to provide data for density modeling. Additionally, two new individuals of the critically endangered North Pacific right whale population were identified in Alaska.
- Long-term acoustic monitoring on Navy hydrophone ranges in Hawaii and Southern California detected and tracked certain marine mammal species, resulting in information on relative abundance over time and changes in vocal behavior.
- Unmanned ocean gliders with acoustic recorders deployed at remote locations provided information on species present in remote and difficult to study habitats.



MARINE SPECIES MONITORING PROGRAM COMPONENTS

STEP 1: COLLECTING THE DATA

The Navy's monitoring program uses a combination of techniques designed to maximize detecting and observing marine animals that provide information to address scientific monitoring objectives. These methods include:

- **Animal tagging**
 - ▶ Acoustic telemetry
 - ▶ Satellite telemetry
 - ▶ Diving and other behavioral data
- **Biopsy sampling and genetic analysis**
- **Historical analysis**
- **Passive acoustic technology/monitoring**
 - ▶ Towed arrays, long-term devices moored to the bottom, autonomous gliders, or instrumented Navy hydrophone ranges
- ▶ Sound analysis using sophisticated computational techniques
- **Photo identification**
- **Visual surveys**
 - ▶ Non-systematic line-transect surveys for species occurrence and density

Animal Tagging

The Navy works with independent scientists using advanced tagging methods, such as satellite tags, acoustic tags, and dive-behavior tags, to observe and track marine species. Deploying tags on animals has helped lead to a deeper scientific understanding of marine species dive behavior, how they move and disperse through areas where naval activities occur, and if they respond to those activities.

Biopsy Sampling and Genetic Analysis

Biopsy samples collected during boat-based visual surveys and tagging efforts and subsequent genetic analysis studies may help in verifying species identification, determining stock origin, confirming sex of biopsied animals, and assisting to explore or answer questions of population structure. These studies also help interpret the results of tagging and photo identification.

Historical Analysis

The Navy analyzes a variety of archived data to gain additional insight. For example, passive acoustic recordings may be analyzed for different species, or reanalyzed with new methods, to examine different behavioral aspects. Long term passive acoustic monitoring allows scientists to look for changes in calling behavior or habitat use over time. An analysis of archived samples from stranded animals allows scientists to screen for newly discovered diseases to determine if it was present or prevalent earlier.



Photo provided by Julie Rivers, taken under NMFS permit no. 731-1774 issued to Dr. Robin Baird.

Passive Acoustic Technology/Monitoring

The Navy has been collecting and analyzing passive acoustic monitoring data for almost two decades throughout Navy ranges. These data provide information on marine species' presence and seasonal occurrence as well as information for assessing animal responses to military readiness activities. The Navy collects passive acoustic data using various technologies, including Navy-instrumented hydrophone ranges, towed arrays, bottom-mounted recording packages, and autonomous gliders.

For example, offshore of the Navy's Pacific Missile Range Facility on Kauai and at the Southern California Anti-Submarine Warfare Range, instrumented hydrophone ranges installed on the seafloor for use during military readiness activities are used to detect and record underwater sound. Since 2002, these high-tech systems have allowed researchers to record marine mammal calls and Navy sound sources to gain a better understanding of the potential behavioral effects of Navy sonar on marine mammals. This unprecedented capability provides a long-term archived data set and analysis that would otherwise be nearly impossible.

Photo Identification

Photo identification allows for the assessment of migration, residency, social structure, and abundance through matching photos to long-term photo identification catalogs.

Visual Surveys

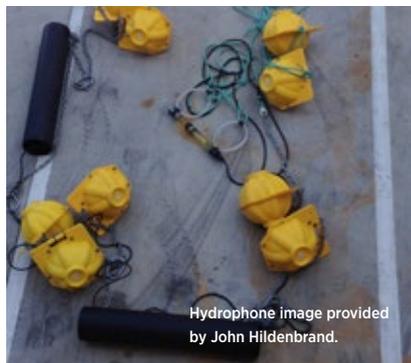
Focal behavioral observations. From 2007 to 2014, the Navy used visual surveys from airplanes to observe and detect marine species before, during, or after certain military readiness activities. During these training events, personnel in aircraft engaged in a "focal follow," gathering video and behavioral observations of marine mammals, which allowed robust behavior-by-behavior observations to ascertain responses to ships or training events. While aerial surveys are no longer occurring, the archived data sets, in combination with the data collected from ships and the instrumented ranges, validated species' locations, movements, and behavior.

Marine mammal observers. From 2010 to 2019, trained marine mammal observers rode aboard Navy ships to assess Navy Lookout team capability for marine mammal and sea turtle observations during training events.

Post-activity monitoring. On varying days after a training event, coastal areas and shorelines were surveyed from the air to search for any animals that may have stranded or were under duress. In more than 10 years of conducting these surveys, the Navy did not detect any strandings of marine mammals after Navy training events.

Line-transect surveys. Surveys conducted by vessel or airplane in structured line-transect surveys provide data to inform species occurrence and density.

Non-systematic surveys. Surveys are conducted by boat to locate animals for photo identification, tagging, and biopsy.



Hydrophone image provided by John Hildenbrand.

“We use the same hydrophones that the Navy uses for training to conduct our marine mammal research. This research is conducted under the Navy’s Marine Species Monitoring Program with the intent of understanding when animals are present in the area, how they use the area, and if they are impacted by any of the Navy’s activities.” — Elizabeth Henderson, bioacoustic scientist, Marine Mammal Program, Space and Naval Warfare Systems Command

SHARING INFORMATION

The Navy strives to maintain transparency and shares marine species data and monitoring reports with scientists, regulatory agencies, and the public. The Marine Species Monitoring Program website (navymarinespeciesmonitoring.us) serves as an online public portal for information on the background, history, and progress of the program, as well as provides access to peer-reviewed publications, reports, documentation, data, and updates on current monitoring projects. Annual monitoring and activity reports provided to NMFS are made available on this website after the Service's review. Data are also available in the Ocean Biodiversity Information System where the public can search for marine research data (seamap.env.duke.edu) and the Animal Telemetry Network (atn.ioos.us).

When visiting the Navy's Marine Species Monitoring Program website, the public may explore:

- **Projects:** Learn about the active marine species monitoring projects in both the Pacific and Atlantic regions.
- **Reporting:** Read annual reports and supporting technical reports about the ongoing work occurring within varying training regions.
- **Data Access:** Explore interactive maps that provide detailed marine species data from visual surveys, acoustic surveys, and data received from tagging.
- **Reading Room:** Review reports, presentations, and peer-reviewed publications related to marine species monitoring program surveys and research.
- **News:** Stay current on the latest peer-reviewed publications and announcements available as they relate to marine species monitoring and science.
- **Blog:** View summaries of marine mammal surveys and research efforts, complete with photos.
- **Media:** Discover a library of videos and images highlighting efforts in environmental stewardship and monitoring.



STEP 2: ANALYZING AND UNDERSTANDING THE DATA

The Navy works with well-respected universities, research institutions, and federal science laboratories to analyze and understand the data collected. Through partnerships and collaboration, the body of scientific knowledge and understanding of marine species has significantly grown.

Monitoring Trends

The Navy has analyzed more than 15 years of marine mammal acoustic data from the Pacific Missile Range Facility and continues to add to the analysis each year. Data analyzed so far provide several indicators that military readiness activities are unlikely to have long-term consequences on marine mammal populations. In addition, the data is allowing scientists to document behavioral responses to natural phenomenon such as weather events and predators, increasing understanding of baseline behavior. Some species have displayed short-term behavioral responses following certain Navy activities. However, the indicators below demonstrate that current protective measures are successful.

- Increases in the number of certain marine species present in areas where military readiness activities occur
- Continued presence of species and long-term residence by individual animals in high-use areas, including species thought to be sensitive to sound
- Lack of observable negative effects on marine mammal stocks or populations over more than 15 years of comprehensive monitoring and data collection

STEP 3: APPLYING THE DATA

Navy research and monitoring efforts have contributed significantly to the overall body of scientific knowledge on marine mammals, sea turtles, fishes, seabirds, and coral, both globally and locally. More than a decade of Navy-funded research, surveys, and data collection efforts have led to a deeper understanding of the distribution, abundance, exposure, and response of marine species to military training activities. This research enables the Navy to use the best available data and scientific methods when analyzing the environmental impacts of sonar, explosives, and other stressors for use in environmental compliance documents and consultations.

Adaptive management is applied throughout the duration of the monitoring program. In some cases, adaptive management has been used to refocus projects and improve results. For example, early monitoring efforts in Hawaii were spread throughout the archipelago, but were not providing robust data on exposure and response. The Navy therefore refocused data collection efforts to occur before, during, and after a mid-sized training event on the Pacific Missile Range Facility. This enabled the Navy to layer several complementary field methods towards answering more complex questions. The resulting research data help prioritize future monitoring efforts pursuant to ESA and MMPA.



PROTECTING MARINE SPECIES WHILE MAINTAINING MILITARY READINESS

Active sonar and in-water explosives produce sound in the water and have the potential to affect marine species. In consultation with NMFS, the Navy develops protective measures for use during certain military readiness activities at sea, some of which include:

- Posting qualified Lookouts to visually observe the area for federally protected marine species prior to and during activities
- Establishing mitigation zones for marine species and sensitive habitats, such as seafloor resources
- Powering down or shutting down active sonar if marine mammals are observed within the mitigation zone
- Restricting some activities under certain conditions
- Navigating safely while transiting to avoid collisions with marine mammals and sea turtles
- Monitoring marine species and sharing scientific knowledge
- Coordinating with NMFS on strandings, including reporting ship strikes or other incidents

Stranding Response Plans

In the past, there have been incidents around the world of marine mammal strandings (when a whale or dolphin washed ashore is unable to return to its natural habitat). Strandings can be traced as far back as ancient Greece; however, exactly why animals strand is still uncertain. Scientists have identified potential contributing factors for strandings including age, illness or disease, ingestion of marine debris/plastics, contaminant load, and manmade sources. The Navy has funded stranding investigations by the University of Hawaii Health and Stranding Lab to better understand the reasons why marine mammals strand in the Pacific Islands. Results of those studies can be found on the monitoring website.

Through MMPA and ESA permitting processes, the Navy updates marine mammal Stranding Response Plans in coordination with NMFS, as needed. The Stranding Response Plans specify the Navy's requirements for reporting marine mammal strandings and assisting with post-stranding data collection.

Protective Measures Assessment Protocol

The Protective Measures Assessment Protocol (PMAP) is a software tool that the Navy uses prior to conducting military readiness activities. Based on the location, date, and type of activity being conducted, PMAP generates a report of the specific mitigation measures that naval units must implement to protect marine resources and to ensure compliance with mitigation requirements.

The Navy uses the most current and best available science for acoustic modeling to improve the analysis of potential environmental impacts from military readiness activities.



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PROTECTING THE SEAS THROUGH SCIENCE

Balancing national defense requirements and environmental stewardship responsibilities is an important goal for the Navy, and critical to its long-term maritime strategy. As testament to its commitment to protecting marine species, the Navy continues to be a leading contributor to the advancement of technology and scientific knowledge related to marine species protection and the effects of manmade sound.

FOR MORE INFORMATION:

- U.S. Navy Marine Species Monitoring Program
navymarinespeciesmonitoring.us
- Commander, U.S. Pacific Fleet
www.cpf.navy.mil
- Office of Naval Research Marine Mammals and Biology Program
<https://www.onr.navy.mil/Science-Technology/Departments/Code-32/all-programs/marine-mammals-biology>
- U.S. Navy Living Marine Resources Program
exwc.navfac.navy.mil/lmr
- Commander, U.S. Pacific Fleet Facebook Page
www.facebook.com/USPacificFleet
- U.S. Navy Stewards of the Sea
www.usff.navy.mil/environmental/
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